FLORA
OF INDIA
SERIES-3

Flora of Chamoli

Volume 1

B.D. NAITHANI

BOTANICAL SURVEY OF INDIA

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Series 3

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BOTANICAL SURVEY OF INDIA

Department of Environment

© Government of India, September, 1984

Price

Published by the Director, Botanical Survey of India
Howrah-711103 and printed at Raje Printers,
3/25, Ramesh Nagar, New Delhi-110015

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FOREWORD

The Botanical Survey of India has started publishing the new flora of India under four series.

Series 1 is the national flora of India, which is being brought out in the form of fascicles dealing with various families, tribes or large genera for the whole country. Sixteen fascicles have been already brought out. The work is being intensified and many manuscripts are in press and under editing or preparation.

Series 2 deals with the inventory of plants of different states or large regions. The states of Karnataka, Himachal Pradesh and Tamilnadu were taken up in first phase, and the former two have been completed.

Series 3 deals with detailed floras of districts or such smaller regions. Four such floras have been published.

Series 4 has special publications, monographs on cryptogams, or such works which can not be covered under 1-3.

The flora of Chamoli in series 3 is being published in two volumes. The district of Chamoli is situated in north-western part of Uttar Pradesh in northern India.

The floristic elements from the neighbouring or sometimes distan regions such as of Europe, Siberia, Malaya, Africa, Australia, China Japan and America are also met in the district.

The work of Shri Naithani will provide interested visitors, to the Himalayas a manual for identifying the trees, shrubs and herbs which they will meet during their trails in the region, including the famous spots of Valley of flowers, Kedarnath, Badrinath, Nandadevi, etc.

The Botanical Survey has intensified its work on the district floras and in addition to the scientists of the Survey, a number of botanists in educational institutions of the country have been involved.

It is hoped that a number of district floras will appear during the current year and the coming years. They should be useful to teachers and students of botany, officials of the forest and agriculture departments and also for persons concerned with utilization and conservation of plant resources.

Shri Naithani will welcome useful suggestions on this flora and will try to incorporate in future editions.

Botanical Survey of India,
Howrah—3
15-5-84

S. K. Jain

PREFACE

Apart from the religious significance, the district Chamoli of Garhwal Himalaya is famous for its high snowclad mountain peaks and enchanting verdant valleys. The rich and varied flora has been of great attraction for the professional collectors as well as amateur enthusiasts. The impetus for plant collection increased with the visit of Thomas Hardwick on a political mission to the ruler of Garhwal in Srinagar along the Alaknanda valley in 1796. Since then the practice of collecting plants from this area has been continuing and a large collection of plants were made by several visitors in whatever capacities they travelled in the district. The most comprehensive collections from the area however, have been those of two European Surveyors, Strachey and Winterbottom which were made between 1846-1849 within the province of Kumaon and adjoining portions of Garhwal and Tibet.

Duthie among one of the pioneer collectors in the area finally incorporated the results of all subsequent visitors to the form of a catalogue and published it in 1906 and provided a good source of information about plants of the area. Since then, the knowledge about the plant wealth of the district has been increased and accounts are found scattered in several published works. To overcome this difficulty it is proposed to incorporate all such informations about the plants of the area and to produce a book which shall supply more materials to the visitors in the district interested in botany and acquainted with the rudiment of that science. This will also help indentifying the trees, shrubs and herbs they see while on travels along the routes in the neighbouring valleys or on excursions to Valley of Flowers, Badrinath, Kedarnath, Tungnath, Niti, Mana; Nandadevi and so many other important places in the district.

It has also been endeavoured to incorporate the requisite informations about the district pertaining to its topography, history, ecology and soil, climate, rainfall and vegetation, etc. available in authentic records and on own and several observations by other workers during expeditions and botanical tours in the district.

Efforts have been made to incorporate all the species preserved in the BSD herbarium as well as those recorded in published works. Apart from this, accounts on floristic, phytogeographic analysis and general statistics are provided in this flora.

The occurrence of large number of species in the area and richness of the flora has rendered the district a botanical paradise. After the ana-

lysis of the flora, the total number of flowering plants recorded in the present work is 2022, including 88 cultigens. These are distributed over 892 genera belonging to 163 families. Among 1921 species of angiosperms 1513 are dicots with over 73 cultigens and remaining 408 constitute monocots with 15 cultigens. The species of dicots are distributed in 690 genera belonging to 135 families ; 408 monocots are distributed under 194 genera belonging to 24 families.

In view of large number of species included in the flora, it is proposed to produce the whole text in two volumes. The first volume contains introduction and a part of systematics dealing with about 967 species belonging to families Ranunculaceae to Asteraceae while the second volume will include 1055 species under families Campanulaceae to Pinaceae including cultigens.

I express my deep gratitude to Dr. S. K. Jain, Director, Botanical Survey of India, Dr. M. A. Rau and Dr. A. S. Rao, former Deputy Directors, Northern Circle, Botanical Survey of India for their valuable suggestions and encouragements during the preparation of this book. I am very grateful to Dr. U. C. Bhattacharya, Dr. R. R. Rao, Deputy Directors for guidance and suggestion and kindly going through the Introductory portion of the manuscript. Thanks are also due to the authorities of the Forest Research Institute and Colleges for according permission to consult the library and the herbarium.

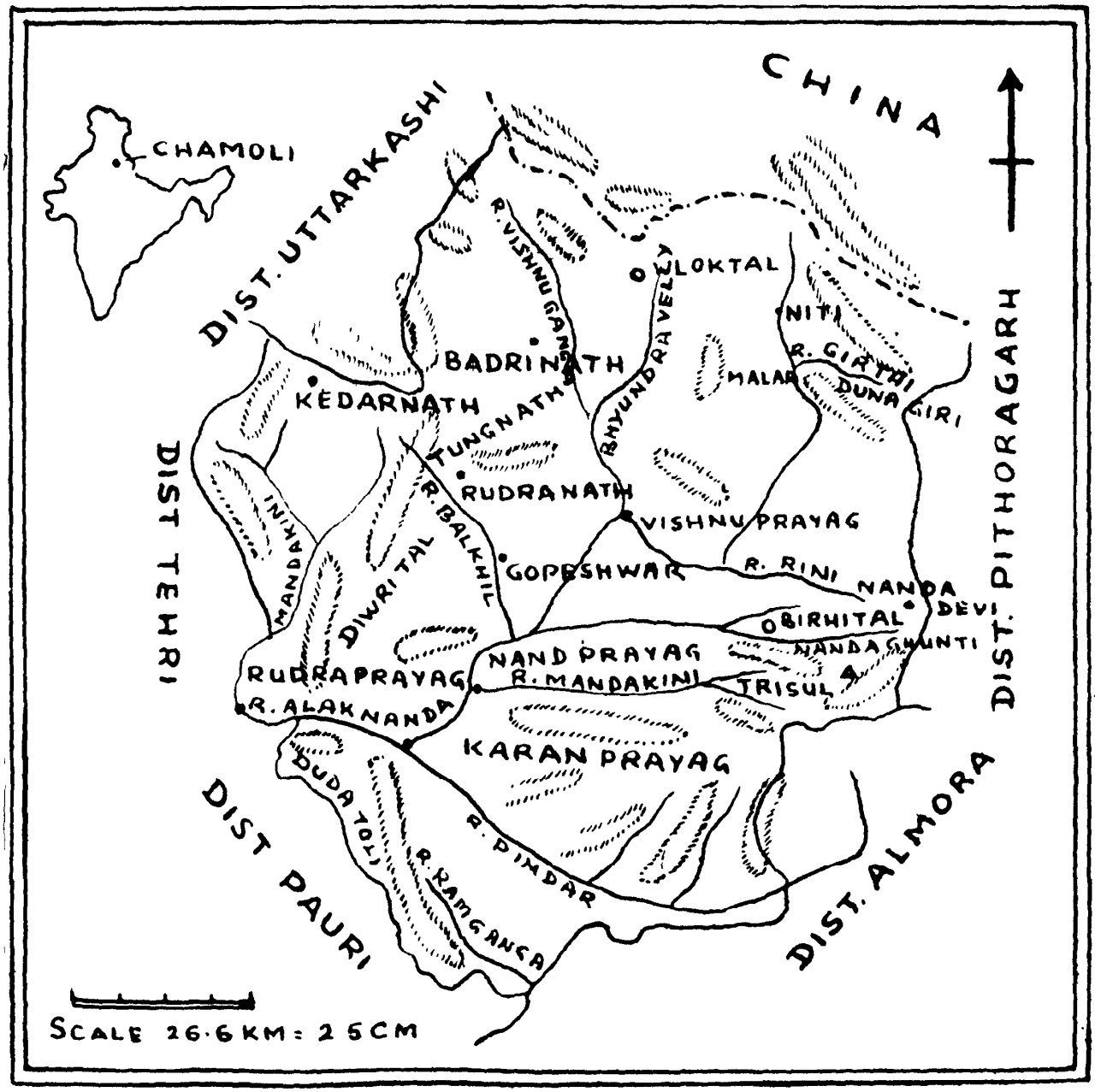
In spite of all possible care and attention, there is always a possibility of creeping ommissions, errors and discrepancies. It will be greatly appreciated if the users of this flora very kindly bring such instances to the notice of the author.

Botanical Survey of India
Northern Circle

Dated : August, 1984.

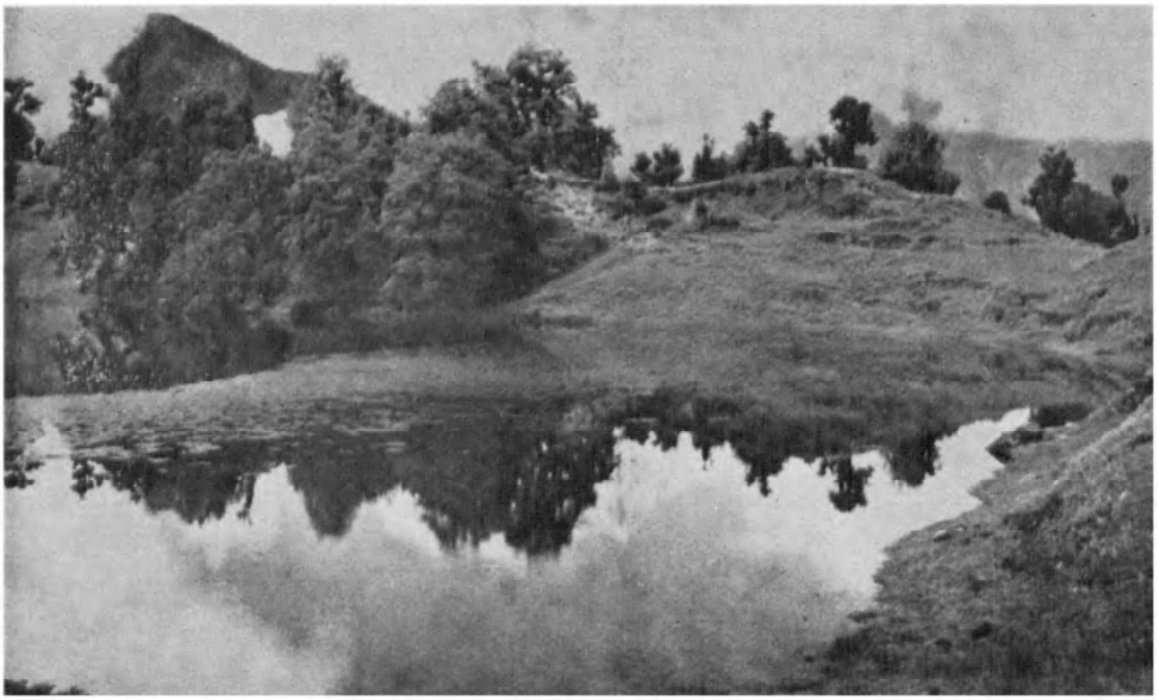
B. D. NAITHANI

CHAMOLI DISTRICT

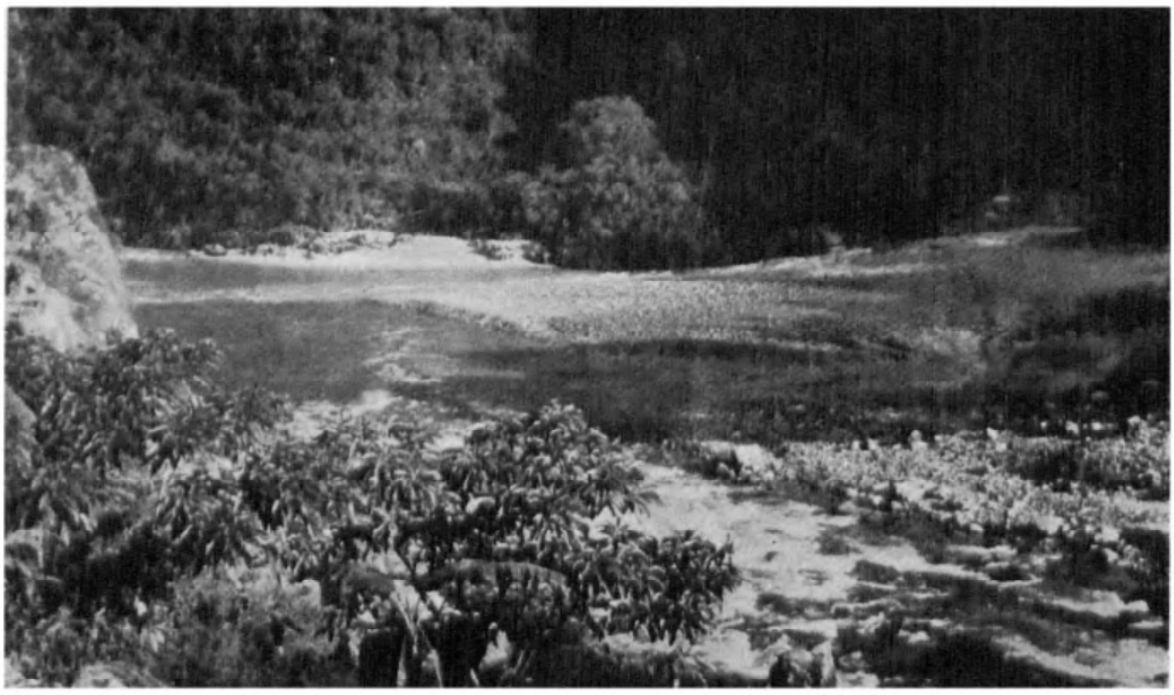


Morus serrata (The Sacred Mulberry Tree) - Joshimath

Saussurea simsoniana Garhwal, Lake Hemkund



Lake Dewariya Garhwal - Ukhimath

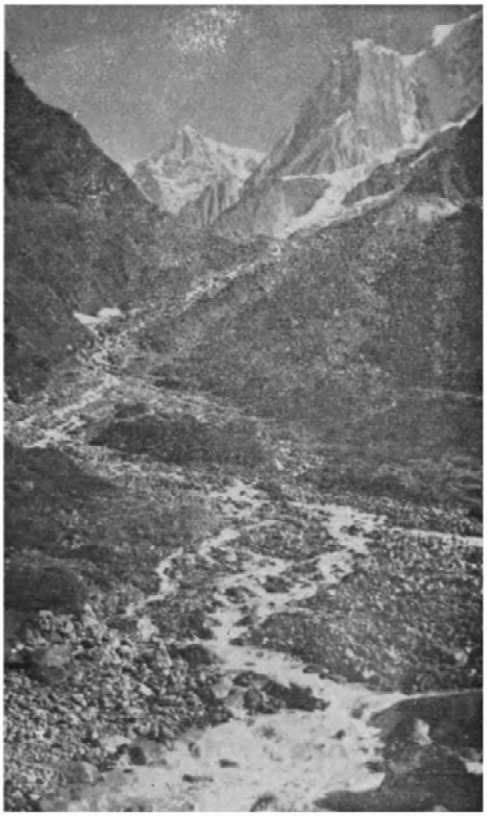


Confluence of Pinder & Alaknanda Rivers at Karanprayag - Garhwal Chamoli

Hill Slopes With **Nardostachya** On Rocks - Garhwal

Oak - Forest (*Quercus dilatata*) Near Gurikund - Kedarnath

Calanthe tricarinata - Garhwal - Ramni



Moraine at Mandakini River Kedarnath

Lichen On A Birch Stem. Garhwal - On Way To Hemkund

Alkapuri Moraine Garhwal Vasudhara

INTRODUCTION

Uttar Pradesh, one of the largest States of the Indian Union occupies an area of about 29.443 km^2. It forms the major bulk of the Gangetic Plains and the famous Kumaon and Garhwal sectors with magnificent snow-capped mountains of the Himalaya, make the north-western part of the State, where the district Chamoli is located. The Garhwal Himalaya is having some of the noblest and most beautiful mountain peaks of the world like Nilkantha, Kamet, Nandadevi etc. The sector of the Himalaya lying between 30^0-31^0 N and 79^0-80^0 E forms Chamoli district of Garhwal Division and occupies an area of about 7098 km^2. It is bounded and butted towards north by Tibet, east by Pithoragarh and Almora, South by Pauri and West by Uttarkashi and Tehri districts. The famous Dudatoli range demarcates the district towards south from Pauri district (MAP). Alaknanda with its tributaries is the principal river which contributes bulk of the perennial water to the Ganges.

The mighty Himalayan sector which cover Chamoli district has been of great interest to the people of various professions. The whole district is spotted with many centres of great religious significance and streams of pilgrims pay visit to the holy shrines of Badrinath and Kedarnath every year during summer and after monsoon. There are also a number of landmarks of great importance from the point of their scenic grandeur.

Amongst them the famous 'Valley of Flowers' and the Nanda Devi National Park have great attraction. Some beautiful natural lakes like Vasukital, Deurital, Devtal, Loktal and Roop Kund etc. are famous for tourism. Gopeswar is the Headquarter of the district on the bank of Alaknanda.

The history of botany of this region dates back from 1796 when T. Hardwick entered the Alaknada Valley on a political mission. However, the major interest on the plant collection started with Strachey and Winter-bottom, the two surveyors who passed through these hills to Tibet in 1844-49. These two surveyors have made best collections in the Himalayan region of the State as well as in Tibet and adjoining parts of Garhwal. Since then frequent visits where made by others and resulted in publication of the important Catalogue of Duthie in 1906. This valuable publication also influenced other workers to write accounts of the plant wealth of other regions of the State. Amongst the important works on the botany of this region, the Forest Flora of Kumaon (Osmoston, 1922) and the Flora of Upper Gangetic Plains (Duthie, 1921-39) are significant, several others also

did work on the botany of other parts of the State like Forest Flora of Pilibhit, Oudh, Gorakhpur and Bundelkhand (Kanjilal, 1933), Flora of Upper Gangetic plains and Adjacent Siwaliks and sub-Himalayan Tract Check list (Rau, 1969), Flora Gorakhpurensis (Srivastava, 1976), Flora Nainitalensis (Gupta, 1968), Herbaceous Flore of Dehra Dun (Babu, 1977) and High Altitude Flowering plants of West Himalaya (Rau, 1975), etc.

With the present day urge for gathering knowledge about our wildlife, the urgency for assessing botanical information at microlevel has received special attention. Moreover, the plant life is threatened with extinction either due to their over exploitation or due to destruction for developmental activities.

Keeping this in view, an account of flowering plants of Chamoli district is presented here and is based on extensive field surveys and studies of herbarium material during 1976-83.

MATERIAL AND METHODS

Routine procedures were followed for collecting and preserving the specimens in the Herbarium (Jain & Rao, 1976).

All the specimens were compared with the earlier authentic specimens, preserved in the herbaria (DD, BSD) and carefully studied and identified with the available standard floras and monographs.

Efforts have been made to bring the nomenclature uptodate in accordance with International Code of Botanical Nomenclature 1978.

TOPOGRAPHY AND GENERAL FEATURES

Chamoli contains inner Himalayan massive mountains in its major part associated with a number of rivers and mountain torrents. Some of the highest peaks in India namely Nanda Devi, Kamet along with a number of other well-known peaks of more than 6000 metres like Trisul, Dunagiri, Mana, Badrinath, Kedarnath and Nilkanta are also famous peaks of this district. Rivers like Alakanda, Mandakini, Nandakini, Dhauli, Pinder and Bhyundar originating far in the glacial beds and down to their south and eastward courses are joined by a number of tributaries to form a major source of drainage. The run of water from all these valleys ultimately confluences with a southerly course with Alaknanda and join the long drainage of the Bhagirathi at Davaprayag whenceforth it is called the Ganga. The forests of varied composition flourish in the valleys

up to an altitude of 3000—3500 metres, above which extensive meadows occur in places, which are covered in summer and autumn months by profusion of flowers of alpine and alpine species.

GEOLOGY AND SOILS

1. **Geology** : As per the records of the Geological Survey of India only a part of the area has been studied in detail, the rest is yet to be surveyed. On the basis of the latest information the various rock formations have been classified into four kinds viz. (i) the Central crystalline, (ii) the Dudatoli (Almora crystalline) (iii) the Baijnath crystalline, (iv) the Garhwal group with instrusive granite and dolomite (or metadolorite). In general, geological composition of the area is of tertiary origin along with older sedimentary and granite rocks. The tertiary fresh water deposits are 1-40 million years old, containing mammalion fossils. The mountain ranges are composed of highly folded marine sedimentary rocks and metamorphosed granite. The Central crystallines are generally found exposed in high altitudinal areas of the district. Terraces along the river valleys generally consist of sandy alluvium bouldered beds and sand as well as plains or slopes have developed on different levels on either banks of Alaknanda, Pindar, Mandakini and Nandakini, etc.

2. **Soil** : The composition of soil in the district varies from place to place and is directly related with the factors prevalent in the particular locality such as in damp evergreen forests, the litters play an important role in generation and conservation of soil caps. The rock type also plays an important role on the quality of soil. For example, gneiss schist and granite yielding high sandy and micaceous soil may be very rich with considerable depth and is excellent for the tree growth under favourable conditions. The type and structure of the rock is also responsible for the quantum growth of the plant in many localities. The soil texture ranges from sandy loam to clayey loam.

CLIMATE

The mountanous tracts of the whole district have varying altitude and relief which contribute to a great extent for the variations of the climatic conditions. Owing to orientation or steepness of slopes, there are marked local effects due to differences in the insolation. Deep river valleys are generally dry but when wind blows through valleys, rainfall is greater. The flow of wind in the upper reaches and slopes have a considerable local influence on the temperature and plays an important role in the distribu-

tion of the vegetation. Winters are very severe at higher elevations and snow-fall occurs even down to 1500 m. Severe frost is observed from December to February. In may and June lower valleys are very hot up to the onset of monsoon, except the higher reaches where it is considerably cool in the hottest period. The most pleasant climate is witnessed during October to November.

Temperature : The lower valleys of Alaknanda, Pindar, Nandakini, Mandakini and Birhi have typical north Indian sub-tropical climate with a hot and more or less dry season from April to June. The rainy season extends from July to September. The temperature in summer reaches maximum up to 45°C in valleys bellow 1600 m and on ridge around 1600m it is up to 35°C and those at 2000 m is ± 30—32°C. The mean temperature in winter at 3000 m is around 0°C.

Rainfall : The rainfall in the district varies during summer and winter between 1500 mm 2000 mm and 500 mm 750 mm. respectively. But it is considerably regulated over the division due to variation in altitude and aspects. In the axtreme north however, the precipitation rapidly decreases and practically ceases beyond the first snow range. Monsoon though uncertain generally breaks in June. July and August are the wettest months receiving upto 90% of total precipitation, November is the driest month. Winter rains, though erratic, seldom fail altogether. During April-May thunder storms are often accompanied by hailstorms which are fairly frequent. As the monsoon advances in the region of Joshimath, it is considerably reduced in Dhauli valley. consequently Niti and Mana regions receive very low percentage of precipitation and almost remain dry and dusty.

PREVIOUS WORK AND PRESENT STUDY

European botanists, army officers, surveyors and surgeons were the pioneers to botanise in the Indian sub-continent including the North-western Himalaya. Botanical history since 1840 includes the visit of T. Hardwick (1796), the first european who collected plants in this division of Kumaon Himalaya including Alaknanda valley. During the early years of nineteenth century Willium Moorcroft crossed over Niti Pass, reached Mansarover and brought a large bulk of collection of plants from the places as far as in the interior of the Himalaya. The restoration of the botanical Garden by Hastings (1820) in Saharanpur further accelerated the impetus of botanical explorations in the Garhwal region.

The most comprehensive collections from the area, however, have been those of two European surveyors, Strachey and Winter-bottom, who made collections during 1846-49 within the province of Kumaon and

adjoining portions of Garhwal and Tibet. The original herbarium of Strachey and Winterbottom included nearly 2000 species and distributed in sets to various museums in 1852-53 along with catalogue mentioned earlier. The original catalogue was first published by Duthie in 1882 and revised in 1906 incorporating the results of subsequent explores in the area from time to time. Among them the notable collectors are Wallich, Royle, Falconer, Blinkworth, T. Thomson and Duthie himself.

Apart from these botanists, O. E Osmaston alro extensively surveyed the Kumaon including the adjoining portions of Garhwal and made a valuable contribution on the ecology of North Garhwal (1922), and also made an excellent account of the flora of this region by writing the Forest Flora of Kumaon 1927. Holdsworth and Smythe who were members of the British Kamet Expedition in 1931, on their return journey also collected plants in the Bhyundar valley and included the list of plants in their work "Kamet Conquered" (1932). Smythe again visited the valley in 1937 and collected more than 250 species and included all plants in his delightful book "Valley of Flowers".

Ghildiyal (1957) made two visits to various parts of Garhwal including the Valley of Flowers and listed 289 species. Since the inception of Northern Circle, Botanical Survey of India, most significant collections of plants in the district have been made by M. A. Rau (1957-1959) and listed approximately 738 species of flowering plants and ferns from North Garhwal. Subsequent botanists from the BSI like U. C. Bhattacharyya, N. C. Nair, B. D. Naithani, B. M. Wadhwa, G. Panigrahi, P. K. Hajra, D. Basu and others also collected large number of plants from remote areas of district and enriched the herbarium and published their valuable information pertaining to the plant wealth of the district. Recently workers from the Garhwal University have also engaged in explorations and have made some contributions to the botany of the district.

The present flora is based on the works of the past more than one hundred fifty years of explorations of the selected valleys, followed by five years of general survey and study of the specimens and literatures.

GENERAL ASPECTS OF VEGETATION

Zonation of vegetation from sub-tropical areas to alpine heights is the characteristic feature of the district. This varies due to different physiognomic conditions and altitudinal range associated with various climatic and biotic factors, Winter follows the defoliation of most of the trees and as the days warm up in spring, new foliage appear and is followed by flowering and fruiting. The alpine zones of the district are

ablazed with a variety of colourful flowers and onset of the monsoon spells a greenery throughout the district. The ephimeral vegetation generally comprised of annuals and biennials is markedly affected by the seasonal changes. In the following pages, forest biodata are discussed in details. Vegetation pertaining to waste-lands, grass-lands, weeds and allies, aquatic and marshland habitats and exotic flora are discussed in brief.

Forests :

Chamoli district abounds in forests and meadows with their characteristic plant composition. For the sake of administrative convenience, the forests in the district are divided into Badrinath and Kedarnath forest divisions lying in the eastern and western parts of the district respectively and preserve a rich flora and fauna of the area. The names of these forest di visions are after the shrines of great religious significance.

Since the forest types in both the divisions extend over a wide altitudinal range above 550 m to perpetual snow in the north, the conifers contribute a major component of the forest communities.

Information on various forest vegetation in the present work is derived mainly from the botanical explorations undertaken during the past more than one hundred fifty years in the area. Several pioneer workers in their expeditions also contributed valuable informations in evaluating the types of vegetation. In order to outline the salient features of the main forest vegetation Champion and Seth's classification (1968) has been followed.

In several localities up to an altitude of 1400m below the zone of Chir Pine, northern mixed dry deciduous type of forest is found to occur common species here are *Albizzia procera, Cassia fistula, Cinnamomum tamala Toona ciliata, Callicarpa macrophylla, Coelebrookia oppositifolia, Euphorbia royleana, Abrus precatorius, Bauhinia vahlii, Clematis gouriana, Arundinella nepalensis, Apluda mutica* and *Arundo donax* etc. Representative of species in such type of forests varies with the local factor. But where excessive grazing, lopping and burning have taken place, the degraded type, i. e. northern tropical dry deciduous scrub with dominant species like *Euphorbia royleana, Engelhardtia spicata, Dioscorea belophylla, Parthenocissus semicordata, Smilax aspera, Cymbopogon martinii, Digitaria granularis* etc. are found to occur. Whereas in both the divisions between 650 m - 2300 m outer himalayan chir forest with the main components of *Pinus roxburghii* along with the other species of plants like *Lyonia ovalifolia, Quercus leucotrichophora, Rhododendron arboreum, Aechmenthera tomentosa, Indigofera dosua, Inula cappa, Galium asperifolium, Micromeria biflora, Rosa brunonii, Arundinella pumila, Capilipedium assimile* and *Eulalia hirtifolia* etc. are found. Quality and distribution of such type of forests varies with other factors like depth and moisture content of the soil. Places where

excessive destruction of natural vegetation has taken place are generally substituted by poor vegetation, mainly scrub is found to prevail with elements like *Carissa opaca, Rhus parviflora, Woodfordia fruticosa, Ziziphus mauritiana* etc. In some localities on the dry exposed southern face of the hill in the Chir belt *Euphorbia royleana* takes its course due to severe biotic factors but completely disappears above 1500 m in both the southern and northern faces. Such scrubs are well represented by the species like *Rhus parvifolia, Woodfordia fruticosa* and *Heteropogon contortus*. In the main himalayan range between 1800-2300 m on the southern face and below 1500 - 1800 m on the northern face banz-oak (*Quercus leucotrichophora*) type of forest is extensively found, except in the areas of poor rainfall. Such type of forests are found to be composed of species like *Betula alnoides, Carpinus viminea, Lindera pulcherrima, Lyonia ovalifolia, Rhododendron arboreum, Cotoneaster obtusus, Myrsine africana, Hedera nepalensis, Vitis lanata, Taxillus vestitus* etc., whereas in the moist zone of the main himalayan axis between 2000 m 2750 m, luxuriant type of moru-oak forest (*Quercus floribunda*) type is found sandwitched between *Quercus semicarpifolia* with the admixture of mainly deciduous and evergreen species. Among the principal elements, which are associated in the formation of such type of forests are *Betula alnoides. Acer caesium, Eurya acuminata, Thamnocalamus falconeri, Salix denticulata, Viburnum cotonifolium, Ulmus wallichiana, Aesculus indica* and *Prunus cornuta* etc. Places where undue destruction of *Quercus leucotrichophora* has taken place, species unpalatable to cattle such as *Rhododendron arboreum, Lyonia ovalifolia, Berberis lycium, Prinsepia utilis*, etc. are generally seen growing.

The most beautiful type of western mixed conifer forests with mixtures of tees like *Abies. Picea*, some *Pinus wallichiana*, occasionally Deodar, associated with the deciduous broad leaved trees are found to occur between 2400 - 3000 m and in individual patches down to 2100 m and are more common in the areas of poor rainfall. In places of requisite rainfall such fo rests are composed of trees like *Quercus floribunda* and *Quercus semicarpifolia* and vary in association in different phases, for example oak are replaced by broad-leaved species like *Acer caesium, Aesculus indica, Juglans regia*, etc. The forest undergrowth is well represented with the herbs and shrubs with the abundance of *Cimnobambusa jaunsarensis* and *Thamnocalamus spathiflora* in patches. In places of moist and deep soil, except in the lowest parts below 1800 m 2700 m, moist temperate type of forests is common throughout the district and is frequently common along the streams, hollow depressions and bottoms of sheltered valleys. Among the elements associated in the formation of such type of forests are *Aesculus indica, Acer caesium, Carpinus viminea, Ulmus wallichiana, Thamnocalamus spathiflora, Viburnum* spp., *Berberis chitria, Strobilanthes wallichii, Paeonia emodi, Impatiens scabrida, Clematis connata*, etc. In north of the

main himalayan range, in dry tracts with moderate rainfall, extensive forests of *Pinus wallichiana* intermixed with *Cedrus deodara* are found to occur. The undergrowth of the forests are well represented mainly with the elements of grasses.

One of the characteristic features of the higher hills of the district is the growth of the Kharsu-oak (*Quercus semecarpifolia*) type of forests in unglaciated maraine tract between 2400 m 3000 m and are composed of elements like *Quercus floribunda. Betula alnoides, Pyrus lanata, Abies pindrow, Rhododendron barbatum, Rosa sericea, Cotoneaster acuminatus, Salix denticulata, Clematis montana* and *Thamnocalamus* species. The undergrowth of forest is well represented with the herbs and shrubs. Close to the mixed coniferous forests between 2600 m -3400 m on sheltered sites, west himalayan upper oak/abies type of forests are found to occur and are associated with the elements like *Abies pindrow, Quercus semecarpifolia, Aesculus indica Taxus baccata, Syringa emodi, Viburnum cotinifolium Schisandra grandiflora* and *Hedera depalensia* etc. The cleared places in such forests are well represented with *Thamnocalamus spathiflora, Chimnobambusa jaunsariensis* in luxuriant growth, where the shady and protected places are sheltered with ferns and mosses.

The undergrowth of Oak-Rhododendron and conifers in cleared places at 2400 m, maintain bamboo forests with species like *Chimnobambusa jaunsariensis, Arundinaria falcata, Thamnocalamus falconeri* and *T. spathiflora.* In forests of *Quercus semecarpifolia, Quercus leucotrichophora* and *Abies pindrow* above 2100 m around Kharaks, himalayan temperate park land type of forests are seen well represented with the elements like *Prunus cornuta, Berberis, Arundinaria* and *Cotoneaster* etc. whereas the areas between 1800 m - 3000 m. where the biotic factors have exercised their influence, grasslands and himalayan temperate pasture type of vegetation, associated with elements like *Agrostis pilosula, Dactylis glomerata, Bromus ramosus, Themeda anathera* and *Chrysopogon grylus* etc. is found.

Areas of permanent water supply throughout the district are well represented with the forests of *Alnus nepalensis.* Such alder type of forests are seen intermixed with the elements like *Populus ciliata, Aesculus indica Celtis australis,* etc. The undergrowth of the forests is well represented with the species like *Ainslaea latifolia, Sarcoccoca saligna* and *Rubus foliolosus* etc.

The natural dry deodar forest type is only represented in south of himalayan axis of Badrinath forest division, whereas plantation of deodar with *Pinus wallichiana* are represented in Kedarnath forest division. Apart from this, such forests are also found to occur in the inner dry valleys beyond the main range between 2400 m - 3000 m, whereas towards upper limits. these forests pass into *Betula utilis, Abies pindrow* or *Juniperus*

forests. The undergrwoth is well represented with the elements like *Abelia triflora, Prunus jacquemontii, Juniperus* spp. and *Artemisia maritima* and *Ribes alpestre*, etc. In areas of moderate rainfall behind the main himalayan axis and moist localities in northern face between 2400 2700 m, in Dhauli valley, west himalayan temperate deciduous type of forests are found to occur with the elements like *Corylus jacquemontii, Aesculus indica. Acer caesium* and *Populus ciliata*, etc. Dry tracts of Dhauli valley in Malari and Dunagiri in the north of himalayan exis between 3000-4000 m, west himalayan high level blue pine (*Pinus wallichiana*) type is found to occur. Exceptionally over a small area such forests pass into *Betula* and *Abies* forests in the upper limits. Undergrowth of such forests is generally comprised of elements like *Lonicera hopoleuca, Rosa sericea, Juniperus* sp. and *Salix denticulatus* etc.

The valleys of himalayas streams between 2300 - 3200 m, are well represented with the type of forests of *Hippophae-Myricaria* scrub and gradually pass into *Juniperus* forests in high altitudes. Such type of forests are also present in transition zones of temperate and alpine forests. Above 3000 m particularly on northern sides, west himalayan sub-alpine-birch/fir type of forests generally consisting of *Betula* and *Rhododendron* elements in irregular forms are found to occur. Favourable areas in the sub-alpine zones between 3000 3500 m, are subjected to heavy biotic interferences and therefore, sub-alpine pastures or bugyal type of vegetation is found to occur with the species like *Brachypodium sylvaticum, Bromus japonica, Poa annua* and *Stipa roylei* etc.

High level grasslands generally found above the tree line between 3300 4500 m and present a picturesque look in summer and rainy seasons on account of luxuriant growth of herbaceous plants, flushed with beautiful flowers. Such alpine pasture type of vegetation is generally composed of the members of *Primula, Anemone, Potentilla, Iris, Gentians, Ranunculus* and several members of *Cruciferae* and Caryophyllaceae etc. Among the elements which constitute the main bulk of the vegetation are *Euratia ceratoides, Juniperus* sp., *Caragana* sp. and *Artemisia* sp. Further higher up areas with the stony desert look is composed of Species belonging to *Sedum, Androsace, Primula, Saxifraga* and *Potentilla.*

Hilly wasteland vegetation :

In the present work the hilly wasteland has been considered to be the areas lying outside the forest and cultivated lands between 1000-2000 m of altitude. The terrain of the whole district is hilly and a major portion is occupied by the forest. Lower valleys along the river banks are generally thickly populated. During the settlement of people, such areas were cleared and the deforested products continued to meet up their usual demands for fuel, fodder and wood for the construction of their houses. Subsequently

considerable portions of the cleared areas remained unused. In course of time certain species of trees began to appear in such areas. Among the principal tree species found to occur in those tracts are *Acacia pennata, Butea monosperma, Bauhinia variegata, Cassia fistula, Casearia graveolens, Dalbergia sissoo, Flacourtia indica, Ficus hispida, Glochidion velutinum, Mallotus phillipensis, Myrsine serrata. Lannea coromandelica, Prunus cerasoides, Pyrus pashia, Xeromphis spinosa, Sapium insigne* etc. Such wastelands are also proned to shelter number of shrubs and undershrubs and among the common species which are found to occur are *Carissa opaca. Cotoneaster* sp., *Adhatoda zeylanica, Colebrookia oppositifolia, Cocculus laurifolius, Colquhounia coccinea, Elsholtzia flava, E. polystachya, Scutellaria repens, Plectranthus coetsa, Achyranthes bidentata, Cyathula tomentosa, Vitex negundo* and *Ziziphus mauritiana* etc. Whereas climbers like *Cryotolepis buchananii, Clematis gouriana, C. grata, Rubia cordifolia, Cissampelos pareira, Ipomoea purpurea* are commonly seen on trees and shrubs found to occur there.

In some places within the wastelands parasites like *Texillus vestitus, Scurulla* sp., *Viscum album* etc. are frequently seen on trees. The ground floor is well represented with the annuals and perennials. Among the commoners are *Ajuga bracteosa, Amaranthus spinosus, Antirrhinum orontium, Berberis aristata, B. asiatica, Capsella bursa-pastoris, Campylotropis eriocarpa, Cleome viscosa, Crotalaria prostrata, Datura stramonium, Euphorbia hirta, Martynea annua, Nicotiana rustica, Solanum nigrum, S. surratense, Verbascum thapsus,* etc. and *Asclepias curassavica* oocasionally along course of streams.

Grass lands

Generally the people of the area take their cattle wealth to wastelands and forests which are principal source of fodder grass. Among the dominant species of grasses which are found to occur are *Apluda mutica, Arundinella nepalensis, Eulaliopsis binnata, Cymbopogon martinii. Heteropogon melanocenchrus* and *Themeda arundinacea* encountered with these are the species like *Aechmanthera tomentosa, Berberis lycium* and *Moghania fruticosa,* etc.

Some beautiful natural grass lands are generally found to occur in higher altitudes which are locally known as Bugyals. These are principal source of fodder for the cattle of the neighbouring areas. Generally people take their cattle wealth to such pasture lands before the onset of rains and remain there till the winter approaches. Among the important species which are generally found to occur are *Agrostis pilosula, Bromus ramosus, Dactylis glomerata, Deschampsia caespitosa, Eremopoa persica, Festuca polycolea, Stipa roylei* and *Themeda anathera* etc. Such pasture lands are

well represented also by species of economic importance such as *Aconitum*, *Anemone*, *Corydalis*, *Delphinium*, *Nardostachys*, *Nomocharis*, *Picrorhiza* and *Potentilla* etc. On account of rich fodder value of grass, such area are being largely exploited. As a result of which luxuriant growth of those valued species adapted under such environmental conditions are generally under depletion. In view of such threats some areas of the district have been protected by declaring them biosphere reserves and sanctuaries.

Cultivated Plants :

Because of the mountainous topography, the agricultural fields are often terraced in the district. The crops are totally dependent on the seasonal rains. In some places however, irrigation is practiced but does not suffice the need of the people. Amongst the main Rabi crops generally cultivated during winter are *Brassica oleracea*, *Hordeum vulgare*, *Lens culinaris*, *Pisum sativum* and *Triticum aestivum* upto 1600 m along river valleys and other places. The Kharif crop during rainy season generally grown are *Dolichos biflorus*, *Echinochloa colonum*, *Eleusine coracana*, *Glycine max*, *Nicotiana tabacum*, *Oryza sativa*, *Paspalum indicum*, *Sesamum orientale* and *Vigna radiata* etc. up to 2000 m. Whereas in remote areas within 3000-4000 m crops like *Amaranthus caudatus*, *A. viridis*, *Fagopyrum esculentum*, *F. tataricum*, *Panicum miliaceum* etc. are cultivated. The summer season crop Jayad includes *Allium cepa*, *A. sativum*, *Solanum tuberosum* etc. which are cultivated in suitable places. The vegetables are commonly grown during the Kharif season. Among the chief vegetables those get preference are *Abelmoschus esculentus*, *Cucurbita maxima*, *Dolichos* sp., *Lagenaria siceraria*, *Lycopersicon asculentum*. *Phaseolus* sp., *Solanum tuberosum* and *Solanum melongena* etc.

Cultivated Trees :

In and around the villages certain species of plants are grown for fodder and wood for the construction of houses. Amongst the principal species of trees which are used for fodder are *Ficus subincisa*, *F. neriifolia* var. *nemoralis*, *F. auriculata*, *Grewia asiatica*, *G. optiva*, *Melia azeadirach* and *Trema orientalis* and the leaves are frequently lopped from these trees whereas *Tonna serrata*, *Celtis australis* and *Pinus roxburghii* are among the wood yielding trees for construction purposes.

Orchard and Garden :

Improved varieties of *Pyrus malus* are cultivated in higher ridges of the district and earn a good revenue. Apart from this, *Aegle marmelos*, *Citrus aurantium*, *C. medica*, *Juglans regia*, *Mangifera indica*, *Prunus armeniaca*, *P. persica*, *Psidium guajava* etc. are seen planted in many places.

Among the beautiful flowering plants generally found in the gardens *are Antirrhinum majus, Dahlia* sp., *Delphinium ajacis, Helianthus annuus, Hibiscus rosa-sinensis, Impatiens balsamina, Petunia* sp., and *Tagetes erecta etc.*

Weeds and Alliens :

Generally in many places the cultivated fields and gardens are well represented with the weeds. Among the common weeds which are generally found to occur are : *Anagallis arvensis, Asclepias curassavica, Caesulia axillaris, Capsella bursa-pastoris, Cannabis sativa, Chenopodium album, C. ambrosioides, Cleome viscosa, Commelina benghalensis, Cyperus aristatus, C. compressus, C. iria, C. paniceus, Euphorbia hirta, Fimbristylis dichotoma, Fumaria parviflora, Lathyrus aphaca, Oxalis dehradunensis, Panicum psilopodium, Ranunculus sceleratus, Silene conoidea, Stellaria media, Tagetes minuta, Triumfetta annua, Vlcia hirsuta* etc.

PLANTS OF MEDICINAL, ECONOMIC AND HORTICULTURAL IMPORTANCE :

Botanical wealth of the area is very rich in medicinal, economic and horticultural plants and are listed below groupwise with their few representative species :

1. **Medicinal plants :**

Abies pindrow, Aconitum atrox, Aesculus indica, Berberis aristata, Clssampelos pareira, Cuscuta reflexa, Dioscorea deltoidea, Doronicum roylei, Ephedra gerardiana, Hyoscyamus niger, Dactylorhiza hatagirea, Picrorhiza scrophulariflora, Rheum tibeticum, Viola pilosa etc.

2. **Plants of economic importance** :

1. **Essential oil yielding** : *Abies pindrow, Centella asiatica, Juniperus communis, Micromeria biflora, Skimmia laureola* etc.

2. **Gum yielding** : *Lannea coromandelica, Prunus cornuta, Rhus wallichii* etc.

3. **Resin yielding** : *Cupressus torulosa, Hedera nepalensis, Juniperus communis, Pistacia khinjuk.*

4. **Tannin yielding** : *Coriaria nepalensis. Dalbergia lanceolaria, Myrica esculenta* etc.

5. **Oil yielding** : *Actaea acuminata, Prinsepia utilis, Sorbus aucuparia* **etc.**

6. **Timber yielding** : *Buxus wallichiana, Cedrus deodara, Pinus roxburghii, P. wallichiana, Toona serrata* etc.

7. **Fibre yielding** : *Boehmeria platyphylla, Crotalaria sessiliflora, Grewia optiva, Urtica dioica* etc.

8. **Ordinary ropes** : *Erianthus ravennae, Eriophorum comosum* etc.

9. **Dye yielding** : *Alnus nepalensis, Berberis aristata, Myrica esculenta, Potentilla nepalensis* etc.

3. **Plants of horticultural importance** :

Anemone vitifolia, Campanula latifolia, Benthamedia capitata, Corylus jacquemontii, Cymbidium iridioides, Delphinium brunonianum, Ficus palmata F. auriculata, Inula grandiflora, Iris kumaonensis, Meconopsis aculeata, Miscanthus nepalensis, Trillidium govanianum, Myrica esculenta, etc.

4. **Interesting plants of botanical importance** :

Arceuthobium minutissimum, Circaeaster agrestis, Didiciea cunninghamii, Hydrobryum griffithii, Listera pinetorum, Stellera chamaejasme, Viscum loranthi etc.

5. **Endangered plants** :

Balanophora involucrata, Carduus edelbergii, Ceropegia longifolia Cypripedium himalaicum, C. cordigerum, Didicea cunninghamii, Dioscorea deltoidea, Falconeria himalaica, Holboelia latifolia, Listera longifolia, Michelia kisopa, Podophyllum hexandrum, Triosteum hirsutum, etc.

6. **Germ-plasm material** : *Avena fatua, Abelmoschus manihot. Cicer microphyllum, Duchesnea indica, Eleusine indica, Echinochloa crus-galli, Ficus palmata, Malus baccata, Lathyrus aphaca, Leymus secalinus, Moghania vestita, Miscanthus nepalensis* etc.

GAME SANCTUARIES/NATIONAL PARKS :

Topography and the natural condition set up of certain areas of the district Chamoli, have offered congenial environment to flourish a large number of species of great economic, Medicinal and horticultural importance and are best suited for the preservation of germ plasm of many domesticated species. Among those reserves added to the flora are :

1. **The Valley of Flowers** (ii) **Nanda Devi Sanctuary** (iii) **Musk Deer National Park.**

1. The Valley of Flowers :

The fame of this Valley of Flowers was brought to light with the enduring efforts of Smythe and Holdsworth in 1931, who were the mem-

bers of the British Kamet Expedition and collected beautiful specimens of flowering plants during their return journey along Bhyundar valley and were so impressed with the scenic grandeur and the wealth of the flora that they named it "Valley of Flowers" and the list of the plants collected during the expedition has been included in Kamet Conquered (1932). Smythe again returned to the Valley for collection of the seeds and bulbs for the Royle Botanic Garden Edinburgh and collected nearly 250 species, a list of which is given in his delightful book "Valley of Flowers" (1938). This enchanting valley with its considerable area preserves several most interesting species of himalayan flowers.

2. **Nanda Devi Sanctuary**: Nanda Davi with its area and altitude 799 km^2. and 7820 m respectively, is a twin peaked mountain, highest in the district defended by a ring of impassible mountain enclosing an undulated table and the name "Sanctuary" has been given by Mr. Huge Ruttedge to the unique Nanda Devi basin. It remained unexplored till 1934, when Shipton and Tillman made their successful attempt for getting entry right up the base of the mountain.

Due to its perilous and difficult configuration it remained unexplored for many years. But the endless efforts of Gurdial Singh and Capt. K. Kumar prized them with success in getting entry right to the basin in 1960 and 1961 respectively. Such expeditions revealed many interesting things of the sanctuary and encouraged later workers for organising expeditions for scientific studies of the area. Subsequently Sri Anup Shah for the first time organised such expedition in 1974. Thereafter the members who visited the sanctuary for scientific studies of the flora and fauna were Lav Kumar, Jayant Society Rajkot (1977) and Dr. P.K. Hajra (POSSCEF) Botanical Survey of India (Northern Circle) 1981 and gathered a number of interesting botanical species and also described few new taxa from the area. Notwithstanding it still stands a challenge for the visitors.

3. **Musk Deer National Park** : There are reports of suitable habitats for the Musk deer in Kedarnath Division around Madmaheswar and Tungnath and a sanctuary has been recently created for the conservation of this animal of great economic importance.

ANALYSIS OF THE FLORA

In the present work, flora of Chamoli is mainly concerned with the flowering plants of 1934 species distributed in 892 genera and 163 families. The table below shows the break with respect to the monocots and dicots. The proportion of species belonging to monocots to dicots is 1: 3.7, of genera 1 : 3.5 and of families is 1 : 5.6. If such ratios are compared taking into account the entire, Indian subcontinent including Malaya (Hooker

1904), species ratio of monocots to diocots comes out to be 1 : 2.3 and genera to species is 1 : 7. This satisfies the general rule that within the same floral region, the smaller the flora, the smaller is the ratio for species to genera.

TABLE 1: GENERAL SURVEY

	Genera	%	Species	%
Monocots	194	21.9	408	21.2
Dicots	690	78.4	1513	78.8
Total	884		1921	

The ten dominant families in the flora of Chamoli with their respective genera and species are listed below in table 2. The comparison of sequence with that of Hooker (1904) for Flora British India, given in table 3, shows that the family Asteraceae takes the highest position in the Flora of Chamoli district and not the family Orchidaceae occupying the top position in Hooker's flora (l.c.). It is interesting to note that the families like Rubiaceae, Euphorbiaceae and Acanthaceae occupying the higher position in dominance according to Hooker, are coming in the last in the flora of Chamoli. Whereas families like Ranunculaceae. Rosaceae and Scrophulariaceae having their suitable dominance in the flora of Chamoli are not at all occupying among the dominant families listed by Hooker. This is perhaps due to the prevallance of the members of these families only in this part of Indian sub-continent.

TABLE 2: THE 10 LARGEST FAMILIES IN CHAMOLI

Family	Genera	Species
Asteraceae	67	157
Poaceae	85	151
Leguminosae (Sensu lato)	56	132
Orchidaceae	43	95
Rosaceae	22	81
Lamiaceae	32	63
Ranunculaceae	14	57
Scropulariaceae	21	56
Cyperaceae	7	54
Urticaceae (sensu lato)	20	49

TABLE 3 : THE 10 LARGEST FAMILIES IN CHAMOLI

Flora of Chamoli	Flora of British India
Asteraceae	Orchidaceae
Poaceae	Leguminosae
Leguminosae	Poaceae
Orchidaceae	Rubiaceae
Lamiaceae	Euphorbiaceae
Cyperaceae	Acanthaceae
Urticaceae	Asteraceae
Rubiaceae	Cyperaceae
Euphorbiaceae	Lamiaceae
Acanthaceae	Urticaceae

Flora of Chamoli when compared with the available Himalayan flora pertaining to the Western Himalaya such as Flora Simlensis (Collett 1921) and Flora Nainitalensis (Gupta 1968) together with the revised check list of Duthie (1906) wherein the early collections from North Garhwal and Kumaon are enumerated, valuable similar and contrasting results have been obtained.

The proportion of dicots and monocots in the flora of Chamoli is 78. 1 : 21.9 and 78.8 : 21.2 in respect of genera and species respectively. The corresponding figures in respect of species for Simla, Nainital and the entire country being respectively 75.8 : 23.2, 80. 43 : 19.57 and 76.57 : 23.43 (Gupta 1968). Table 4 contains the number of families, genera and species collected from Kumaon and Garhwal (Duthie 1906) and their percentages in the flora of Chamoli.

TABLE 4 : COMPARATIVE STATEMENT BETWEEN KUMAON & GARHWAL AND CHAMOLI

	Families Kumaon Garhwal	(Sensu lato) Chamoli	%	Genera Kumaon & Garhwal	Chamoli	%	Species Kumaon & Garhwal	Chamoli	%
Monocots	20	18	90	201	194	96.5	752	408	54.1
Dicots	115	109	95	773	690	89.2	1906	1513	79.3

The comparative statement as shown in Table 4 justifies that from the total number of species reported in respect of monocots and dicots from Kumaon and Garhwal in Duthie's Catalogue (1906) more than 50%

and 79% of species belonging to monocots and dicots have been collected from the Chamoli district. The ratio of collections of monocots and dicots when compared with the flora of Nainital with 22% and 36.67% of plants belonging to monocots and dicots respectively, indicates that the percentage of species collected in the Chamoli district is much higher. This is perhaps due to the wider coverage of the area in Chamoli district.

A comparison with the flora of Chamoli, Nainital and Simla shows that there are 23 families with 20 or more species in Chamoli as compared to 12 end 19 for Nainital and Simla respectively. Apart from this there are 37 families with one genus and single species as compared to 22 and 23 families in Nainital and Simla respectively. There are 17 Families represented with one genus but more than one species in the flora of Chamoli district while there are similarly 16 and 12 families represented in Nainital and Simla respectively.

Comparative studies revealed that flora of Chamoli has closer affinity with the flora of Simla for having the elements of arid climatic zone like *Caragana brevispina, Carduus edelbergii, Cedrus deodara, Herniaria hirsuta, Hippophae tibetana, Hyoscyamus niger, Morina coulteriana, Oxybaphus himalaicus, Parietaria micrantha, Ribes grossularia* and *Thesium himalense*. etc. whereas on the other hand, it has also the resemblances with the flora of Nainital in having species like *Aristolochia dilatata, Callicarpa arborea, Colquhounia coccinea, Pentapanax parasitichum* and *Porana racemosa* etc. which have their distribution in Kumaon eastwards.

PHYTOGEOGRAPHICAL ANALYSIS

While analysing the floristic composition in the flora of Chamoli distric it has been observed that the species of west and middle Asian mountains suited to comparatively dry conditions, are found to occur in the areas adjoining Tibet. Species originating from the moist areas of high mountain are also represented in the flora of the Chamoli district. Among the species belonging to western, middle and northern Asia are the members of *Artemisia* and Chenopodiaceae, *Lamium rhomboideum* and *Physochlaina praealta* etc., which are found to occur in the north west of Chamoli district. Apart from this, elements of other distributional pattern such as *Cedrus deodara* along with other several elements like *Paeonia emodi* and many species of *Epilobium* and *Primula* are represented in the flora of Chamoli. The influx of Western Chinese elements like *Aletris pauciflora, Anemone rupicola* and *A. vitifolia* etc. are represented here. The most interesting distributional pattern can be well cited in respect of the influx of extraneous elements from north west China to the northern part of the district by the occurrence of *Circaeaster agrestis*. Apart from this, elements

from the neighbouring region are also associated in the formation of the flora of Chamoli. Among the Malayan elemrnts the genera like *Engelhardtia*, *Daphniphyllum*, *Balanophora*, *Gaultheria* and numbers of Zingeberaceae, etc. The African elements like *Flacourtia*, *Dipsacus*, *Grewia*, *Phoenix*, *Gerbera*, *Striga* and species like *Albizia lebbeck*, *Atylosia scrabaeoides* and *Elatostemma sessile* etc. are worth mentioning. Apart from this Australian type elements like *Pittosporum* ; typical sino-japanese elements like *Bischoffia javanica*, *Cornus macrophylla* ; American elements like *Podophyllum*, *Meconopsis*, *Rhododendron* etc. are well represented in the fiora of Chamoli.

The occurrence of *Hydrobryum griffithii* in Nigol valley of the district further confirms the view of a common flora existing in the past and must have covered the whole of east of Asia including Himalaya, China and Japan during Tertiary period. The Chinese mountains being older in age have had considerable influence over the Himalayan flora and allowed migration of many species of plants westward to this younger Himalaya.

The present status of flora is, therefore, very different in their floristic composition than what it was at the beginning. The reason behind this change must have been due to great changes those had taken place in the topography and climate of the region.

Due to the recession of ice sheet, several elements from the north migrated in the district from many directions and constituted the high altitude flora. Such successive changes in the topography and the climate during pleistocene not only brought many new elements but also disturbed the existing elements driving out of the old habitants. Such periodic disburbance resulted the disjunct distribution of many genera and species. In support of the view the occurrence of *Cedrus deodara* forest in patches particularly in the Badrinath division of the district can very well be cited, which probably had existed in a continuous belt rather than what we find today. Flora of Chamoli is further enriched with the species like *Didiceia cunninghamii*, *Lestera longi caulis*, *L. pinetorum Triosteum* and *Falconeria himalaica* etc. which are not reported to have been occurring in any part beyond their natural habitats. Such new reports in the flora of Chamoli has thrown light in understanding the phytogeographical significance. Taking into account all these facts it strongly confirms the view of Hooker (1904) that the Flora of India is a mixture of floras from the surrounding areas, enriched by migration of the plants from China, Tibet and Siberia in the north, Malaysia in the south and Africa and Europe in the west.

PLAN OF THE FLORA

In the present work vascular plants like Angiosperms and Gymnosperms of Chamoli district having been included. The families are

arranged according to Bentham and Hooker's classification (1862-83) except in few cases in which Hutchinson's (1959) concept regarding splitting of families is followed. The names of the families are without the name of the author and description. In case of genera, the names are followed by the name of the author, but without description.

Keys: Dichotomous keys, based mostly on macroscopic characters, for the identification of taxa from the rank of family to infra-specific level are given.

Nomenclature : Attempts have been made to adopt the latest correct names according to ICBN (ed. 1978). The references to the latest monograph and taxonomic revision if available follow the adopted name. The basionym is given to indicate the source of valid combination as an indirect source. The important synonyms are given to connect the valid names with the names accepted in the flora of British India. The conserved names have been marked as 'nom' cons.',

Local names : The local names in, Garhwali, a dialect of Uttar Pradesh, have been given in inverted commas after citation.

Description : Brief descriptions of the species and infra-specific taxa based on the species studied have been given. Efforts have been made to avoid the characters in the descriptions reflecting in the keys. For plants recorded in the literature but could not be collected or seen in any herbaria by the author, the descriptions are based on authentic literature.

Flowering and fruiting time : Flowering and Fruiting time for the plants growing in the district has been indicated as per the records available in the herbarium. In case of the plants recorded from literature the timings have been given as noted by the author.

Illustrations : A district map showing forest ranges and other important localities surveyed has. been included. As there are quite a number of good illustrations of the species in some of the standard floras, it has not been felt essential to depict them in the flora of Chamoli.

Measurements : Conventional abbreviations to metric measurements have been used. m : meter cm. : centimetre, $\pm$: more or less, var. is variety.

Distribution : The data about the locality and the altitude have been given at the end of the text of each species except where the plants are either planted or in cultivation. One representative field number for each species has been given within bracket. In cases where the plants are referred from some literature or authentic work the number mentioned by the author has been given and only the author's name has been indicated within the brackets when no collection number was recorded. Such references are

followed by the word 'Lit.' at the end. Where a particular species seems to be very uncommon or rare only in such cases the frequencies have been given at the end.

Notes : In certain cases where it was not possible to use the latest name by the author but sueh names have been indicated in the flora are marked by an asterisk.(*)

Cultigens : Cultigens with their valid names, important synonyms and brief descriptions have been given at the end either of genera or of families. Efforts have been made to include the cultigens in the keys but have not been taken into account for the purpose of floristic analysis of the Flora.

Abbreviations : Efforts have been made to use the abbreviations of serials and floras in conformity with the common usage in the botanical taxonomy and are cited in accordance with the recommendations made by the International Code of Botanical Nomenclature (ed. 1978). The abbreviations of various herbaria have not been given in the present work except where the field numbers are represented in BSD.

CONCLUDING REMARKS

On account of its famous old temples, high snowclad peaks, beautiful lakes, picnic spots and wild life sanctuaries and National Parks, the Chamoli district is of great religious and aesthetic importance for the devotees, mountaineers and naturalists. Apart from this, the rich flora and fauna play an important role in the field of development of the area. The fauna with the beautiful birds and animals such as snow Leopard (*Panthera unica*), Goral Himalayan goat (*Nemorhaedus goral*), Sambhar (*Cervus unicolor*), Kakar-Barking deer (*Muntiacus muntjak*), the Himalayan Thar (*Hemitragus jemlahicus*), Musk deer (*Moschus moschiferus*), Monal (*Lophophorus impejanus*), and Asela-Hill Troat (*Schizothorax reichardsoni*), etc. deserve special attention for their conservation on account of their rarity and to preserve the national heritage.

At the same time the flora of the district presents a very rich and varied assemblege of species due to topography and climatic conditions which offer most cangenial environment for the growth of plants of great economic and medicinal importance. The occurrence of large number of species in the area and richness of the flora has rendered the district a botanical treasure.

The presence of wide range of species in the district provides a great source of natural resources potential for the development of forest based industries like 1 resin and its distilation products, 2 - on medicinal herbs,

3 on wood suitable for making sport articles, furniture and decorative pieces etc. 4 on packing cases, 5 on ringals (*Arundinaria*), 6 on paper pulp etc.

It is obvious from the account of the flora that district Chamoli has a good prospect in its plant resources where suitable projects can be carried out in planned manner and implemented under scientific expertise.

CLASSIFICATION OF THE NATURAL ORDERS OF FLOWERING PLANTS REPRESENTED IN THE FLORA OF CHAMOLI

The sequence of Natural Orders in this work is adopted from Ben tham and Hooker's 'Genera Plantarum' (1862 1883) with some modi fications by Airy Shaw (1973) and Hutchinson (1959).

KEY TO THE FAMILIES

1a. Ovules in closed ovary, fertilized through stigma

2a. Leaves reticulately veined ; perianth 4 - 5 merous, embryo with two Cotyledon

3a. Plants insectivorous or parasite

4a. Plants insectivorous.

5a. Leaves with glandular tenta - cles ... DROSERACEAE 56

5b. Leaves with bladder and glands ; without tentacles ... LENTIBULARIACEAE 97

4b. Plants parasitic.

6a. Parasite leafless ; climbers or erect herbs.

7a. Climbers ... CONVOLVULACEAE 93 (*Cuscuta*)

7b. Eerect herbs.

8a. Root parasites ; stems small brown or yellow.

9a. Flowers minute, uni-sexual crowded in ovoid globose heads ... BALANOFORACEAE 124

9b. Flower small, bi - sexual.

10a. Flowers irre - gular ; ovary 1 - celled.

11a. Brown annuals; corolla - tube curved... OROBANCHACEAE 96

11b. White or reddish perennials; corolla-tube not curved ... SCROPHULARIACEAE 95 (*Lathraea*)

10. Flowers regular; ovary 4 - 5 celled ... MONOTROPACEAE 80

8b. Stem parasites; stems very minute ... LORANTHACEAE 122 (*Arceuthobium*)

6b. Parasites leafy; shrubs or herbs.

12a. Shrubs; fruit drupe or berry.

13a. Stem parasites ... LORANTHACEAE 122

13b. Root parasites ... SANTALACEAE 123 (*Osyrus*)

12b. Herbs; fruit a nut ... SANTALACEAE 123 (*Thesium*)

3b. Plants not insectivorous or parasite.

14a. Climbers and twiners or with trailing stems.

15a. Tendrils present.

16a. Flowers regular.

17a. Ovary superior ... VITACEAE 39

17b. Ovary inferior ... CUCURBITACEAE 64

16b. Flowers irregular.

18a. Flowers papilionaceous; ovary 1-celled; fruit a pod ... PAPILIONACEAE 49

18b. Flower not papilionaceous; ovary 3-celled; fruits globose membranous capsules ... SAPINDACEAE 42 (*Cardiospermum*)

15b. Tendrils absent.

19a. Armed with spines or prickles.

20a. Leaves simple.

21a. Ovary apocarpus ... ROSACEAE 52 (*R. paniculata*)

21b. Ovary syncarpus.

22a. Leaves alternate; fruit a berry ... CAPPARACEAE 12

22b. Leaves opposite, fruit a drupe ... RHAMNACEAE 38 (*Sageretia*)

20b. Leaves compound.

23a. Leaves 3-foliolate ... ROSACEAE 52

23b. Leaves pinnate ... CAESALPINACEAE 50

19b. Unarmed.

24a. Leaves simple.

25a. Perianth differentiated into calyx and corolla.

26a. Flowers polypetalous.

27a. Flowers uni-sexual.

28a. Flowers showy; ovary many; ovules 2 ... SCHISANDRACEAE 4

28b. Flowers minute; ovaries 3; ovule solitary ... MENISPERMACEAE 5

27b. Flowers bi-sexual or polygamous.

29a. Flowers usually with a few large conspicuous sterile outer flowers in corymsb ... HYDRANGEACEAE 54

29b. Flowers without conspicuous outer sterile flowers; inflorescence various.

30a. Flowers solitary axillary ... SABIACEAE 45 (*S. campanulata*)

30b. Flowers in umbels or panicles.

31a. Flowers in umbels ; calyx-tube adnate to the ovary... ARALIACEAE 70

31b. Flowers in panicles.

32a. Leaves entire ; stamens 10 ... MALPIGHIACEAE 28

32b. Leaves serrate ; stamens 5 ... RHAMNACEAE 38

26b. Flowers gamopetalous.

33a. Leaves alternate ... CONVOLVULACEAE 93

33b. Leaves opposite.

34a. Filaments united into a tube ; anthers adnate to the stigma ... ASCLEPIADACEAE 87

34b. Filaments free ; anthers not adnate to the stigma APOCYNACEAE 86

25b. Perianth not differentiated.

35a. Perianth often dilated ... ARISTOLOCHIACEAE 114

35b. Perianth not dilated.

36a. Flowers on the inner surface of the fleshy hollow receptacle ... MORACEAE 129

36b. Flowers in spikes or panicles.

37a. Leaf base cordate ... POLYGONACEAE 113

37b. Leaf base acute ... AMARANTHACEAE 110

24a. Leaves compound.

38a. Flowers polypetalous.

39a. Flowers zygomorphic ... PAPILIONACEAE 49

39b. Flowers actinomorphic.

40a. Flowers in umbels ... ARALIACEAE 70

40b. Flowers in axillary fascicles or in racemes or panicles.

41a. Leaves alternate.

42a. Leaflets toothed ... VITACEAE 39

42b. Leaflets entire ... LARDIZABALACEAE 7

41b. Leaves opposite ... RHAMNACEAE 38

38b. Flowers gamopetalous.

43a. Leaves opposite, stipulate ; stipules inter or intrapetiolar ; ovary infe - rior ... RUBIACEAE 74

43b. Leaves opposite or alternate ; exstipulate ; ovary superior ... BIGNONIACEAE 99

14b. Trees, shrubs and herbs.

44a. Trees and shrubs,

45a. Armed with spines or prickles,

46a. Succulent shrubs with minute or 0 leaves ... CACTACEAE 67

46b. Non succulent.

47a. Perianth differentiated into calyx and corolla.

48a. Flowers polypetalous.

49a. Stamens indefinite.

50a. Calyx poly - sepalous. ... FLACOURTIACEAE 14

50b. Calyx gamos - epalous.

51a. Leaves alternate, stipulate ... ROSACEAE 52

51b. Leaves opposite, ex - stipulate ... PUNICACEAE 62

49b. Stamens up to 10.

52a. Flowers irregular ... PAPILIONACEAE 49

52b. Flowers regular.

53a. Flowers in umbels ... ARALIACEAE 70

53b. Flowers not in umbels.

54a. Flowers 3 - merous ... BERBERIDACEAE 6

54b. Flowers 5 - merous.

55a. Calyx imbricate ; leaves dotted, aromatic ... RUTACEAE 32

55b. Calyx velvate ; leaves not dotted ... RHAMNACEAE 38

48b. Flowers gamopetalous.

56a. Leaves opposite.

57a. Stipules present ; ovary inferior, 2 or 5 celled ... RUBIACEAE 74

57b. Stipules none ; ovary superior, 2 - celled... APOCYNACEAE 86

56b. Leaves alternate ; ovary superior ... SOLANACEAE 94

47b. Perianth not differentiated or apetalous.

58a. Plants covered with dense silvery scales ; flowers in axillary fascicles... ELAEAGNACEAE 121

58b. Plants not covered with silvery - scales ... MORACEAE 129

46b. Unarmed shrubs or trees.

59a. Leaves simple.

60a. Leaves opposite (or rarely in whorls of three).

61a. Perianth differentiated into calyx and corolla.

62a. Flowers polypetalous.

63a. Stamens indefinite.

64a. Calyx polysepalous not adnate to ovary ... HYPERICACEAE 20

64b. Calyx gamosepalous and adnate to ovary ... MYRTACEAE 59

63b. Stamens upto 12.

65a. Petals hypogynous, stamens inserted on the hypogynous disc formed by expansion of the torus.

66a. Stems 4 - angled ; ovary 1 - celled ... CORIARIACEAE 47

66b. Stems cylindric ; ovary 1 - celled.

67a. Stamens 4 - 5 ; fruit not a samara.

68a. Calyx imbricate, stamens alternating with petals ... CELASTRACEAE 37

68b. Calyx valvate ; stamens opposite the petals ... RHAMNACEAE 38

67b. Stamens generally more than 5 ; fruit a double samara with membranous wings ... ACERACEAE 43

65b. Petals perigynous ; stamens inserted on the calyx or ovary or epigynous or perigynous disk.

69a. Style simple.

70a. Trees ; flowers upto 1 cm across ... CORNACEAE 72

70b. Shrubs ; flowers more than 5 cm across ... MELASTOMATACEAE 60

70b. Styles 2 or more ... HYDRANGEACEAE 54

62b. Flowers gamopetalous.

71a. Ovary inferior.

72a. Leaves usually exstipulate ... CAPRIFOLIACEAE 73

72b. Leaves always stipulate ... RUBIACEAE 74

71b. Ovary superior.

73a. Flowers regular ; ovary of two carpels.

74a. Stamens 2 ... OLEACEAE 85

74b. Stamens 4 - 5.

75a. Juice generally milky ; stamens 5 ... APOCYNACEAE 86

75b. Juice not milky ; stamens 4 ... BUDDLEJACEAE 88

73b. Flowers zygomorphic ; ovary of 2 - 4 carpels.

76a. Bracts conspicuous ; stem with swollen joints ; ovary 2 - celled ... ACANTHACEAE 102

76b. Bracts minute or absent ; joints of stem not swollen ; ovary 4 - celled.

77a. Ovary entire ; style terminal ... VERBENACEAE 105

77b. Ovary 4 - celled ; style gyno - basic ... LAMIACEAE 106

61b. Perianth not differentiated or apetalous.

78a. Flowers on inner surface of a fleshy hollow receptacle ... MORACEAE 129

78b. Flowers not in receptacles.

79a. Flowers bi-sexual ... THYMELAEACEAE 120

79b. Flowers uni-sexual.

80a. Overy 1 - celled ... URTICACEAE 130

80b. Ovary 3 - celled ... EUPHORBIACEAE 125

60b. Leaves alternate or fascicled.

81a. Perianth differentiated into calyx and corolla.

82a. Flowers polypetalous.

83a. Calyx polysepalous.

84a. Torus small or elongated ; not expanded.

85a. Stamens many.

86a. Ovary apocarpus ... MAGNOLIACEAE 3

86b. Ovary syncarpus.

87a. Placentation parietal ... FLACOURTIACEAE 14

87b. Placentation axile.

88a. Flowers on simple pedicels ... THEACEAE 21

88b. Flowers in panicles ... ACTINIDIACEAE 22

85b. Stamens not more than 10.

89a. Leaves scale like ... TAMARICACEAE 19

89b. Leaves broad not scale like ... PITTOSPORACEAE 15

84b. Torus thickened or exapnded into a fleshy disc.

90a. Leaves crenate or serrate.

91a. Stamens alternate with petals ... CELASTRACEAE 37

91b. Stamens opposite with petals ... SABIACEAE 45

90b. Leaves entire ... ANACARDIACEAE 46

83b. Calyx more or less connate.

92a. Flowers irregular ... CAESALPINIACEAE 50

92b. Flowers regular.

93a. Stamens indefinite.

94a. Anthers 2 - locular.

95a. Filaments united into a tube ... STERCULIACEAE 25

95b. Filaments free.

96a. Receptacle elevated bearing the sepals and petals at the base ... TILIACEAE 26

96b. Receptacle not elevated ; calyx tube inserted with the stamens and petals ... ROSACEAE 52

94b. Anthers 1 - locular ... BOMBACACEAE 24

93b. Stamens upto 10.

97a. Calyx adnate to the ovary.

98a. Stamens 4 5 ... SAXIFRAGACEAE 53

98b. Stamens 6 - 10.

99a. Fruit a berry ; seeds 2 ... ALANGIACEAE 71

99b. Fruit usually a capsule ; seed 1 ... COMBRETACEAE 58

97b. Calyx free from the ovary.

100a. Calyx valvate ... RHAMNACEAE 38

100b. Calyx imbricate ... AQUIFOLIACECE 36

82b. Flowers gamopetalous.

101a. Ovary inferior.

102a. Flowers in heads ... ASTERACEAE 77

102b. Flowers in cymose corymbs forming panicles ... SYMPLOCACEAE 84

101b. Ovary superior.

103a. Stamens inserted on the receptacle ; flowers bi-sexual ... ERICACEAE 79

103b. Stamens inserted on the corolla.

104a. Ovules indefinite ... SOLANACEAE 94

104b. Ovules definite.

105a. Leaves gland-dotted ... MYRSINACEAE 83

105b. Leaves not gland-dotted ; ovary 2 - 4 celled ... EHRETIACEAE 92

81b. Perianth not differentiated or apetalous.

106a. Flowers bi-sexual.

107a. Ovary inferior ... SANTALACEAE 123

107b. Ovary superior.

108a. Anthers 4 - celled, opening by 4 - valves ... LAURACEAE 119

108b. Anthers 2 - celled, opening by slits.

109a. Plants covered with silvery scales ... ELAEAGNACEAE 121

109b. Plants not covered with silvery scales.

110a. Stamens twice the perianth lobes ... THYMELAEACEAE 120

110b. Stamens as many or fewer than perianth lobes ... AMARANTHACEAE 110

106b. Flowers uni-sexual.

111a. Male flowers (sometimes also female) in catkins or spikes.

112a. Leaves exstipulate ... MYRICACEAE 132

112b. Leaves stipulate (except in *Morus*) not palmately nerved or lobed.

113a. Ovary superior ; ovules few or many ... SALICACEAE 135

113b. Ovary inferior or sub inferior.

114a. Female flowers many in dense spikes ; female perianth 0 ... BETULACEAE 133

114b. Female flowers in slender terminal spikes in pairs at the base of a foliaceous bract or solitary or in cluster or short spiked, each enclos - ed in an involucre ; female perianth ad - nate to the ovary ... FAGACEAE 134

111b. Flowers not in catkins or spiked (flower clusters sometimes arranged in interrupted spikes).

115a. Ovary 3 - celled with 1 or 2 ovules in each locule.

116a. Leaves mostly stipulate ... EUPHORBIACEAE 125

116b. Leaves exstipulate ... BUXACEAE 126

115b. Ovary 1 - celled, 1 - ovuled.

117a. Flowers crowded inside a fleshy receptacle ... MORACEAE 129

117b. Flowers not in a fleshy receptacle.

118a. Leaves entire ... LAURACEAE 119

118b. Leaves serrate, dentate or crenate.

119a. Anthers usually influxed in end ; style simple ; fruit an achene ... URTICACEAE 130

119b. Anthers erect in end.

120a. Trees ; fruit a samara or a drupe ... ULMACEAE 127

120b. Erect shrubs ; fruit an achene ... CANNABACEAE 128

59b. Leaves compound.

121a. Leaves pinnate.

122a. Perianth differentiated into calyx and corolla.

123a. Flowers polypetalous.

124a. Flowers irregular.

125a. Anthers 1 - celled... MORINGACEAE 48

125b. Anthers 2 - celled... PAPILIONACEAE 49

124b. Flowers regular.

126a. Stamens indefinite

127a. Leaves tripin - nate ... MIMOSACEAE 51

127b. Leaves bipin - nate ... ROSACEAE 52

126b. Stamens not more than 12.

128a. Leaves 1 - 3 pinnate.

129a. Leaves 2 - 3 pin - nate ... MELIACEAE 35

129b. Leaves 1 - pin- nate.

130a. Leaves gland-dotted.. RUTACEAE 32

130b. Leaves not gland - dotted.

131a. Leaflets entire.

132a. Ovary 1 - celled.

133a. Fruit a pod. ... CAESALPINIACEAE 50

133b. Fruit a drupe ... ANACARDIACEAE 46

132b. Ovary more than 1 - celled.

134a. Stamens 5 ; fruit a capsule, septifragally 5 - valved. ... MELIACEAE 35

134b. Stamens 8 10, fruit a fleshy coriaceous 1 - 2 coccous, indehiscent ... SAPINDACEAE 42

131b. Leaflets serrate or crenate.

135a. Petiole dilated at the base into sheathing stipule ... LEEACEAE 40

135b. Petiole not dilated at the base ; stipule 0.

136a. Stamens united into a tube ; ovules more than 2 in each cell... MELIACEAE 35

136b. Stamens free ; ovule 1 in each cell.

137a. Plants resinous ; drupes fleshy, globose 1.75 - 3 cm in diam ... BURSERACEAE 34

137b. Plants not resinous .5 .75 cm in diam ... SIMAROUBACEAE 33

128b. Leaves 3 - foliolate ; fruit an inflated membranous capsule ... STAPHYLEACEAE 44

123b. Flowers gamopetalous.

138a. Ovary inferior ; flowers in heads ... ASTERACEAE 77

138b. Ovary superior ; flowers not in heads.

139a. ovary 2 - celled.

140a. Stamens 2 .. OLEACEAE 85

140b. Stamens 4 ... BIGNONIACEAE 99

139b. Ovary 1 - celled ... MYRSINACEAE 83

122b. Perianth not differentiated or apetalous.

141a. Perianth adnate to ovary ; leaves exstipulate ; fruit drupe or nut. ... JUGLANDACEAE 131

141b. Perianth O ; leaves stipulate ; fruit a berry ... PIPERACEAE 117

121b. Leaves digitate.

142a. Flowers polypetalous.

143a. Flowers irregular ... PAPILIONACEAE 49

143b. Flowers regular.

144a. Leaflets 5-9 ... HIPPOCASTANACEAE 41

144b. Leaflets 3. ... ANACARDIACEAE 46

142b. Flowers gamopetalous. ... VERBENACEAE 105

44b. Herbs.

145a. Terrestrial or rarely amphibuous herbs.

14a6. Leaves simple.

147a. Calyx and corolla present.

148a. Flowers with both calyx and corolla.

149a. Flowers polypetalous.

150a. Flowers not regular.

151a. Stamens more than 10 ... RANUNCULACEAE 1

151b. Stamens less than 10.

152a. Flowers spurred ... BALSAMINACEAE 31

152b. Flowers not spurred.

153a. Stamens 8 - 10.

15a4. Stamens 8 ; ovary 2 - celled ... POLYGALACEAE 16

154b. Stamens 10 ; Ovary 1 - celled ... PAPILIONACEAE 49

153b. Stamens 5 ; ovary 1 - celled ... VIOLACEAE 13

150b. Flowers regular.

155a. Ovary inferior or subinferior.

156a. Ovary inferior ; plants erect, ascend - ding.

157a. Flowers not in umbels.

158a. Flowers uni-sexual ... BEGONIACEAE 65

158b. Flowers bi-sexual.

159a. Leaves entire ... MELASTOMATACEAE 63

159b. Leaves toothed ... ONAGRACEAE 63

156b. Ovary sub inferior ; plants, prostrate, succulent ; seeds tubercled, pitted ... PORTULACACEAE 18

155b. Ovary superior.

160a. Flowers uni-sexual ... EUPHORBIACEAE 125

160b. Flowers bi-sexual.

161a. Floral parts other than ovary in series of three ; scapigerous herbs ; leaves 2 ... PODOPHYLLIACEAE 8

161b. Floral parts other than ovary in series of four to five.

162a. Stamens more than 10.

163a. Carpels apocarpus.

164a. Carpels not seated on a fleshy disc.... RANUNCULACEAE 1

164b. Carpels seated on a fleshy disc ... PAEONIACEAE 2

163b. Carpels syncarpus.

165a. Leaves opposite ... HYPERICACEAE 20

165b. Leaves alternate.

166a. Sepals 2 or 3 ... PAPAVERACEAE 9

166b. Sepals 4 or 5 ... MALVACEAE 23

162b. Stamens not more than 10.

167a. Leaves opposite.

168a. Ovary of distinct car - pels ... CRASSULACEAE 55

168b. Ovary of combined carpels.

169a. Leaves entire.

170a. Styles 2 - 5 ... CARYOPHYLLACEAE 17

170b. Style simple ... LYTHRACEAE 61

169b. Leaves lobed or toothed ... GERANIACEAE 29

167b. Leaves alternate.

171a. Ovary of distinct carpels ... CRASSULACEAE 55

171b. Ovary of combined carpels.

172a. Petals 4 ... BRASSICACEAE 11

172b. Petals 5.

173a. Sepals connate below... SAXIFRAGACEAE 53

173b. Sepals free... LINACEAE 27

149b. Flowers gamopetalous.

174a. Ovary inferior.

175a. Stamens 3 ... VALERIANACEAE 75

175b. Stamens 2, 4 or 5.

176a. Ovary 1 - celled.

177a. Anthers united ... ASTERACEAE 77

177b. Anthers free ... DIPSACACEAE 76

176b. Ovary more than 1 - celled.

178a. Leaves stipulate ; whorled ... RUBIACEAE 74

178b. Leaves exstipulate, never whorled ... CAMPANULACEAE 90