

FLORISTIC DIVERSITY AND CONSERVATION STRATEGIES IN INDIA

VOL. II : IN THE CONTEXT OF STATES AND UNION TERRITORIES



BOTANICAL SURVEY OF INDIA
Ministry of Environment and Forests

FLORISTIC DIVERSITY AND CONSERVATION STRATEGIES IN INDIA

Volume - II
IN THE CONTEXT OF STATES AND
UNION TERRITORIES

Editors

V. Mudgal

P.K. Hajra



भारतीय वनस्पति सर्वेक्षण
BOTANICAL SURVEY OF INDIA

BOTANICAL SURVEY OF INDIA
Ministry of Environment and Forests

© Govt. of India, 1999

Date of Publication : December, 1999

No part of this publication can be reproduced stored in a retrieval system, or transmitted, in any form or means by electronic, mechanical, photocopying, recording, or otherwise, without prior written permission of the Director, Botanical Survey of India.

Price :

Published by the Director, Botanical Survey of India, P-8, Brabourne Road, Calcutta-700 001; Composed and Printed at Shiva Offset Press, 14, Old Connaught Place, Dehra Dun 248 001.

टी.आर. बालू
T.R. BAALU

मंत्री
पर्यावरण एवं वन
भारत सरकार
नई दिल्ली-110003
MINISTER
ENVIRONMENT & FORESTS
GOVERNMENT OF INDIA
NEW DELHI-110003

MESSAGE

Biodiversity is essential to the ecological security and economic prosperity of a nation. India, with over 46,000 known species of plants, accounts for eleven per cent of global floristic diversity. Of these, 17,500 species belong to the group of flowering plants which have significant direct and indirect use for mankind. In order to derive optimal benefit in a sustained manner, it is extremely important to know the precise identity of these plants, their habitat, distribution and utility. Botanical Survey of India, the premier survey organisation under the Ministry of Environment and Forests, has done commendable work in carrying out the onerous task of survey and documentation of the vast floristic resources of the country.

I am happy to note that based on enormous data on various facets of floristic wealth of our country accumulated over a period of more than hundred years, the Botanical Survey of India has initiated the publication of Status Report on plant diversity of the country, entitled "Floristic Diversity and Conservation Strategies in India" in six volumes. The first volume in this series, covering lower groups of plants or Cryptogams and the Gymnosperms was published in the Golden Jubilee year of India's Independence. The present volumes (II & III) are devoted to the Angiosperm plant diversity in various States and Union Territories of the Nation. These publications not only provide valuable information needed for evolving strategies for short and long term conservation of these resources but also provide valuable insight for their sustainable utilisation.

I take this opportunity to compliment the Scientists of BSI for bringing out these publications.


(T.R. BAALU)

विश्वनाथ आनंद
VISHWANATH ANAND



सचिव
पर्यावरण एवं वन मंत्रालय
भारत सरकार

SECRETARY
MINISTRY OF ENVIRONMENT & FORESTS
GOVERNMENT OF INDIA

FOREWORD

I am glad to know that the Botanical Survey of India is bringing out volumes II and III of "Floristic Diversity and Conservation Strategies in India"

The first volume in this series has already been published which contains valuable information on different recognised groups of non-flowering plants and Gymnosperms.

Volume II and III are devoted to the Biodiversity of flowering plants occurring in different Phytogeographical regions of India. These volumes capture the enormous floristic diversity, their utility and status. Numerous illustrations and coloured pictures have been added to enhance the scientific utility of the volumes.

I am sure that these volumes will prove very useful to managers, scientists, policy makers and general public.

(Vishwanath Anand)

CONTENTS

		<i>Page</i>
Message		iii
Foreword		v
Andaman and Nicobar Islands	P.S.N. Rao B.K. Sinha	473
Andhra Pradesh	V. Chandrasekaran S.R. Srinivasan	525
Arunachal Pradesh	H.J. Chowdhery	547
Assam	A.K. Baishya	615
Bihar	M. Das R.P. Bhattacharya V. Mudgal	663
Chandigarh	Bipin Balodi J.R. Sharma B.P. Uniyal	699
Dadra and Nagar Haveli	N.P. Singh P.P. Sharma	715
Daman and Diu	N.P. Singh P.P. Sharma P.G. Diwakar	731
Delhi	B.D. Naithani B.P. Uniyal	745
Goa	N.P. Singh M.J. Kothari	757
Gujrat	R.P. Pandey V. Singh	775

Haryana	S. Kumar	807
Himachal Pradesh	H.J. Chowdhery	845
Jammu and Kashmir	D.K. Singh B.P. Uniyal R. Mathur	905
Karnataka	N.P. Singh P.V. Prasanna B.G. Kulkarni	975
Kerala	M. Mohanan V.J. Nair	997

CONTRIBUTORS

A.K. Baishya	Botanical Survey of India Eastern Circle Shillong-793 003.
R.P. Bhattacharya	Botanical Survey of India Howrah-711 103.
V. Chandrasekaran	Botanical Survey of India Southern Circle Coimbatore-643 003.
H.J. Chowdhery	Botanical Survey of India Central Botanical Laboratory Howrah-711 103.
M. Das	Botanical Survey of India Howrah-711 103.
P.G. Diwakar	Botanical Survey of India Western Circle Pune-411 001.
M.J. Kothari	Botanical Survey of India Western Circle Pune-411 001.
B.G. Kulkarni	Botanical Survey of India Western Circle Pune-411 001.
S. Kumar	Botanical Survey of India Northern Circle Dehra Dun-248 195.
R. Mathur	Botanical Survey of India Northern Circle Dehra Dun-248 195.
M. Mohanan	Botanical Survey of India Southern Circle Coimbatore-643 003.

V. Mudgal	Botanical Survey of India Howrah-711 103.
V.J. Nair	Botanical Survey of India Southern Circle Coimbatore-643 003.
B.D. Naithani	Botanical Survey of India Northern Circle Dehra Dun-248 195.
R.P. Pandey	Botanical Survey of India Arid Zone Circle Jodhpur-342 008.
P.V. Prasanna	Botanical Survey of India Western Circle Pune-411 001.
P.S.N. Rao	Botanical Survey of India Andaman and Nicobar Circle Port Blair-744 102.
J.R. Sharma	Botanical Survey of India Northern Circle Dehra Dun-248 195.
P.P. Sharma	Botanical Survey of India Western Circle Pune-411 001.
D.K. Singh	Botanical Survey of India Northern Circle Dehra Dun-248 195.
N.P. Singh	Botanical Survey of India Western Circle Pune-411 001.
V. Singh	Botanical Survey of India Arid Zone Circle Jodhpur-342 008.

B.K. Sinha

**Botanical Survey of India
Andaman Nicobar Circle
Port Blair-744 102.**

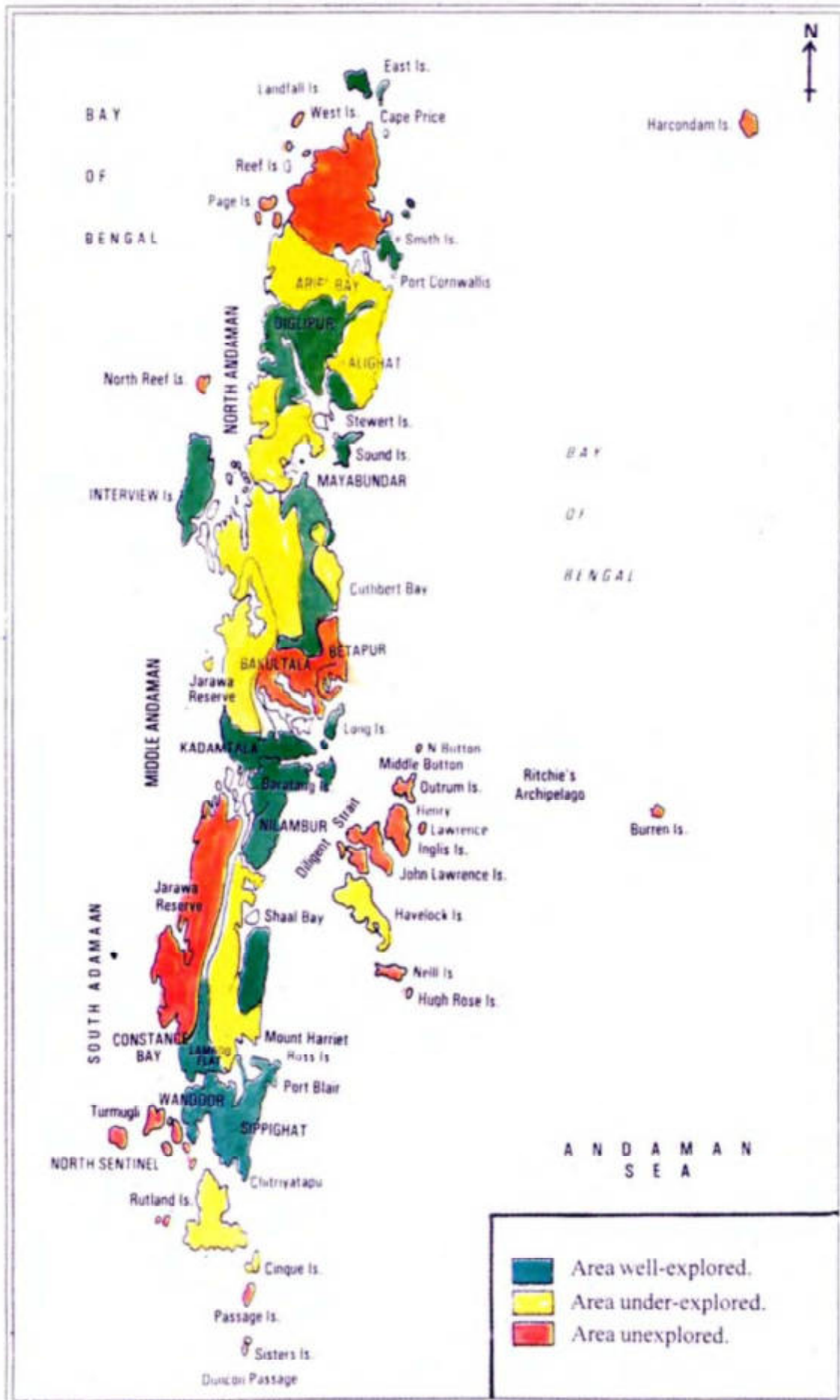
S.R. Srinivasan

**Botanical Survey of India
Southern Circle
Coimbatore-643 003.**

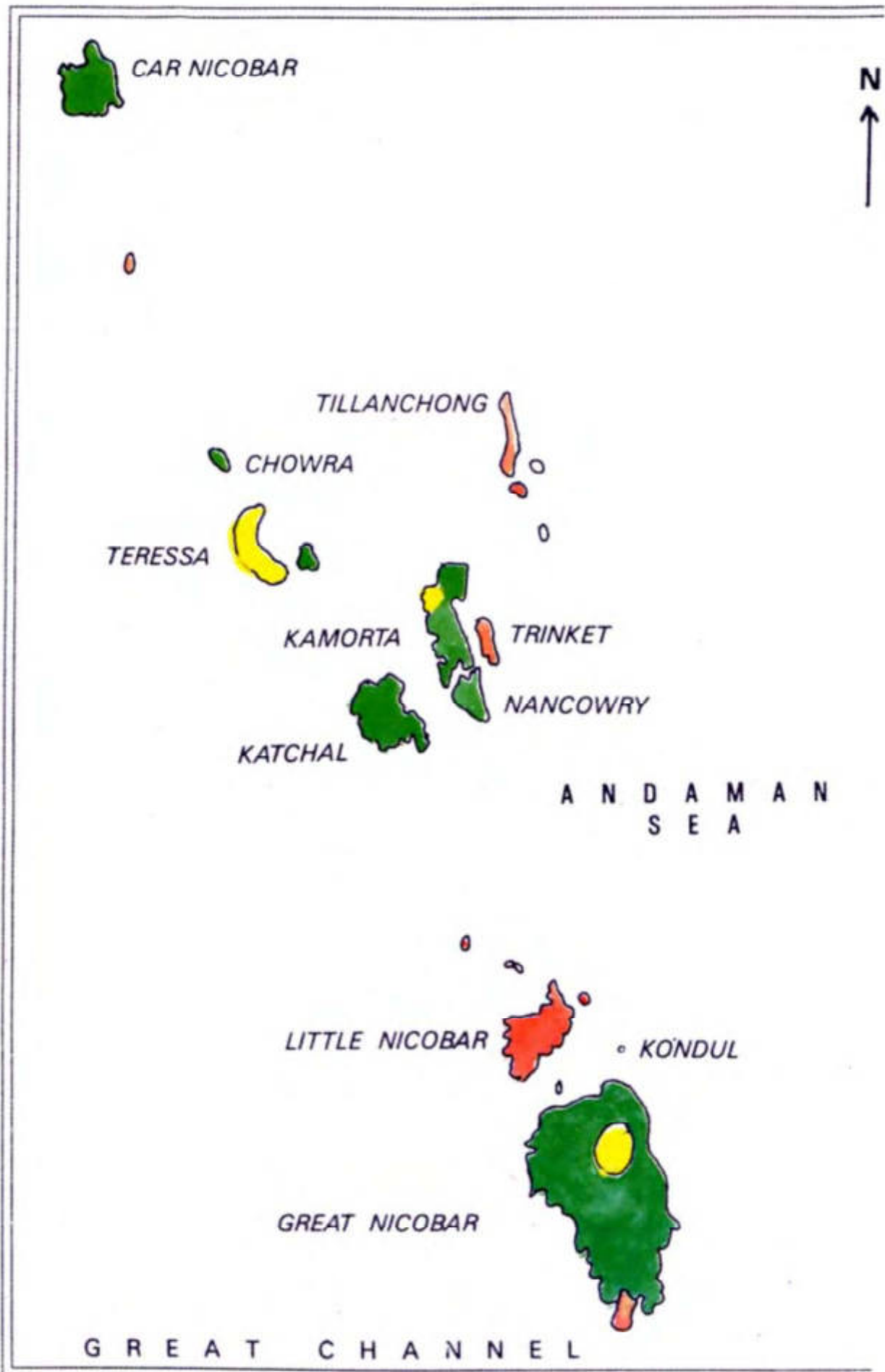
B.P. Uniyal

**Botanical Survey of India
Northern Circle
Dehra Dun-248 195.**

4. FLORISTIC DIVERSITY - IN THE CONTEXT OF STATES AND UNION TERRITORIES



MAP OF ANDAMAN ISLANDS



MAP OF NICOBAR ISLANDS

ANDAMAN AND NICOBAR ISLANDS

P.S.N. Rao

B.K. Sinha

The Andaman and Nicobar archipelago consisting of about 350 islands and over 200 islets lies in the Bay of Bengal (Latitude 6° - 14° N and Longitude 92° - 94° E). Almost all the islands and islets oriented in north-south direction simulate an arch and stretch over a length of about 912 km. The northern most Landfall island is about 190 km from Cape Negrais in Myanmar and southern most Great Nicobar island is about 150 km from Sumatra in Indonesia. The Andaman islands are separated from the Nicobar group of islands by a sea space of 155 km which includes 10 degree channel. With a total geographical area of about 8290 sq km the terrain of most of the islands is hilly with undulating small mountains. The highest hill in the Andaman group is the Saddle Peak scaling a height of about 720 m and in the Nicobar group is Mt. Thullier with an altitude of about 670 m above m.s.l. The 1960 km long coastline is highly indented and several creeks penetrate into the island from inland bays.

The islands are mainly of thick eocene sediments deposited on pretertiary fine grey sandstone, shales and silt stones in which basic and ultrabasic igneous rocks are found to be intrusive. The calcareous sandstones and sand rocks are interspersed with conglomerates and intercalated clays. Higher elevations are characterised by serpentine and gabbro formations while coral reef formations of recent origin are important geological formations in the intertidal belt. The rock formations of southern most Great Nicobar Island are considered to be of younger tertiary age and are geologically similar to the south-west coast of Sumatra and younger in origin than that of Andaman group of Islands.

The soils are immature, loose in texture, poor in drainage and low in moisture retaining capacity. As the soils are poor in nutrient content, the entire nutrient capital necessary for the continuous growth of lush green tropical vegetation is tied up in the living plant itself. Sandy alluvial soil is generally found in the creeks and sheltered coasts. The richer grey, brown and red soils are found in the island forest and humus is not allowed to accumulate much as it is washed away by torrential rains.

The monsoonal regime of south-east Asia governs the climate of the islands. The general climatic condition of the islands is that of warm and humid tropics with the temperature ranging between 22° C and 30° C. The islands receive heavy rainfall from both the south-west and north-east monsoon, the former from May to September and the latter from October to December with the average annual rainfall ranging from 3000 to 3800 mm. The cyclonic winds accompanied by thunder and lightning frequent the islands. January to March show fairly dry weather with scanty rainfall. The mean relative humidity is rather high and usually remains between 82 and 85% throughout the year.

The flora of these islands still remains rather insufficiently known. Earlier explorations were confined to only a few inhabited islands, leaving many islands untouched which were unapproachable. Only recently with the intensive explorations of the Botanical Survey of India, the islands with virgin forest are becoming better known botanically.

A knowledge of the botanical history of any geographical area is of paramount importance for understanding its flora and its phytogeography. As known from literature, the botanical history of the islands of Andaman and Nicobar dates back to 1791 when colonel Robert Kyd visited the islands and introduced to the Royal Botanic Garden, Calcutta, some Andaman plants which were later described in Roxburgh's *Flora Indica*. Helfer, a Russian Scientist and Geologist visited the islands with a view to ascertain their mineral resources, also made extensive botanical collections but after his murder by aborigines on a North Andaman Island, were unfortunately mixed up with his Tenasserim plants and all were labelled 'Tenasserim and Andaman' which resulted in a great deal of confusion. In the year 1866, Kurz, a German botanist and then Curator of the herbarium of the Royal Botanic Garden, Calcutta was sent to collect materials for flora of the Andaman Islands who made extensive collections and published a report in 1870 on the vegetation of South Andaman Islands. Subsequently, several botanists like Parish, Prain, King, and Rogers made extensive botanical studies between 1870 and 1903, which and his own efforts enabled Parkinson (1923) to bring out a Flora of Andaman Islands dealing mainly with woody elements. Since then vegetational accounts on Nicobar Islands, especially the Great Nicobar Island, were published by Sahni (1953), Thothathri (1962), Balakrishnan (1987) subsequent to this a preliminary list of angiosperms of Andaman and Nicobar Islands by Vasudeva Rao (1986), a supplementary list by Lakshminarasimhan and Rao (1996) and a phytogeographical note on

the islands by Rao (1996) have greatly contributed towards understanding the floristic composition of the archipelago and in knowing their phytogeographical significance.

VEGETATION

The insular nature of the island territory, physical isolation between the islands and from the neighbouring continental land masses through millions of years has resulted in the evolution of a rare and distinct flora, which though related to flora mainland India shows much closer affinity with Myanmar, Malaysian and Indonesian flora. The rich natural vegetation of Andaman and Nicobar Islands can be broadly classified as tropical evergreen. Balakrishnan (1989) has dealt with the vegetation and floristics and based on the proximity of the sea and salinity of the soil, the vegetation is placed into two types as Littoral and Inland types.

The Littoral and Inland forest are further classified as follows:

- | | | |
|----|------------|---------------------------------|
| A. | LITTORAL : | 1. Mangrove forest |
| | | 2. Strand (or beach) vegetation |
| | | 3. Tidal or swamp forest |
| B. | INLAND : | 1. Evergreen forest |
| | | 2. Deciduous forest |
| | | 3. Grasslands |
| | | 4. Hydrophytic vegetation |

A. LITTORAL

1. Mangrove forest

The irregular and deeply indented coastline of these islands results in innumerable creeks, bays and estuaries which facilitate the development of rich and extensive mangrove forest. The mangroves develop well in areas which are covered with brackish water during high tides protected against heavy wave action and somewhat sheltered from high winds. They prefer clayey soil. The mangrove vegetation is evergreen and simple in structure varying from 6 to 24 m in height. The most common trees are : *Rhizophora mucronata*, *R. apiculata*, *Bruguiera gymnorrhiza*, *B. parviflora* and *Ceriops tagal*, *Avicennia marina* is frequent forming small patches. Some of the less common plants are *Lumnitzera littorea*, *L. racemosa*, *Aegiceras corniculatum*, *Excoecaria agallocha* and

Xylocarpus granatum, *Nipa fruticans* is a water coconut found in the mangrove forest. The mangrove fern *Acrostichum aureum* is associated with *Acanthus ilicifolius*.

2. Strand vegetation

The vegetation occupying the sandy belt exhibits several species of plants. These include herbaceous dune formations on the open beach and wooded beach forest towards the interior. On the sandy beach, the foreground is marked by *Ipomoea pescaprae*, *Cassytha filiformis*, *Vigna marina* and *Phyla nodiflora*. Immediately behind these plants are a number of littoral shrubs. *Scaevola sericea* is seen fringing the coast as a green hedge. Behind the dense growth of *Scaevola sericea* are other shrubby plants like *Ximenia americana*, *Hibiscus tiliaceus*, *Colubrina asiatica*, *Caesalpinia crista*, *Desmodium umbellatum* and *Crinum asiaticum*. *Mucuna gigantea* is a common climber.

Along retreating coasts, the dominant tree is *Barringtonia asiatica* which is often associated with trees like *Guettarda speciosa*, *Calophyllum inophyllum* and *Pongamia pinnata* and shrubs like *Pemphis acidula*, *Argusia argentea*, *Vitex trifolia*, *Pandanus andamanensium* and *P. tectorius*.

The beach forest which occur behind the sand zone and *Barringtonia* formations are comprised of trees like *Hernandia peltata*, *Thespesia populnea*, *Pandanus tectorius*, *Manilkara littoralis*, *Intsia bijuga*, *Syzygium samarangense*, *Sophora tomentosa* and *Glochidion calocarpum*. *Cycas rumphii* occurs in the beach forest in large populations in Andaman and Nicobar Islands. The herbaceous plants include *Ischaemum muticum*, *Acalypha indica*, *Euphorbia hirta*, *Centotheca lappacea*, *Ophiorrhiza mungos*, *Aerva lanata* and *Cyperus kyllinga*. Climbers found on the trunks of many trees include *Dischidia benghalensis*, *D. nummularia*, *Pothos roxburghii* and *Hoya parasitica*. Epiphytic orchids like *Bulbophyllum lepidum*, *Cymbidium aloifolium*, *Eria andamanica* and ferns like *Polypodium phymatodes* and *Drynaria quercifolia* are also common.

3. Tidal or swamp forest

They are typical a closed evergreen forest of medium-sized trees which have adapted in various ways to live on tidal mud which is

permanently wet with salt water and submerged during every tide. A peculiarity of the tidal forest trees is the occurrence of special root formations, stilt roots supporting stem base, plank buttress root formations, conically thickened stem bases of small erect aerial roots emerging from mud. These help to improve the air supply to the root system or to support and protect the trees against strong winds. Trees like *Cerbera odollam*, *Heritiera littoralis* and *Barringtonia racemosa* are common in association with *Ficus microcarpa*, *Cynometra iripa*, *Cynometra ramiflora*, *Scyphiphora hydrophyllacea*, *Excoecaria agallocha*, *Lumnitzera racemosa*, *Xylocarpus granatum*, *Sonneratia acida* and *Dolichandrone spathacea*, *Phoenix paludosa*, *Derris trifoliata* a slender erect palm is also common. *Caesalpinia crista*, *Derris scandens*, *D. heterophylla*, *Flagellaria indica* are the common woody climbers and stragglers. *Sarcolobus carinatus*, *Hoya parasitica* and *Dischidia benghalensis* are other climbers. Epiphytic orchids like *Dendrobium*, *Bulbophyllum*, *Eria* etc., and ferns like *Drymoglossum*, *Lepisorus* and *Asplenium* grow on trunks and branches of the trees.

B. INLAND

1. Evergreen forest

These represent the climax vegetation with a closed compact community of diverse tropical plants. The canopy is closed and consists of three storeys. There is little sunlight penetrating the forest floor. The soil is composed of clayey loam with micaceous sandstones below.

The vegetation is mainly composed of tall trees ladden with lianas and other epiphytes. *Dipterocarpus griffithii*, *D. incanus*, *D. turbinatus*, *Sideroxylon longipetiolatum*, *Hoppea odorata*, *Endospermum diadenum* and *Planchonia andamanica* occur in top storey. The second storey consists of smaller trees like *Baccaurea sapida*, *Myristica andamanica*, *Buchanania spendens*, *Randia longiflora*, *Pometia pinnata* etc. Shrubs like *Clerodendrum viscosum*, *Leea indica*, *Dinochloa andamanica*, *Maesa andamanica*, etc., occur. Amongst the lianas the common ones include *Calamus longisetus*, *Daemonorops manii*, *D. kurzianus*, *Entada rheedii*, *Mezoneuron cucullatum* etc. *Phragmites karka* and *Saccharum spontaneum* occur sometimes in open places and edges of forest. *Asplenium nidus*, *Drymoglossum piloselloides* are the epiphytic ferns. *Dendrobium aphyllum* and *D. secundum* are the epiphytic orchids commonly seen.

2. Deciduous forest

Such forest occur on undulating ground in the foot hills where the soil is comparatively dry as compared to evergreen forest. *Pterocarpus dalbergioides* is associated with *Terminalia procera*, *T. bialata*, *T. manii*, *Canarium euphyllum*, *Parishia insignis*, *Albizia lebbeck* etc. The second storey consists of small trees like *Lannea coromandelica*, *Sageraea elliptica*, *Sterculia villosa*, *Semicarpus kurzii* etc. The third storey is represented by *Licula spinosa*, *Grewia disperma*, *Cordia grandis* etc. Among the shrubs *Actephila excelsa*, *Ixora grandifolia*, *Bridelia griffithii*, *Rinorea bengalensis* occur. Canes are sparsely distributed. *Dinochloa andamanica* is a common climber. Herbaceous vegetation is represented by *Paspalum conjugatum*, *Echinochloa crus-galli*, *Dichanthium annulatum* and also fern *Pteris quadriaurita*. Epiphytic plants are less which include *Dendrobium aphyllum*, *Cymbidium aloifolium* and *Pholidota imbricata*.

3. Grasslands

Several disturbed, deforested and denuded hill rocks exhibit rich grasslands with *Imperata cylindrica* and *Saccharum spontaneum* as dominant species. Grasses like *Heteropogon contortus*, *Chrysopogon aciculatus*, *Eragrostis unioides* are found associated with sedge like *Scleria lithosperma* and ferns *Dicranopteris linearis* and *Lygodium flexuosum*. The herbs and undershrubs include *Uraria lagopodioides*, *Desmodium heterocarpon*, *Triumfetta rhomboidea* and *Urena lobata*. Large shrubby plants are rare and comprise *Melastoma malabathricum* and *Erycibe paniculata*.

4. Hydrophytic vegetation

The scarcity of natural stagnant pools, lakes etc., results in rather poor fresh water flora in these islands. In the few ponds and paddy fields, plants like *Ipomoea aquatica*, *Lemna purpusilla*, *Najas indica*, *Nymphaea stellata* are seen. Among the fresh water marshy plants, notable ones are *Ludwigia perennis*, *Blyxa roxburghii*, *Monochoria vaginalis*, *Polygonum barbatum*, *Fuirena glomerata*, *Hygrophila erecta* and various species of sedges.

About 70% of the total geographical area which constitutes more than forty inhabited and uninhabited islands is explored. The remaining 30% of the geographical area encompasses reserved/protected forest,

Jarawa and Sentenelese hostile areas and some inaccessible islands. On the basis of the explorations undertaken in the Union Territory, it is presumed that not more than 100 taxa can be added to the existing flora. In due course these unexplored and underexplored areas will be targetted so as to have a comprehensive account of the floristic diversity.

FLORISTIC DIVERSITY AND PHYTOGEOGRAPHY

The presence of over 2000 indigenous and 500 non-indigenous angiospermic species within a land area of 8290 sq km is a significant feature of Andaman and Nicobar Islands becoming a cynosure not only for plant taxonomists but also for conservationists. The rare and distinct flora which evolved through millions of years due to insular nature of the territory, physical isolation between the islands and also from the neighbouring continental landmasses is unique to India. Though allied to mainland Indian flora, the flora of Andaman group shows much closer affinity towards Sunda biogeographical zone. Representing 700 genera and belonging to 137 families, about 14% of the angiosperm species are endemic to the islands (Table I). At the generic level endemism is rather less with only two genera viz., *Sphyranthera* (Euphorbiaceae) with two species and *Pubistylis* (Rubiaceae) with one species. The islands are rich in Pteridophytic flora also with little over 100 species represented, of which the 'Tree fern' *Cyathea* is most interesting with significant population density in Great Nicobar.

Table I
Endemic plants

ACANTHACEAE	ANNONACEAE
<i>Hypoestes anamanensis</i>	<i>Artabotrys nicobarianus</i>
<i>H. thothatrhii</i>	<i>Friesodielsia khoshooii</i>
<i>Rostellularia andamanica</i>	<i>Miliusa andamanica</i>
<i>Strobilanthes andamanensis</i>	<i>Mitrephora andamanica</i>
<i>S. glandulosus</i>	<i>Orophaea katschallica</i>
	<i>O. salicifolia</i>
ANACARDIACEAE	<i>O. torulosa</i>
<i>Buchnanina platyneura</i>	<i>Polyalthea parkinsonii</i>
<i>Mangifera andamanica</i>	<i>Popowia parvifolia</i>
<i>Semicarpus kurzii</i>	<i>Pseuduvaria prainii</i>

Sageraea listeri

Uvaria andamanica

U. hamiltonii var. *kurzii*

U. nicobarica

APOCYNACEAE

Alstonia kurzii

Chilocarpus sunainainanus

Tabernaemontana crispa

ARALIACEAE

Pseudobrassiaopsis andamanica

Schefflera pushpangadanii

ASCLEPIADACEAE

Genianthus horei

Toxocarpus kurzii

ASTERACEAE

Vernonia andamanica

BEGONIACEAE

Begonia andamanensis

BOMBACACEAE

Bombax insigne var. *andamanica*

B. insigne var. *polystemon*

BORAGINACEAE

Tournefortia wallichii

BURSERACEAE

Canarium manii

CAESALPINIACEAE

Bauhinia nicobarica

Crudia balachandrae

CELASTRACEAE

Glytopetalum calocarpum

Nicobariodendron sleumeri

CLUSIACEAE

Garcinia andamanica

G. cadelliana

G. calycina

G. jelinekii

G. kingii

G. kurzii

G. microstigma

Mesua manii

COMBRETACEAE

Terminalia manii

T. procera

CONNARACEAE

Connarus kingii

C. nicobaricus

Ellipanthus calophyllus

DICHAPETALACEAE

Dichapetalum gelonoides ssp.
andamanica

DILLENACEAE

Dillenia andamanica

DIPTEROCARPACEAE

Dipterocarpus incanus

D. turbinatus var. *andamanica*

EBENACEAE

Diospyros marmorata

EUPHORBIACEAE

Actephila puberula

Antidesma andamanicum

Bridelia kurzii

B. nayaraii

B. nicobarica

Claoxylon rostratum

Cleistanthes balakrishnii

Cleistanthes occidentalis
Cnesmone javanica var. *glabriscula*
Dimorphocalyx balakrishnii
D. dilipianus
Drypetes bhattacharyai
D. andamanica
D. calocarpa
D. leiocarpa
Euphorbia epiphylloides
Excoecaria rectinervis
Glochidion airy-shawii
G. andamanicum
G. bilobulatum
G. brunneum ssp. *andamanicum*
G. calocarpum
G. calocarpum var. *subsessile*
G. subsessile
Macaranga nicobarica
Mallotus andamanicus
M. floribundus
M. oblongifolius
Phyllanthus andamanicus
Sphyrantha airy-shawii
S. lutescens
Trigonostemon nicobaricus
T. viridissimus var. *confertifolius*

FABACEAE

Derris andamanica
D. elegans f. *andamanensis*
Pterocarpus dalbergioides
Tadehagi triquetrum ssp.
andamanicum

FLACOURTIACEAE

Casearia andamanica
C. insularis

GESNERIACEAE

Cyrtandra burtii
C. occidentalis

HIPPOCRATEACEAE

Hippocratea andamanica
H. nicobarica
Salacia nicobarica

ICACINACEAE

Codiocarpus andamanica
Gomphandra comosa

LAMIACEAE

Scutellaria andamanica

LAURACEAE

Cryptocarya andamanica
C. ferrarsii
C. insularis
Litsea kurzii
L. leiantha
Neolitsea andamanica
N. balakrishnanii
N. nicobarica
Nothaphoebe nicobarica
N. panduriformis var.
paucinervia

LEEACEAE

Leea grandifolia

LOGANIACEAE

Strychnos andamanensis
S. narcondamensis

LORANTHACEAE

Ginjalloa andamanica

LYTHRACEAE

Lagerstroemia hypoleuca

MALPIGHIACEAE

Hiptage thoatharii

MELASTOMATACEAE

Otanthera nicobarensis

MELIACEAE

Aglaia fusca

A. glaucescens

Amoora andamanica

A. manii

Dysoxylum andamanicum

D. thyrosoidenum var.
andamanica

Walsura candollei

MEMECYLACEAE

Memecylon andamanicum

M. caeruleum var. *pulchrum*

M. collinum

M. elegans

MENISPERMACEAE

Cyclea pendulina

Stephania andamanica

Tinomiscium nicobarica

Tinospora andamanica

MORACEAE

Ficus andamanica

MYRISTICACEAE

Horsfieldia macrocarpa var.
cannaroides

Knema andamanica ssp.
andamanica

Myristica andamanica

MYRSINACEAE

Ardisia andamanica var. *effusa*

Embelia microcalyx

Maesa andamanica

M. andamanica var.
longipedicellata

MYRTACEAE

Cleistocalyx nicobaricus

Syzygium andamanicum

S. kurzii var. *andamanica*

S. manii

OLACACEAE

Olex imbricata var. *membranifolia*

OLEACEAE

Chionanthus parkinsonii

Jasminum andamanicum

J. cordifolium ssp. *andamanicum*

J. multiflorum var. *nicobaricum*

J. unifoliolatum

PASSIFLORACEAE

Adenia heterophylla ssp.
andamanica

RANUNCULACEAE

Clematis smilacifolia ssp.
andamanica

RHAMNACEAE

Gouania andamanica

RUBIACEAE

Aidia forbesii

Argostemma sonerelioides

Canthium gracilipes

Diplospora andamanica

Hedyotis andamanica

H. congregata var. *nicobarica*

H. paradoxa

Hydnophytum andamanensis

Ixora andamanica

I. barbata

I. brunnescens

I. capituliflora

Ixora cuneifolia var. *macrocarpa*
I. finlaysoniana
I. hymenophylla
I. rosella
I. tenuifolia
I. longibracteata
I. multibracteata
I. nicobarica
Jainia nicobarica
Lasianthes andamanicus
Neonauclea gageana
N. nicobarica
Ophiorrhiza infundibularis
O. nicobarica
Psychotria andamanica
P. balakrishnanti
P. helferi var. *angustifolia*
P. kurzii
P. nicobarica
P. pendula
P. platyneura
P. tylophora
Pubistylus andamanensis
Randia andamanica
Rothmannia pulcherrima
Tarenna weberaefolia
Urophyllum andamanicum
Wendlandia andamanica

RUTACEAE

Citrus nobilis var. *limonellus*
Glycosmis mauritiana var.
andamanensis
G. mauritiana var. *insularis*
G. pilosa
Paramignya andamanica
Zanthoxylum andamanicum

SANTALACEAE

Henslowia erythrocarpa

SAPINDACEAE

Allophyllus subfalcatus var.
acutissimus
Lepidopetalum jackianum
Lepisanthes andamanica

SAPOTACEAE

Diploknema butyracea
 var. *andamanensis*
Manilkara littoralis
Mimusops andamanensis
Planchonella kingiana
P. kingiana var. *andamanica*

SCROPHULARIACEAE

Cyrtandroemia nicobarica
Limnophila chinensis var.
scaberrima

STERCULIACEAE

Sterculia rubiginosa var.
glabrescens

THYMELAEACEAE

Enkleia andamanica

TILIACEAE

Grewia calophylla

ULMACEAE

Apananthe lucida

URTICACEAE

Elatostemma novarae
Pellionia procrudifolia

VERBENACEAE

Clerodendrum lankawilense var.
andamanense
Vitex diversifolia
V. wimberleyi

VIOLACEAE*Rinorea heteroclita***VITACEAE***Tetrastigma andamanicum***XANTHOPHYLLACEAE***Xanthophyllum andamanicum***MONOCOTYLEDONS :****AGAVACEAE***Dracaena brachyphylla***AMARYLLIDACEAE***Crinum pusillum***ARACEAE**

Aglaonema nicobarica
Amorphophallus carnosus
A. longistylus
A. oncophyllus
Arisaema saddlepeakense

ARECACEAE

Bentinckia nicobarica
Calamus andamanicus
C. dilaceratus
C. nicobaricus
C. pseudorivalis
C. unifarius var. *pentong*
C. viminalis var. *fasciculatus*
Daemonorops kurzianus
D. manii
Korthalsia rogersii
Pinanga andamanensis
P. manii
Rhopaloblaste angusta

CYPERACEAE

Cyperus kurzii
Hypolytrum balakrishnanii

DIOSCOREACEAE

Dioscorea rogersii
D. vexans

MARANTACEAE

Phrynium paniculatum
Stachyphrynium cadellianum

ORCHIDACEAE

Aerides emericii
Anoectochilus nicobaricus
Bulbophyllum protractum
Dendrobium gunnarii
Dendrobium tenuicaule
Eria andamanica
E. bractescens var. *kurzii*
Eulophia nicobarica
Habenaria andamanica
Malaxis andamanica
Malleola andamanica
Phalaenopsis speciosa
P. speciosa var. *christiana*
P. speciosa var. *imperatrix*
Poaephyllum nicobaricum
Pomatocalpa andamanicum
Pteroceras alatum
P. muriculatum
Smitinandia helferi
Taeniophyllum andamanicum
Trichoglottis orchidea
Vanilla andamanica
Zeuxine andamanica
Z. rolfiana

PANDANACEAE

Pandanus leram var.
andamanensium

POACEAE

Bambusa kurzii
Oryza indandamanica
Schizostachyum rogersii

ZINGIBERACEAE*Alpinia manii**A. phoenicea**Amomum fenzlii**Boesenbergia albo-lutea**Globba pauciflora**Kaempferia siphonantha*

Among the non-endemic angiospermic species about 40% are not found in mainland India but extend their distribution to south-east Asia including Myanmar, Thailand, Malayasia and Sumatra (Table II). As the flora of the Nicobar Islands is essentially Malesian it is also called subcontinental island flora (Balakrishnan, 1989). The flora of Andaman group of islands is distinctly different from that of Nicobars which is evident from the fact that the genera *Pterocarpus* and *Dipterocarpus* so common in the Andaman islands are not found in the Nicobar islands while the Melastomaceous genera *Otanthera* and *Astronia*, the Gesnariaceous genus *Cyrtandra*, *Stemonurus* of Icacinaceae, *Bentinckia* and *Rhopaloblaste* of Arecaceae, *Spathoglottis* of Orchidaceae and many more species occurring in Nicobar Islands are totally absent or sometimes cultivated in the Andaman Islands. The striking dissimilarities between the flora of Andaman group and Nicobar group are owing to the reason that the Andaman Islands have more species common to north-east India, Myanmar and Thailand while Nicobar Islands have more species common with Malaysia in the east and Indonesia in the south. To cite a few, some rare orchids of north-east India such as *Porpax meirax* and *Ascocentrum ampullaceum* find place on the Saddle Peak in the North Andaman. The species which share their distribution between north-east India, Myanmar, Thailand and Andaman Islands are *Coelogyne trinervia*, *C. thailandica*, *Thunia alba* and *Hopea helferi*.

Table II

Plant species found only in Andaman and Nicobar biogeographic zone of India followed by world distribution

Name of the species	Distribution
ANGIOSPERMS	
<i>Anaxagorea javanica</i>	Malaya, Java
<i>Goniothalamus malayanus</i>	Malay peninsula, Borneo, Sumatra
<i>Mazzetia parviflora</i>	Malesia, Sumatra, Borneo, Thailand
<i>Miliusa mollis</i>	Thailand

Name of the species	Distribution
<i>Uvaria rufa</i>	Thailand, Malesia, China to New Guinea
<i>Polyalthia caulifera</i>	Indonesia, Thailand
<i>Pycnarrhena longifolia</i>	Malaya, Java
<i>Tinomiscium petiolare</i>	Malaya, Sumatra, Java
<i>Casearia grewiaefolia</i> var. <i>gelonoids</i>	Indo-China M. Peninsula, Indonesia
<i>Xanthophyllum vitellinum</i>	Sumatra, Java
<i>Saurauia bracteosa</i>	Java
<i>Indrouchera griffithiana</i>	Malaya, Borneo, Java
<i>Atalantia simplicifolia</i>	Malaya
<i>Euodia parkinsonii</i>	Myanmar
<i>Dacryodes rugosa</i>	Malaya, Sumatara, Java, Borneo
<i>Aglaia argentea</i>	Malaya, Java
<i>Chisocheton longistipitatus</i>	Indonesia, New Guinea
<i>Dysoxylum arborescens</i>	Indo-China
<i>D. densiflorum</i>	Sumatra, Java
<i>D. macrocarpum</i>	Java
<i>D. thyrsiodeum</i>	Malaya
<i>Sandoricum koetjapa</i>	Myanmar, Thailand, Malesia
<i>Walsura pinnata</i>	Java
<i>Smythea lanceata</i>	Malesia, Java, Philippines
<i>Allophyllus dimorphus</i>	Indo-China, Philippines
<i>Connarus semidecandrus</i>	China, Thailand, Malesia to Pacific Islands
<i>Combretum yunnanense</i>	Malaya, Java, Indo-China
<i>Meliosma lanceolata</i>	Sumatra, Java, Borneo
<i>Ochthocharts javanica</i>	Thailand, Sumatra, Java, Borneo, Philippines
<i>Memecylon excelsum</i>	Sumatra, Java, Borneo, Malaya
<i>M. oleifolium</i>	Indonesia, Malesia, Thailand
<i>Schefflera longifolia</i>	Malesia, Java
<i>Mastixia trichotoma</i> var. <i>maingayti</i>	Malaya, Sumatra, Java
<i>Alangium javanicum</i>	Java

Name of the species	Distribution
<i>Gardenia tubifera</i>	Malaya, Sumatra, Java
<i>Greenia jackii</i>	Malaya
<i>Ixora kurziana</i>	Sumatra, Java
<i>Mussaenda villosa</i>	Malaya, Bornea, Thailand
<i>Lasianthus stipularis</i>	Myanmar, M. Peninsula
<i>Timonius compressicaulis</i>	Malaya, Sumatra, Java
<i>Uncaria cordata</i> var. <i>ferruginea</i>	Malaya, Sumatra, Java
<i>U. lanosa</i> var. <i>ferrea</i>	Malaya, Sumatra, Java
<i>Vernonia cymosa</i>	Java
<i>Embelia viridiflora</i>	Java
<i>E. macrocarpa</i>	Malaya Peninsula
<i>Symplocos fasciculata</i>	Malaya, Java, Philippines
<i>Ligustrum glomeratum</i>	N. Malaya, Sumatra, Myanmar, Java, Philippines
<i>Alstonia macrophylla</i>	Thailand, Malesia
<i>Kopsia scortechinii</i>	Malaya Peninsula
<i>Rauvolfia sumatrana</i>	Malaya, Sumatra
<i>Hoya wrayi</i>	Malaya Peninsula
<i>Aeschynanthus volubilis</i>	Java
<i>Rhynchotechum parviflorum</i>	Malaya, Sumatra, Java
<i>Mañanthes sumatrana</i>	Java, Sumatra
<i>Storbilanthes timorensis</i>	Timor Island
<i>Telismanniodendron pteropodum</i>	Malaya, Indonesia, Philippines.
<i>Apama tomentosa</i>	Java
<i>Aristolochia unguifolia</i>	Sumatra, Borneo
<i>Piper clypeatum</i>	Malay Peninsula
<i>Piper miniatum</i>	Malaya, Java
<i>Knema laurina</i>	Thailand, Malaya, Borneo, Java, Sumatra
<i>Myristica elliptica</i>	Malaya, Sumatra, Borneo
<i>Kibara coriacea</i>	Malaya, Sumatra, Java
<i>Nothophoebe panduriformis</i>	Malaya
<i>Helicia serrata</i>	Malaya, Sumatra, Borneo, Java
<i>Phaleria macrocarpa</i>	Malaya, Java
<i>Aporosa nigricans</i>	Thailand, Malaya, Borneo

Name of the species	Distribution
<i>Blumeodendron kurzii</i>	Myanmar, Java, Malaya
<i>Baccaurea sumatrana</i>	Malaya, Sumatra, Borneo
<i>Bridelia tomentosa</i> var. <i>glabrifolia</i>	Philippines, Lesser Sunda Island
<i>Cleidion nitidum</i>	Sri Lanka
<i>Dryetes microphylla</i>	Malaya, Borneo, Philippines
<i>Mallotus floribundus</i>	S.E. Asia to Queensland
<i>M. laevigatus</i>	Java, Sumatra, Borneo
<i>Neoscortechinia nicobarica</i>	Malaya, Borneo, Java
<i>Cypholophus moluccanus</i>	Sumatra to Pacific Island
<i>Ficus pendens</i>	Malaya, Sumatra, Sarawak, North Borneo
<i>Ficus magnoleaefolia</i>	Java
<i>Gironneira subaequalis</i>	China, Thailand, Myanmar, Malesia to Pacific Islands
<i>Bulbophyllum macranthum</i>	Myanmar, Borneo, Java, Malaya
<i>Dendrobium pènsile</i>	Malaya
<i>Hetaeria obliqua</i>	Malaya, Indonesia
<i>Hetaeria oblongifolia</i>	Myanmar, Thailand, Malesia, North Australia
<i>Nervilia punctata</i>	Thailand, Malesia, Indonesia
<i>Phalaenopsis speciosa</i> var. <i>tetraspis</i>	Java
<i>Plocoglottis javanica</i>	Myanmar, Thailand, Malesia, Indonesia
<i>Pteroceras berkeleyi</i>	Malaya
<i>Spathoglottis plicata</i>	Thailand, Indo-China, Taiwan, Malesia
<i>Thrixspermum hystrix</i>	Myanmar, Thailand, Malesia
<i>Trichoglottis cirrhifera</i>	Thailand, Malaya, Java
<i>Vrydagzynea albida</i>	Myanmar, Thailand, Malesia, Indo- China
<i>Korthalsia echinometra</i>	Myanmar, Malesia
<i>Aglaonema simplex</i>	Myanmar, Java
<i>A. simplex</i> var. <i>malaccense</i>	Myanmar, Malaya

Name of the species	Distribution
<i>Homalomena griffithii</i> var. <i>ovata</i>	Malaya
<i>H. nutans</i>	Malesia
<i>Pothos macrocephalus</i>	Malesia
<i>Carex cryptostachys</i>	S.China, Malaya, Philippines, Australia
<i>Carex rafflesiana</i>	Malesia, Java, Philippines
<i>Mapania cuspidata</i> var. <i>angustifolia</i>	Malesia
<i>Centotheca longilamina</i>	Sri Lanka, Myanmar, Malaya, Thailand, Java
<i>Coelorachis glandulosa</i>	Myanmar, Malaya, Java, Indo-China, Philippines

PTERIDOPHYTES

<i>Syngramma alsimaefolia</i>	Malesia
<i>Vittaria ensiformis</i>	Malesia, Madagascar
<i>Lindsaea parasitica</i>	Malesia
<i>L. tetragona</i>	Malesia, Fiji and Solomon Islands
<i>Bolbitis sinuata</i>	Thailand, Malesia, New Guinea
<i>Nephrolepis falcata</i>	Thailand, Malesia
<i>Davallia solida</i>	Myanmar, Malesia, Australia
<i>Humata heterophylla</i>	Malesia to Pacific Is.
<i>H. pectinata</i>	Sumatra to Soloman Is.
<i>Asplenium sublaspertifolium</i>	Malaya, S. China
<i>A. tenerum</i> var. <i>retusum</i>	Malaya
<i>Cyclosorus heterocarpus</i>	S. China, Malesia
<i>C. polycarpus</i>	Thailand, Malaya
<i>Crepidomanes bilabiatum</i>	Thailand, W. Malesia
<i>Reediella humilis</i>	Thailand, Malesia to New Zealand
<i>Vandenboschia maxima</i>	Thailand, Vietnam, Taiwan, S. Japan, Malesia
<i>Colysis macrophylla</i>	S. China, Malesia, New Guinea
<i>Microsorium insigne</i>	Malesia, Philippines

The climatic conditions of the Western Ghats of peninsular India and Sri Lanka are similar to that of Andaman and Nicobar Islands as all these areas lie in the tropical zone and experience heavy rainfall from the south-west and north-east monsoon. Although these areas are not contiguous and separated from each other by the Bay of Bengal, they show striking resemblance in their floristic composition. Several rare plants especially orchids common to peninsular India and Bay Islands are *Calanthe triplicata*, *Corymborkis veratrifolia*, *Geodorum densiflorum*, *Eulophia graminea*, *Nervilia aragoana*, *Porpax reticulata* and *Thrixspermum album*. Other species which have common distribution are *Myanmarnnia championii*, *Christisonia subacaulis*, *Floscopa scandens*, *Myxopyrum smilacifolium*, *Phylloclamis spinosa*, *Osbeckia tenera* and several other species. For example, the palm genus *Bentinckia* has two species in the world, one of them *B. condapanna* is found in the Southern western Ghats of Peninsular India while the other *B. nicobarica* in the Nicobar Islands.

Thus the Andaman and Nicobar Islands stretching from Arakkan Yoma in Myanmar to Sumatra in Indonesia are characterised by a rare and distinct flora, although exhibiting phytogeographical affinity with the neighbouring biogeographic zones of south-east Asian countries, and north-east, Western Ghats and Deccan Peinsular biogeographic zones of mainland India by virtue of which the islands constitute a transition zone phytogeographically. More interestingly, the southern most Great Nicobar Island with a mixture of Malaysian and Indonesian species and northern most Andaman Islands with several Myanmar elements exhibit a striking resemblance to that of neighbouring biogeographical zones rendering them truly transitional from a floristic point of view. The floristic analysis also indicates that while 14% of angiospermic species are endemic to the islands, about 54% are also occurring in mainland India. The remaining 32% extend to the south-east Asian countries and Malesia but not recorded in mainland India. The phytogeographical distinction between Andaman Islands and the Nicobar group of Islands is evident from the fact that only 28% of the angiospermic species reportedly have a common distribution on both the Andaman and Nicobar groups, whereas the remaining 72% occur either on the Andaman or on the Nicobars, that is 47% on the former and 25% on the latter.

Among the 137 families representing the angiospermic flora of the islands, the ten dominant families are given in (Table III) according to the number of species in decreasing order. The families Poaceae, Rubiaceae,

Euphorbiaceae, Cyperaceae, Moraceae and Annonaceae are predominant in terms of population density as well as number of species followed by Orchidaceae in terms of number of species only with less population size.

Table III
Statistical Analysis of Ten Dominant Families

Sl.No.	Family	No. of Genera	No. of Species
1.	<i>Poaceae</i>	70	158
2.	<i>Rubiaceae</i>	40	115
3.	<i>Euphorbiaceae</i>	40	110
4.	<i>Orchidaceae</i>	50	98
5.	<i>Cyperaceae</i>	12	80
6.	<i>Fabaceae</i>	29	60
7.	<i>Moraceae</i>	7	52
8.	<i>Annonaceae</i>	18	50
9.	<i>Arecaceae</i>	20	37
10.	<i>Meliaceae</i>	11	31

A comparison between ten dominant families of Andaman and Nicobar Islands with those given in Hooker (1904) 'A Sketch of the Flora of British India' is given in (Table IV). The position of Poaceae is first in present flora which is third in Flora of British India. The position of Orchidaceae is first in Flora of British India while it is fourth in present flora. The position of other families too vary in both cases. In this account Fabaceae, Caesalpiniaceae and Mimosaceae are treated separately while Hooker included them under Leguminosae. Besides, the plant groups which contribute to a great extent to the plant diversity and richness of the flora in the transition zones like Great Nicobar Islands, a place rich in species with Sundaic affinity are Pteridophytic flora comprising of about 100 species of which the populations of 'Tree Fern' constitute major fraction of the vegetation of certain places along the hilly slopes of interior forest. Another aspect of the vegetation of Andaman and Nicobar Islands is that

over 11% of the total geographical area is occupied by the Mangrove forest with more than 20 species which are perhaps the best formations in the entire south-east Asia providing natural habitats for a varied aquatic life offshore and climbing and epiphytic plants on the shore.

Table IV

A comparison between ten dominant families of Andaman and Nicobar Islands with those in Flora of British India

Sl. No.	Family in Flora of British India	Family in Flora of Andaman and Nicobar Island
1.	Orchidaceae	Poaceae
2.	Leguminosae	Rubiaceae
3.	Poaceae	Euphorbiaceae
4.	Rubiaceae	Orchidaceae
5.	Euphorbiaceae	Cyperaceae
6.	Acanthaceae	Fabaceae
7.	Asteraceae	Moraceae
8.	Cyperaceae	Annonaceae
9.	Lamiaceae	Areaceae
10.	Urticaceae	Meliaceae

RARE AND THREATENED PLANTS

Balakrishnan and Vasudeva Rao (1983) have given a detailed account of the dwindling plant species of the Bay Islands. They have categorised these dwindling species under two groups as follows:

Rare and endangered endemic taxa

In this group they enumerate 110 taxa indicating that 73 have never been collected after type collection (T.C.) and that 37 have been recollected from type localities (T.L.) only (Table V).

Table V
Rare and Endangered Endemic Taxa of
Andaman and Nicobar Islands

ACANTHACEAE		
<i>Hypoestis andamanensis</i>	M. Andaman	TC
<i>Strobilanthes andamanensis</i>	Andaman	TC
AMARYLLIDACEAE		
<i>Crinum pusillum</i>	Nicobar Is.	TC
ANACARDIACEAE		
<i>Mangifera andamanica</i>	S. Andaman	TL
ANNONACEAE		
<i>Artabotrys nicobarianus</i>	Gt. Nicobar	TC
<i>Miliusa tectona</i>	Andaman	TL
<i>Mitrephora andamanica</i>	Baratang Is.	TL
<i>Orophaea salicifolia</i>	M. Andaman	TC
<i>O. torulosa</i>	M. Andaman	TC
<i>Popowia parvifolia</i>	Nicobar Is.	TC
<i>Sageraea listeri</i> var. <i>andamanica</i>	Andaman	TL
<i>Uvaria hamiltonii</i> var. <i>kurzii</i>	Andaman	TC
<i>Uvaria nicobarica</i>	Gt. Nicobar	TC
ARACEAE		
<i>Aglaonema nicobaricum</i>	Nicobar Is.	TC
<i>Amorphophallus carnosus</i>	Andaman	TC
<i>A. longistylus</i>	S. Andaman	TC
<i>A. oncophyllus</i>	S. Andaman	TC
ARECACEAE		
<i>Bentinckia nicobarica</i>	Kamorta Is.	TI
<i>Calamus dilaceratus</i>	Andaman	TC
<i>C. nicobaricus</i>	Nicobar Is.	TC
<i>Corypha macropoda</i>	S. Andaman	TC
<i>Korthalsia rogersii</i>	Havelock Is.	TL

BOMBACACEAE

Bombax insigne var. *polystemon* Narcondum Is. TC

CELASTRACEAE

Hippocratea andamanica S. Andaman TC

H. nicobarica Nicobar Is. TC

CLUSIACEAE

Garcinia cadelliana S. Andaman TC

G. calycina Kamorta Is. TC

G. kingii Andaman TC

Mesua manii S. Andaman TC

CONNARACEAE

Connarus nicobaricus Gt. Nicobar TC

Ellipanthus calophyllus S. Andaman TL

CYPERACEAE

Cyperus kurzii Andaman TC

Hypolytrum balakrishnanii M. Andaman TC

DICHAPETALACEAE

Dichapetalum gelonoides ssp.
andamanica S. Andaman TL

DISCOREACEAE

Dioscorea rogersii Andaman TC

D. vexans Andaman TC

EUPHORBIACEAE

Antidesma andamanicum S. Andaman TC

Bridelia kurzii Kamorta Is. TC

Cnesmone javanica var.
glabriuscula S. Andaman TL

Drypetes andamanica S. Andaman TL

D. leiocarpa S. Andaman TC

Excoecaria rectinervis Katchal Is. TC

Glochidion andamanicum S. Andaman TL

Sphyrantha lutescens M. Andaman TC

GESNERIACEAE

<i>Cyrtandra burttii</i>	Gt. Nicobar	TL
<i>C. occidentalis</i>	Gt. Nicobar	TL

ICACINACEAE

<i>Gomphandra comosa</i>	S. Andaman	
--------------------------	------------	--

LAMIACEAE

<i>Scutellaria andamanica</i>	S. Andaman	TL
-------------------------------	------------	----

LAURACEAE

<i>Cryptocarya ferrarsi</i>	M. Andaman	TL
<i>Litsea leiantha</i>	S. Andaman	TL
<i>Neolitsea andamanica</i>	Andaman	TC
<i>N. nicobarica</i>	Nicobar Is.	TC

LOGANIACEAE

<i>Strychnos narcondamensis</i>	Narcondam Is.	TC
---------------------------------	---------------	----

LORANTHACEAE

<i>Ginolla andamanica</i>	S. Andaman	TC
---------------------------	------------	----

MARANTACEAE

<i>Phrynium cadellianum</i>	Andaman	TC
<i>P. paniculatum</i>	Gt. Nicobar	TL

MELIACEAE

<i>Aglaiia fusca</i>	Andaman	TC
<i>Amoora manii</i>	S. Andaman	TL

MENISPERMACEAE

<i>Stephania andamanica</i>	S. Andaman	TC
<i>Tinospora andamanica</i>	Andaman	TC

MORACEAE

<i>Ficus andamanica</i>	S. Andaman	TC
-------------------------	------------	----

MYRISTICACEAE

<i>Horsfieldia macrocarpa</i> var. <i>canarioides</i>	Andaman	TC
--	---------	----

MYRSINACEAE

<i>Ardisia andamancica</i>	S. Andaman	TC
var. <i>effusa</i>		
<i>Embelia microcalyx</i>	Katchal Is.	TC

MYRTACEAE

<i>Cleistocalyx nicobaricus</i>	Katchal Is.	TL
<i>Syzygium andamanicum</i>	Andaman	TC
<i>S. kurzii</i> var. <i>andamanica</i>	S. Andaman	TL
<i>S. manii</i>	M. Andaman	TL

OLACACEAE

<i>Olax imbricata</i> var. <i>membranifolia</i>	Katchal Is.	TC
--	-------------	----

OLEACEAE

<i>Jasminum andamanicum</i>	S and M Andaman	TC
<i>J. unifoliolatum</i>	N. Andaman	TC

ORCHIDACEAE

<i>Anoectochilus nicobaricus</i>	Gt. Nicobar	TL
<i>Dendrobium tenuicaule</i>	M. Andaman	TL
<i>Eulophia nicobarica</i>	Car Nicobar	TL
<i>Habenaria andamanica</i>	S. Andaman	TL
<i>Malleola andamanica</i>	S and L Andaman	TC
<i>Phalaenopsis speciosa</i>	Andaman	TC
<i>Taeniophyllum andamanicum</i>	M. Andaman	TC
<i>Zeuxine andamanica</i>	S. Andaman	TL
<i>Z. rolfiana</i>	S. Andaman	TC

RUBIACEAE

<i>Diplospora andamanica</i>	N. Andaman	TL
<i>Hedyotis andamanica</i>	S. Andaman	TC
<i>H. congesta</i> var. <i>nicobarica</i>	Nicobar	TC
<i>Ixora andamanica</i>	Andaman	TC
<i>I. hymenophylla</i>	Andaman	TC
<i>I. capituliflora</i>	Andaman	TC
<i>I. longibracteata</i>	Nicobar	TC

<i>Ixora tenuifolia</i>	Nicobar	TC
<i>Nauclea gageana</i>	Andaman	TC
<i>Ophiorrhiza nicobarica</i>	Gt. Nicobar	TL
<i>Prismatomeris andamanica</i>	S. Andaman	TC
<i>Psychotria andamanica</i>	Andaman	TC
<i>P. helferiana</i> var. <i>angustifolia</i>	S. Andaman	TC
<i>P. polyneura</i> var. <i>longipetiolata</i>	Andaman	TC
<i>P. tylophora</i>	Katchal Is.	TC
<i>Pubistylis andamanensis</i>	S. Andaman	TC
<i>Urophyllum andamanicum</i>	S. Andaman	TL
<i>Wendlandia andamanica</i>	N. Andaman	TL
SANTALACEAE		
<i>Henslowia erythrocarpa</i>	Kamorta Is.	TC
SAPOTACEAE		
<i>Mimusops andamanensis</i>	Andaman	TC
VERBENACEAE		
<i>Clerodendrum lankawiense</i> var.		
<i>andamanense</i>	S. Andaman	TL
<i>Vitex wimberleyi</i>	S. Andaman	TL
VITACEAE		
<i>Tetrastigma andamanicum</i>	Andaman	TC
ZINGIBERACEAE		
<i>Boesenbergia albo-lutea</i>	Andaman	TC
<i>Globba pauciflora</i>	S. Andaman	TL
<i>Kaempferia siphonantha</i>	N. Andaman	TC

Rare and endangered non endemic extra Indian taxa

In this group they enumerate 125 rare and endangered taxa most of which are endangered only as far as Indian territory is concerned (Table VI).

Table VI
Rare and Endangered Taxa common to
Andaman and Nicobar Islands and Adjoining countries

Name	Distribution
ANACARDIACEAE	
<i>Buchanania sessiliflora</i>	Katchal Is., Myanmar, Laos, Vietnam, Thailand, Malaya and Borneo
ANNONACEAE	
<i>Cyathostemma viridiflorum</i>	N. Andaman
<i>Polyalthia lateriflora</i>	Car Nicobar, Myanmar.
<i>P. macrophylla</i> (Andaman)	Myanmar, Borneo, Sumatra, and Java
<i>Saccopetalum horsfieldii</i>	Katchal Is., Java.
<i>Uvaria sumatrana</i> (Andaman)	Sumatra
APOCYNACEAE	
<i>Microchites polyantha</i> (Andaman)	Malacca and Java
ARACEAE	
<i>Amorphophallus rex</i>	Narcondum Is., Java
<i>Cryptocoryne ciliata</i>	Gt. Nicobar, Malaya, Java
<i>Homalomena griffithii</i> var. <i>ovata</i>	Gt. Nicobar, Malaya
<i>Homalomena nutans</i>	Gt. Nicobar, Malaya
<i>Scindapsus cuscuaria</i>	Nicobar, Java and Moluccas
ASCLEPIADACEAE	
<i>Tylophora globifera</i>	S. Andaman, Malacca
ASTERACEAE	
<i>Vernonia patula</i>	S. Andaman, Myanmar, Malaya and Philippines
BURMANNIACEAE	
<i>Burmannia championii</i>	Gt. Nicobar, Sri Lanka, China, Japan, Malaysia, Java Borneo and New Guinea.

CELASTRACEAE*Cassine viburnifolia*

S. Andaman, Thailand, Malaya, Borneo, Celebes and Sumatra

Lophopetalum wallichii

Andamans, Myanmar, Indo-China

CLUSIACEAE*Calophyllum kuntzleri*

S. Andaman, Malaya, Borneo and Philippines

C. wallichianum

Nicobar, Malaya

Garcinia brevirostris

Andaman, Malaya, Sumatra, Java and Phillipnes

G. hambroniana

S. Andaman, Indo-China, Malaya

CORNACEAE*Mastixia tetrandra*

S. Andaman, Sri Lanka

M. trichotoma var. *maingayi*

Gt. Nicobar, Malaya, Borneo and Sumatra

CYPERACEAE*Carex cryptostachys*

Gt. Nicobar, S. China, Formosa, Thailand and Malesia

C. rafflesiana

Gt. Nicobar, Malesia, Australia

Cyperus sanguinolentus spp.
cryptostachys

Andaman, Throughout Malesia

Hypolytrum comspectum

Andaman, Indo-China, Malaya, Borneo, Philippines to New Guinea

Scirpodendron ghaeri

Gt. Nicobar, Sri Lanka, Thailand, Malesia to Australia and Polynesia

Scleria neesii

Car Nicobar, Sri Lanka, Indo-China and Malaya

DIPTEROCARPACEAE*Dipterocarpus kerrii*

S. Andman, Thailand, Malaya.

Hopea helferi

N. Andaman, Myanmar, Thailand and Malaya

EBENACEAE*Diospyros multibracteata*

Car Nicobar, Philippines

ELAEOCARPACEAE*Elaeocarpus macrocerus*

Gt. Nicobar, Java

EUPHORBIACEAE*Antidesma coriaceum*

(Kamorta Is.) - Malaya, Sumatra, Borneo

A. tomentosum

(Kamorta Is.) Malaya, Sumatra, Java

Blumeodendron kurzii

Andaman and Nicobar Is., Myanmar, Thailand, Malaya, Sumatra and Java

Breynia racemosa

Nicobars, Malaya, Sumatra, Java

Claoxylon longipetiolatum

Andaman, Myanmar

Endospermum peltatum

S. Andaman, Philippines

Neoscortechinia nicobarica

Nicobar, Malaya.

Phyllanthus gomphocarpus

Car Nicobar and Gt. Nicobar Malaya

Spathistemon javense

Gt. Nicobar, Malaya, Sumatra, Java

Trigonostemon aurantiacus

S. Andaman, Thailand, Malaya, Java

T. laevigatus

Andaman, Indo-China, Thailand, Malay, Borneo and Philippines

FABACEAE*Derris elliptica*

Gt. Nicobar, Myanmar, Bangladesh, Thailand, Malaya and Sumatra.

Strongylodon siderospermus

S. Andaman, Sri Lanka, Polynesia

Tadehagi triquetrum ssp.
auriculatum

S. Andaman, Myanmar, Malaya

FLACOURTIACEAE*Casearia grewiaefolia*var. *deglabrata**Scolopia kermodei*Nicobar, Malaya to Solomon
Islands

Andaman, Myanmar

GESNERIACEAE*Aeschynanthus griffithii*

S. Andaman, Myanmar

GONOSTYLACEAE*Gonostylus macrophyllus*

Gt. Nicobar, Malaya

HYPOXIDACEAE*Molineria latifolia*

M. Andaman, Malaya, Sumatra

LAURACEAE*Actinodaphne macroptera**Cryptocarya ferrea*

S. Andaman, Malaya, Sumatra

Kamorta Is., Malaya, Java

MALPIGHIACEAE*Aspidopterys elliptica**A. tomentosa*

Andaman, Malaysia, Java

Andaman, Myanmar, Java

Malaya, Borneo

MELIACEAE*Sandoricum indicum*

Andaman, Myanmar, Malaya

MEMECYLACEAE*Memecylon coeruleum**M. excelsum*

Andaman, Myanmar, Malaya

Nicobar, Malaya.

MENISPERMACEAE*Tinomiscium petiolare*

Nicobar, Malaya, Java, Sumatra.

MIMOSOIDEAE*Archidendron ellipticum*Kamorta Is., Malaysia, Sumatra,
Java*Pithecollobium monadelphum*

Nicobar, Malaysia

MONIMIACEAE*Kibara coriacea*Nicobar, Malaysia, Sumatra,
Java**MORACEAE***Artocarpus peduncularis*

Nicobar, Malaya

Ficus capillipes

Andaman, Indo-China, Myanmar

F. chrysocarpa

Kamorta Is., Myanmar, Malaya

F. costata

Nicobar, Sri Lanka

F. fulva

Andaman, Myanmar, Malaya

Plecosperrum andamanicum

Andaman, Myanmar

NYMPHAEACEAE*Barclaya longifolia*

S. Andaman, Myanmar, Malaya.

ORCHIDACEAE*Appendicula reflexa*Gt Nicobar, Malaya, Sumatra,
Java.*Bulbophyllum crassipes*

Andaman, Myanmar.

*B. rufinum*Andaman, Myanmar, Cambodia,
Thailand.*Ceratostylis subulata*Gt. Nicobar, Thailand, Java,
Malaya and Sumatra.*Cleisostoma elegans*Andaman and Nicobar Is.,
Myanmar, Thailand.*Coetogyne thailandica*

Saddle peak, Thailand.

*C. trinervis*S. Andaman, Myanmar, Indo
China, Java, Thailand and Ma-
laya.*Cymbidium pubescens*Gt. Nicobar, Thailand, Java,
Malaya,*Dendrobium pensile*

Gt. Nicobar, Malaya.

*Grossourdyia muscosa*M. Andaman, Myanmar, Ma-
laya.*Nervilia punctata*Nicobar, Thailand, Malaya, Java,
Borneo, Sumatra.

<i>Phraetia secunda</i>	Saddle peak. Thailand, Java, Sumatra, Malaya and Philippines
<i>Plocoglottis javanica</i>	Gt. Nicobar, Thailand, Java, Malaya, Sumatra
<i>Podochilus microphyllus</i>	Gt. Nicobar, Myanmar, Malaya, Thailand, Borneo, Sumatra
<i>Schoenorchis minutiflora</i>	Saddle peak, Malaya
PASSIFLORACEAE	
<i>Adenia penangiana</i>	Nicobar, Thailand, Borneo, Malaya
PHILYDRACEAE	
<i>Philydrum lenuginosum</i>	Andaman, Myanmar, China, Malaya
PIPERACEAE	
<i>Piper clypeatum</i>	Gt. Nicobar, Malaya
<i>P. miniatum</i>	Katchal Is., Malaya, Java
PITTOSPORACEAE	
<i>Pittosporum ferrugineum</i>	Nicobar, Malesia
RHAMNACEAE	
<i>Smythea calpicarpa</i>	Andaman, Myanmar
RHIZOPHORACEAE	
<i>Gynotroches axillaries</i>	Gt. Nicobar, Myanmar, Thailand, Malesia to Australia
ROSACEAE	
<i>Parastemon urophyllus</i>	Nicobar, Myanmar, Malaya
<i>Prunus javanica</i>	Andaman, Myanmar, Java, Malaya
RUBIACEAE	
<i>Aulacodiscus premnoiaes</i>	Andaman, Myanmar, Malaya

<i>Coelospermum truncatum</i>	M. Andaman, Malaya
<i>Diplospora abnormis</i>	Katchal Is., Sumatra, Java
<i>Greenia jackii</i>	Gt. Nicobar, Myanmar, Thailand, Malaya
<i>Hedyotis macrophylla</i>	Nicobar, Myanmar, Thailand, Indo-China, Malaya
<i>H. nicobariensis</i>	Nicobar, Myanmar, Thailand, Malaya
<i>Ixora cuneifolia</i>	Barren Is., Myanmar
<i>I. fluminalis</i>	S. Andaman, Malaya
<i>Lasianthus constrictus</i>	Andaman, Myanmar
<i>L. kurzii</i>	Andaman, Myanmar, Malaya
<i>L. obscurus</i>	Andaman, Myanmar, Java, Sumatra
<i>Mussaenda wallichii</i>	Gt. Nicobar, Myanmar
<i>Psychotria helferiana</i>	Andaman, Myanmar, Malaya
SAPINDACEAE	
<i>Aryteria littoralis</i>	Nancowry Is., Myanmar, Malaya
<i>Cupania lessertiana</i>	Andaman, Myanmar, Malaya.
SAPOTACEAE	
<i>Payena lucida</i>	Andaman, Malaya
SMILACACEAE	
<i>Smilax polyacantha</i>	Kamorta Is., Malaya
STERCULIACEAE	
<i>Helicteres angustifolia</i>	Kamorta Is., Myanmar, Java, China, Thailand and Malaya
<i>Sterculia macrophylla</i>	Gt. Nicobar, Malaya, Java
SYMPLOCACEAE	
<i>Symplocos fasciculata</i>	Gt. Nicobar, Malaya, Java, Sumatra

THYMELAEACEAE*Enkleia malaccensis*

Andaman, Myanmar, Indo-China, Malaya, Borneo, Sumatra.

Phaleria macrocarpa

Gt. Nicobar, Malaya.

TILIACEAE*Colona javanica*

Kamorta Is., Java.

Grewia acuminata

Gt. Nicobar, Myanmar, Malaya.

URTICACEAE*Cypholophus moluccanus*

Gt. Nicobar, Malaya, Sumatra.

Procris frutescens

Nicobar, Myanmar, Java, Malaya.

VERBENACEAE*Clerodendrum penduliferum*

Nicobar, Myanmar, Malaya

Premna pyramidata

Gt. Nicobar, Myanmar, Thailand, Malaya.

Teijsmanniodendron pteropodum

Gt. Nicobar, Java, Sumatra and Malaya.

VIOLACEAE*Rinorea longiracemosa*

Nicobar, Myanmar, Indo-China, Thailand, Malaya, Borneo, Sumatra, Java.

ZINGIBERACEAE*Amomum aculeatum*

S. Andaman, Malaya, Java.

A. maximum

S. Andaman, Java.

PLANT RESOURCES AND THEIR UTILISATION

From time immemorial, plants have been used as a source of food, shelter, clothing, medicine, timber, resin and oil and for an array of other miscellaneous purposes. Thothathri (1980) has given a detailed account of the plant resources and their utilisation in Bay Islands. Here we have dealt with the natural plant resources of Andaman and Nicobar Islands

with special reference to timber yielding plants, cash crop plants, alcohol yielding plants, plants used as food and as a source for minor forest products like rubber, tannin etc.

Timber yielding plants

A number of forest species yield valuable and useful timber which forms the major source of revenue to the Andaman and Nicobar Administration. Hard and soft timbers, canes and bamboos obtained from the forest are used for a variety of purposes. The important timber yielding tree species are enumerated below (Table VII).

Table VII
Important timber yielding plants

Name of the species	Local name
Hard wood	
<i>Pterocarpus dalbergioides</i>	Padauk
<i>Manilkara littoralis</i>	Khari Mahua
<i>Albizia lebbeck</i>	Koka
<i>Calophyllum soulattri</i>	Lalchini
<i>Terminalia procera</i>	White Bombway
<i>T. bialata</i>	White chuglam
<i>T. manii</i>	Black chuglam
<i>Artocarpus chaplasha</i>	Toungpeinne
Soft wood	
<i>Dipterocarpus spp.</i>	Gurjan
<i>Pterocymbium tinctorium</i>	Papita
Botanical Name	Local Name
<i>Pterygota alata</i>	-
<i>Bombax insigne</i>	Didu
<i>Canarium euphyllum</i>	Dhup
<i>Planchonia andamanica</i>	Red Bombway
<i>Sideroxylon longipetiolatum</i>	Lamba Pathi

There are still a number of tree species which can be exploited for the extraction of timbers. They require further evaluation from the utilisation point of view (Table VIII).

Table VIII
Less known timber yielding plants

Name of the species	Family
<i>Sageraea elliptica</i>	Annonaceae
<i>Scolopia crenata</i>	Flacourtiaceae
<i>Xanthophyllum andamanicum</i>	Xanthophyllaceae
<i>Cratoxylum formosum</i>	Hypericaceae
<i>Sterculia macrophylla</i>	Sterculiaceae
<i>Ailanthus kurzii</i>	Simaroubaceae
<i>Garuga pinnata</i>	Burseraceae
<i>Amoora rohituka</i>	Meliaceae
<i>Dracontomelon mangiferum</i>	Anacardiaceae
<i>Mangifera camptosperma</i>	Anacardiaceae
<i>Adenanthera pavonina</i>	Mimosaceae
<i>Chydenanthus excelsus</i>	Baringtoniaceae
<i>Duabanga grandiflora</i>	Sonneratiaceae
<i>Tetrameles nudiflora</i>	Tetramelaceae

The forest are endowed with a number of canes and bamboos which grow abundantly as well as luxuriantly. They offer good raw materials for cane industry. Important canes are : *Calamus viminalis* (Jungli beth), *C. pseudorivalis* (Malay beth), *C. andamanicus* (Mota beth), *C. basui* (Safed Beth), and *Korthalsia laciniosa* (Lal Beth). Noteworthy Bamboo species are *Bambusa schizostachyoides* and *Dinochloa andamanica*.

Plants of major economic importance

Coconuts (*Cocos nucifera*) and Areca nuts (*Areca catechu*) are the most important cash crops in these islands. Since the climate and rainfall of the Bay Islands are identical to Malay peninsula, rubber (*Hevea*

brasiliensis) is being cultivated in plantations in Katchal and South Andaman Islands. Kaju (*Anacardium occidentale*) grows well in these islands and is widely cultivated.

The *Nipa fruticans* (Mangrove Palm) grows in large populations in the mangrove creeks, well sheltered bays in the Andaman and Nicobar Islands and on the banks of the rivers and streams in the Great Nicobar Island. It might prove to be a species of great economic importance in the extraction of alcohol.

Plants as food

The large orange coloured fruits of *Pandanus andamanensium* (*Pandanus leram*) and *Pandanus tectorius* constitute the staple food of the tribal population. These plants grow in large numbers in the coastal beach forest. The fruits are boiled and the orange coloured pulp surrounding the individual fruit is separated and made into 'Pandanus Cheese' which is eaten with honey. The unripe fruits of *Artocarpus incisa* (Nicobar bread fruit tree) are cooked and eaten by the tribals in Nicobars. Tubers of *Dioscorea glabra* and *Tacca leontopetaloides* constitute a part of the food of the tribals. The unripe fruits of *Canavalia turgida* and *Vigna marina* which grow commonly in the beach forest can be used as good vegetable. Some important wild edible plants used by the various tribes are given below (Table IX).

Plants of medicinal importance

Andaman and Nicobar Islands are known to harbour a rich wealth of medicinal plants which is used for amelioration of people's suffering. A number of medicinal plants are used by the primitive tribes of Bay Islands for curing various ailments, a few of them are given in Table X.

Table IX
Wild food plants used by the tribals of Bay Islands

Part used	Name of the species	Ni.	Sh.	On.
Bulbs	<i>Dioscorea glabra</i>	+	+	+
Tubers	<i>Tacca leontopetaloides</i>	+	+	-
	<i>Colocasia esculenta</i>	-	+	-

Part used	Name of the species	Ni.	Sh.	On.
Fruits	<i>Morinda citrifolia</i>	+	+	
	<i>Nypa fruticans</i>	+	-	+
	<i>Sterculia rubiginosa</i>	+		-
	<i>Syzygium samarangense</i>	+		
	<i>Annona squamosa</i>	+		
	<i>Pandanus leram</i>	+	+	+
	<i>Artocarpus incisa</i>	+	+	-
	<i>A. integrifolia</i>	+	+	-
	<i>Baccaurea sapida</i>		-	+
	<i>Careya pallida</i>	-	-	+
	<i>Champereia griffithiana</i>		-	+
	<i>Cyclea peltata</i>	-	-	+
	<i>Hunteria zeylanica</i>			+
	<i>Manilkara litoralis</i>	-	-	+
	<i>Pometia pinnata</i>	-	-	+
	<i>Salacia chinensis</i>	-	-	+
	<i>Semecarpus kurzii</i>	-	-	+
	<i>Ximenia americana</i>	-	-	+
	<i>Ardisia solanacea</i>	-	+	-
	<i>Calamus</i> spp.	-	+	-
<i>Citrus</i> spp.	-	+	-	
<i>Terminalia catappa</i>		+		
<i>T. manii</i>	-	+	-	
Stem/Leaf	<i>Flagellaria indica</i>	-	+	
	<i>Celosia argentea</i>	-	+	-
	<i>Ipomoea aquatica</i>	-	+	-

Ni : Nicobarese. Sh: Shompens, On: Onge.

Table X
List of Medicinal Plants Used by the Tribals of
Andaman and Nicobar Islands

Name of the species	Plant part	Diseases
<i>Adenia penangiana</i>	lf	Body and Chest pain
<i>Adenostemma lavenia</i>	lf	Chest pain
<i>Aerva lanata</i>	lf	Fever
<i>Ageratum conyzoides</i>	lf	Piles, wounds, eye pain
<i>Alstonia macrophylla</i>	rt,bk	Fever, stomach ache
<i>A. kurzii</i>	rt,bk	Fever
<i>Amomum fenzlii</i>	rh	Fever, stomach disorder
<i>Ardisia solanacea</i>	lf	Mumps
<i>A. oxyphylla</i>	lf	Improve fertility
<i>Argyreia hookeri</i>	lf	Swellings
<i>Aristolochia tagala</i>	lf	Malarial fever
<i>Blumea balsamifera</i>	lf	Cest pair
<i>Breynia retusa</i>	lf	Swellings and pain
<i>Caesalpinia bonduc</i>	sd	M. fever, Colic pain
<i>Callicarpa longifolia</i>	lf	Cuts, wounds
<i>Calophyllum inophyllum</i>	lf,	Night blindness, bone fracture, resin
<i>Casearia grawiaefolia</i>	lf	Dysentery
<i>Cassia alata</i>	lf	Skin diseases
<i>C. occidentalis</i>	lf	Skin diseases, fever
<i>Catharanthus roseus</i>	lf	Eye diseases
<i>Celosia argentea</i>	lf	Cuts, Wounds
<i>Claoxylon indicum</i>	lf,	Wounds, Headache
<i>Clerodendrum inerme</i>	lf	Body and Joint pain
<i>C. viscosum</i>	bk	Malarial fever
<i>C. paniculatum</i>	lf	Ulcer, Wounds
<i>Colubrina asiatica</i>	lf	Malarial fever
<i>Cordia grandis</i>	lf	Stomach ache
<i>Costus speciosus</i>	rh	Asthma, anthelmentic,
	lf	Stomach disorders

Name of the species	Plant part	Diseases
<i>Crataeva religiosa</i>	lf	Rheumatic pain
<i>Croton argyratus</i>	sd	Stomach disorder
<i>Cycas rumphii</i>	bk	Swellings
<i>Desmodium umbellatum</i>	lf	Fever
<i>Dischidia major</i>	lf	Bone fracture
<i>Donax cannaeformis</i>	rt,lf	Fever, Spinal pain
<i>Dracaena angustifolia</i>	lf	Stomach ache
<i>Drynaria quercifolia</i>	lf	Anthelmentic, Body pain
<i>Eclipta alba</i>	wp	Filaria, Jaundice
<i>Eria bractescens</i>	lf	Malarial Fever
<i>Erioglossum rubiginosum</i>	lf,fr	Antifertility
<i>Eupatorium odoratum</i>	lf	Cuts, Wounds
<i>Chromolaena odorata</i>		
<i>Euphorbia atoto</i>	lf	Ulcer, skin diseases
<i>E. hirta</i>	lf	Dysentery, wounds
<i>Garcinia nervosa</i>	lf	Body pain
<i>Globba marantia</i>	rh	Asthma, Eye trouble
<i>Glochidion calocarpum</i>	sd	Skin diseases
<i>Glycosmis arborea</i>	lf	Headache
<i>Hedyotis biflora</i>	lf	Ulcer, Headache
<i>Hernandia peltata</i>	lf	Ulcer, Headache
<i>Hibiscus tiliaceus</i>	lf	Urinary trouble, Sores

lf: Leaf; rt: Root; bk: Bark; rh: Rhizome; sd: Seed; wp : Whole plant

Plants of minor economic importance

Seeds of *Calophyllum inophyllum* and *Pongamia pinnata*, are the source of oil that can be used for burning etc. Tannin could be extracted from the bark of *Terminalia bialata*, *T. catappa*. *Rhizophora mucronata* and *Bruguiera gymnorrhiza*. The large, pinnately compound leaves of *Nipa* and Coconut palms, and the grass *Phragmites karka* and *Imperata cylindrica* offer excellent thatching and roofing materials. Fruits of *Barringtonia asiatica* are powdered and used as fish poison. 'Pan' leaf

is obtained from *Piper betel* that grows wild and abundant in the forests.

CONSERVATION

The insular species are generally characterised by a small gene pool, reduced interspecific competition, inbreeding and small population size by virtue of which they are more vulnerable to extinction due to habitat destruction. The Bay islands being no exception to this, conservation of rare and threatened endemic species as well as extra Indian species has become inevitable for ensuring the preservation of species diversity. Mt. Harriet in South Andaman and the Saddle Peak in North Andaman are declared as national park and biosphere reserve respectively by Government of India for habitat conservation in these centres of speciation. Apart from this, Government of India has already declared Great Nicobar as biosphere reserve. So far, the conservation strategies were species oriented. As this may lead to overlapping the role of that particular species in the ecosystem causing certain imbalances, it has become imperative to give due weightage to all the components of environment to cover the total ecosystem. With the increasing population beyond carrying capacity and recent spurt in developmental activities in the inhabited islands, several measures are suggested by Saldanha (1989) to strike a balance between development and conservation so that wild germplasm resources such as canes, rattans, bamboos, orchids and timber yielding tree species are well taken care of. Botanical Survey of India on its part has already brought out a list of rare and threatened plants of Andaman and Nicobar Islands in the form of Red Data Books for conservation purposes in its Botanic Garden at Port Blair where economically important endemic species such as *Myristica andamanica*, *Knema andamanica*, *Vanilla andamanica* etc., are successfully propagated and grown, while local Forest Department has been concentrating on *in situ* conservation of rattans, palms and 'Tree ferns'. Efforts are also afoot to grow several plant species of phyto-geographical significance and aesthetically important endemic orchid species which are threatened in their natural habitats owing to habitat deterioration.

REFERENCES

- Balakrishnan, N.P. 1987. Recent botanical studies in Andaman and Nicobar Islands. *Bull. Bot. Surv. India* 19: 132-138.
- Balakrishnan, N.P. 1989. Andaman Islands-vegetation and floristics In : *Andaman Nicobar & Lakshadweep an Environmental Impact Assessment* C.J. Saldanha (ed.). Oxford & IBH Publishing Co., New Delhi. pp. 55-68.
- Balakrishnan, N.P. and M.K. Vasudeva Rao 1983. The dwindling plant species of Andaman & Nicobar Islands. In : *An assessment of Threatened plants of India*, S.K. Jain and R.R. Rao (eds.). Botanical Survey of India, Howrah. pp. 186-201.
- Hooker, J.D. 1904. A sketch of the flora of British India Oxford.
- Kurz, S. 1870. *Report on the vegetation of Andaman Islands*, Calcutta.
- Lakshminarasimhan, P. and P.S.N. Rao 1996. A supplementary list of angiosperms recorded (1983-93) from Andaman and Nicobar Islands. *J. Econ. Tax. Bot.* 20(1): 175-185.
- Parkinson, C.E. 1923. *A Forest Flora of the Andaman Islands*, Govt. of India, Shimla.
- Rao, P.S.N. 1996. Phytogeography of Andaman and Nicobar Islands. *Malayan Nature Journal* 50 : 57-79.
- Sahni, K.C. 1953. Botanical exploration in the Great Nicobar Islands. *Indian For.* 79: 3-16.
- Saldanha, C.J. 1989. *Andaman, Nicobar and Lakshadweep - An Environmental Impact Assessment*. Oxford and IBH Publishing Co., New Delhi.
- Thothathri, K. 1962. Contribution to the flora of Andaman and Nicobar Islands. *Bull. Bot. Surv. India* 4: 281-296.

Thothathri, K. 1980. Plant resource and their utilisation in the Andaman and Nicobar Islands. *J. Econ. Tax. Bot.* 1: 111-114.

Vasudeva Rao, M.K. 1986. A preliminary report on the angiosperms of Andaman and Nicobar Islands. *J. Econ. Tax. Bot.* 8(1) : 107-184.



A view of forest in north Andaman islands



Deforestation in Great Nicobar islands



Gnetum montanum : an interesting gymnosperm



Saddle peak with scrub vegetation



Mt. Thullier : evergreen vegetation



Heritiera littoralis with keeled fruits



Mangrove vegetation (*Rhizophora mucronata*)



Vanilla andamanica : a climbing endemic orchid



Cyathea albosetacea : 'Tree Fern' from Great Nicobar island



Knema andamanica : a wild nutmeg endemic to Andaman and Nicobar islands



Casearia andamanica : a rare, endemic species with fruits of bird's delicacy

ANDHRA PRADESH

V. Chandrasekaran
S.R. Srinivasan

Andhra Pradesh was formed more than four decades ago on 1st November 1956. This is the 5th largest state in India both in area and population with an area of 2,75,909 sq km. There is no comprehensive work on the flora of this state until now. The state encompasses the major portion of Eastern Ghats with the highest hill tops reaching altitudes from 1300 to 1500 m. The recorded forest area is 63,726 sq km. Andhra Pradesh is administratively divided into twenty three districts which are generally grouped into three geographically distinct regions called (i) Circars or Coastal Andhra with nine districts, (ii) Rayalaseema with four districts and (iii) Telangana with ten districts.

- (i) Circars or Coastal Andhra consists of East Godavari, Guntur, Krishna, Nellore, Prakasam, Srikakulam, Visakhapatnam, Vizianagaram and West Godavari districts and covers a total land area of 92,906 sq km and has a total forest area of 19,563 sq km.
- (ii) Anantapur, Chittoor, Cuddapah and Kurnool which cover a total land area of 67,299 sq km including a forest area of 15,008 sq km comes under Rayalaseema area.
- (iii) Telangana has the districts of Adilabad, Hyderabad, Karimnagar, Khammam, Mahaboobnagar, Medak, Nalgonda, Nizamabad, Ranga Reddy and Warangal with a total land area of 1,14,863 sq km (forest area 29,242 sq km) under it.

Krishna and Godavari are the major river systems in the state. The Godavari is the largest and the broadest river of South India. The Tungabhadra is an important tributary of Krishna. Other important rivers are Vennar, Vamsadhara and the Nagavali. All these rivers are rainfed and are of great economic significance because of their rich hydropower and irrigation potential.

Andhra Pradesh is bounded by Madhya Pradesh and Orissa on the north, Bay of Bengal on the east, Tamil Nadu and Karnataka on the south and Maharashtra on the west.

Northern parts of Andhra Pradesh is mountainous with an annual rainfall of 110 - 125 cm. In the southern parts of Andhra Pradesh, rainfall comes down to about 50 cm annually. The climate is generally hot and humid. Rainfall in Andhra Pradesh is mainly by the south-west monsoon and the north-east monsoon contributes only about 1/3 of the rainfall.

VEGETATION

I. COASTAL VEGETATION

The coastal vegetation of Andhra Pradesh is divisible into two sub-groups viz. Strand and Estuarine. The strand vegetation is characteristic with open, mat-forming pioneer species followed by scattered herbs, shrubs and trees dispersed along the relief beyond the high tide limit or the back-shore region. This is further divisible into two substrata types, namely Strand sand and Strand rock.

1. STRAND VEGETATION

(a) Strand sand

The strand sand vegetation along the sandy beaches exhibits zonation distinguishable into open pioneer, closed herbaceous, middle mixed and inner woodland zones.

(i) Open pioneer zone: This zone is the first in the supra tidal region immediately preceding the drift line. In this, the vegetation is rather sparse with a few plants like *Ipomoea pes-caprae*, *Cyperus arenarius*, *Launaea sarmentosa*, *Trachys muricata* and *Zoysia sp.*

(ii) Closed herbaceous zone: Here, vegetation attains a little more density with some mat-forming herbaceous plants, of which *Ipomoea pes-caprae*, *Crotalaria hebecarpa*, *Trachys muricata*, *Tribulus terrestris*, *Portulaca oleracea*, *P. quadrifida*, *Perotis indica*, *Phyla nodiflora*, *Mollugo nudicaulis*, *Gisekia pharnaceoides*, *Fimbristylis polytrichoides*, *Solanum surattense* and *Spinifex littoreus* are common.

(iii) Middle mixed or bushy zone : There is mingling of herbaceous plants with some sub-shrubby/bushy plants giving rise to a

mixed vegetation in this zone. The commonly noticeable herbaceous plants are *Euphorbia rosea*, *Synostemon bacciforme*, *Geniosporum tenuiflorum*, *Phyllanthus rotundifolius*, *Borreria articularis*, *Zornia gibbosa*, *Coldenia procumbens*, *Allmania nodiflora*, *Boerhavia diffusa* and *Asystasia gangetica*. Sub-shrubby/bushy plants found in the zone include: *Crotalaria linifolia*, *C. verrucosa*, *Tephrosia hirta*, *T. purpurea*, *Opuntia dillenii*, *Calotropis procera*, *Solanum trilobatum*, *Carissa spinarum*, *Jatropha gossypifolia*, *Dodonaea viscosa* and *Clerodendrum inerme*.

(iv) Inner woodland zone: This is chiefly dominated by tree species like *Borassus flabellifer* and *Prosopis cineraria*. Some climbers like *Gloriosa superba*, *Leptadenia reticulata*, *Pergularia daemia* and *Hemidesmus indicus* grow in this zone. At places, dense growth of *Pandanus odoratissimum* with branching stems form an eye-catching aspect. This zone gradually merges into wastelands and the cultivated fields in the hinterland region in the coastal belt.

(b) Strand rock

This particular type of habitat is much limited to small strips at Waltair and Poodimadaka where inland hillocks and their rocky promontories project into the sea. The vegetation and flora are mostly a mixture of coastal and inland plants occurring in the following zones.

(i) The wave-cut rocky humps and slopes: Rocky humps and slopes are subjected to regular sea water inundation and get exposed only during the low tide and support a rich growth of marine algae belonging to the species of *Padina*, *Sargassum*, *Enteromorpha*, *Caulerpa* and *Ulva*.

(ii) Rocky relief slopping inland having a thin mantle of sand in crevices, pot-holes and crannies: In this type, *Blepharis repens*, *Euphorbia thymifolia*, *Portulacca tuberosa*, *Crotalaria hebecarpa*, etc. are commonly met with.

(iii) Inland, gravelly/rocky habitat : The vegetation in this zone, resembles a scree type characterised by spiny thickets and herbs. *Carissa spinarum*, *Toddalia asiatica*, *Ziziphus oenopia*, *Dichrostachys cinerea*, *Maytenus emarginatus*, etc., are the dominant shrubby species. The common herbaceous plants are *Hybanthus enneaspermus*, *Pavonia zeylanica*, *Acanthospermum hispidum*, *Echinops echinatus*, *Caralluma*

attenuata and *Acalypha indica*. The common climbers in the zone are *Tylophora asthmatica* and *Cissus quadrangularis*.

2. ESTUARINE VEGETATION

In Andhra Pradesh, the mangrove vegetation which develops along muddy tidal banks, is primarily restricted to the Godavari and Krishna estuarine systems. The mangroves in Andhra region are few and consequently the vegetational units or zonations are also restricted in number.

In Coringa and Guderu tidal estuaries of Godavari estuarine system, on newly formed silt deposits in the intertidal region, the grass *Porteresia coarctata* grows as a pioneer together with a few plants of *Avicennia* and *Sonneratia*. Further interior, *Avicennia alba* and *Sonneratia apetala* dominate forming a *Avicennia*-*Sonneratia* "crop". Along the sheltered banks of side creeks near the estuarine mouth, well-grown trees of *Rhizophora apiculata*, *R. mucronata* and *Bruguiera gymnorrhiza* are commonly noticeable. Further away from estuarine mouth, the vegetation is composed of mangrove species like *Avicennia alba*, *A. marina*, *A. officinalis*, *Aegiceras corniculatum* and *Ceriops decandra*. Behind this zone, under the influence of more fresh water influx, *Excoecaria agallocha*, *Hibiscus tiliaceus*, *Lumnitzera racemosa*, *Sonneratia apetala*, *Xylocarpus granatum* and *Avicennia officinalis* grow well giving a mosaic appearance. These trees are usually with climbers like *Caesalpinia crista*, *Dalbergia spinosa* and *Derris trifoliata*, forming dense impenetrable thickets. *Ipomoea macrantha* and *Sarcolobus carinatus* are the common climbers. *Clerodendrum inerme*, *Acanthus ilicifolius*, *Myriostachya wightiana* and *Cyperus rotundus* mostly grow along the water margins. The upland dry "blank" areas that lie behind and away from tidal influx, support a sparse growth of halophytic species.

Not very far from the coastline in Sriharikota, in some undisturbed areas, the vegetation is composed of tree species of *Strychnos nux-vomica*, *Terminalia arjuna*, *Hydnocarpus* sp., *Sapindus emarginatus*, *Albizia amara* and *Tamarindus indicus* and the shrubby zone is chiefly dominated by *Memecylon umbellatum* and *Dodonaea viscosa*. The common climbers in these areas are *Abrus precatorius*, *Ichnocarpus frutescens* and *Hemidesmus indicus*. The margins of ponds are fringed with luxuriantly growing dense thickets of *Calamus* sp. The above floristic

composition suggests the existence of moist deciduous type of vegetation here in the past. Extensive plantations of *Eucalyptus*, *Casuarina* and cashewnut exist now.

The vast mud flats/saline flats that occur particularly at places in the vicinity of Kakinada, Machilipatnam and Tada (Pulicat Lake) support sparse vegetation, composed of halophytic species like *Suaeda maritima*, *S. nodiflora*, *Salicornia brachiata*, *Sesuvium portulacastrum*, *Heliotropium curassavicum*, *Enicostema hyssopifolia* and *Cressa cretica*. The occurrence of *Exacum pedunculatum*, *Osbeckia zeylanica* and an orchid *Eulophia epidendreaea* on silty-clay loam saline flats adjoining the Pulicat Lake in the vicinity of Tada is of considerable interest.

The mud flats along the creeks harbour of *Avicennia marina*, *Dalbergia spinosa*, *Derris trifoliata* and *Acanthus ilicifolius* to give rise to a secondary type of mangrove vegetation.

II. VEGETATION OF TELANGANA

In the Telangana region, teak occur in pure formations or along with its associates in varying proportions. On well drained slopes rich with deep loam teak may be represented to the extent of 30% to 50% or even more, occasionally tending to form pure and gregarious formations. On alluvial and dry shallow soils with bad drainage, the percentage of teak goes down appreciably and that of the miscellaneous species likewise increases. In very dry places and on trap and sandstone areas teak trees become stunted and malformed or may even disappear altogether. Sandy loam and loamy clay soils support a luxuriant growth of mixed forest with abundance of teak associates. The common teak associates which increase or decrease in preponderance with the corresponding decrease or increase of teak are *Acacia catechu*, *Adina cordifolia*, *Albizia odoratissima*, *Anoengeissus latifolia*, *Bombax ceiba*, *Boswellia serrata*, *Buchanania lanzan*, *B. angustifolia*, *Cleistanthus collinus*, *Diospyros chloroxylon*, *D. exsculpta*, *D. montana*, *Dalbergia paniculata*, *D. latifolia*, *Dolichandrone falcatus*, *Ehretia laevis*, *Phyllanthus emblica*, *Hardwickia binata*, *Lagerstroemia parviflora*, *Lannea coromandelica*, *Madhuca indica*, *Morinda tomentosa*, *Pterocarpus marsupium*, *Schleichera oleosa*, *Strychnos potatorum*, *S. nux-vomica*, *Terminalia bellirica* and *T. crenulata*.

When the underlying rock is sandstone there is seen a preponderance of *Chloroxylon swietenia* and *Soymida febrifuga*. On hard sandy soils *Acacia catechu* is very common and on clay and clay loam where the underlying rock is limestone, *Azadirachta indica* and *Hardwickia binata* are quite frequent. On rocky and bouldery soils and also on laterite, gregarious patches of *Xylia xylocarpa* are often seen. In teak forest, the lower storey is composed of *Butea monosperma*, *Gardenia resinifera*, *Holarrhena antidysenterica*, *Nyctanthes arbor-tristis*, *Xeromphis spinosa*, *X. uliginosa* etc. *Cochlospermum religiosum* is seen scattered throughout in relatively open forest. Interspersed with arboreal vegetation, patches of bamboos comprising mainly *Dendrocalamus strictus* are also seen. Bamboos may also be seen in some forest to the exclusion of all undergrowth. The undergrowth in relatively drier areas consists of grasses other than bamboos.

There is a greater abundance of shrubby undergrowth and that of woody climbers in the mixed forest having lesser percentage of teak; in rich teak forest their frequency of occurrence is considerably reduced. The common shrubs and woody climbers met with in these forest are *Alangium salvifolium*, *Annona squamosa*, *Butea superba*, *Calotropis gigantea*, *C. procera*, *Cassia auriculata*, *Calycopteris floribunda*, *Combretum ovalifolium*, *C. decandrum*, *Dalbergia volubilis*, *Dodonaea viscosa*, *Dregea volubilis*, *Grewia hirsuta*, *Maytenus emarginata*, *Ochna squarrosa*, *Opilia amentacea*, *Phoenix acaulis*, *Ventilago maderaspatana*, *Woodfordia fruticosa*, etc. Along banks of the river Godavari *Tamarix ericoides* can be seen in abundance.

Eroded ravines and denuded hill slopes strewn with boulders support scrub vegetation. *Acacia nilotica* subsp. *indica*, *Cassia auriculata*, *Dodonaea viscosa*, *Gardenia turgida*, *Nyctanthes arbor-tristis*, *Prosopis juliflora*, low and bushy forms of *Streblus asper*, *Vitex negundo*, *Woodfordia fruticosa* and *Ziziphus* sp. are the commonest species in these habitats. Large clumps of *Borassus flabellifer* and *Phoenix humilis* are frequently seen on eroded lands and afford a beautiful landscape when viewed from a distance. The flat wastelands are at times covered with long stretches of *Butea monosperma*.

Deep inside the forest, herbaceous elements are quite meagre. Among the species which are usually found along the sides of forest patches on dried up streams mention may be made of the following: *Aerva*

lanata, *A. monsonia*, *Achyranthes aspera*, *Celosia argentic*, *Cassia tora*, *C. occidentalis*, *Elytraria acaulis*, *Hemigraphis latebrosa*, *Indigofera linnaei*, *Justicia diffusa*, *Lepidagathis cristata*, *Sida acuta*, *S. cordifolia*, *S. cordata*, *Tephrosia purpurea*, *T. villosa* and *Tridax procumbens*.

The species that are growing in or near water include *Bergia ammannioides*, *Cleome viscosa*, *Canscora diffusa*, *Hydrolea zeylanica*, *Ludwigia hyssopifolia*, *Oldenlandia umbellata* and *Rotala densiflora*. *Argemone mexicana* has become a common feature near human habitations and has spread to the fringes of forest and along streams.

Notable parasitic species found on forest trees in Telangana region of Andhra Pradesh are *Dendrophthoe falcata*, *Korthalsella opuntia*, *Scurrula parasitica* and *Viscum nepalense*.

Paddy (*Oryza sativa*), Jowar (*Sorghum bicolor*) and Maize (*Zea mays*) are the chief cereals cultivated throughout the entire Telangana region. *Paspalum scrobiculatum* is also cultivated at times. Tobacco (*Nicotiana tabacum*) is the most important and extensively cultivated cash crop of the area. Cotton is also cultivated. *Parkinsonia aculeata* is frequently planted for hedge and grows often as an escape.

III. VEGETATION OF RAYALASEEMA

The vegetation of Rayalaseema is treated here under the following broad headings.

1. Scrub forest
2. Deciduous forest
3. Dry evergreen forest and
4. Riparian vegetation

1. Scrub Forest

This type is usually confined to the bases of hills bordering villages and generally in the much disturbed and degraded dry deciduous forest. Amidst this type there are southern thorn forest with *Acacia catechu* var. *chundra*, *A. horrida* etc., southern *Euphorbia* scrub forest with *Euphorbia antiquorum* type are found in the eastern Nallamalais.

The forest areas of Srisailam have been disturbed because of large scale human interference. The following trees are common in this type of forest, *Atalantia monophylla*, *Balanites aegyptiaca*, *Dichrostachys cinerea*, *Diospyros chloroxylon*, *Maytenus emarginata*, *Moringa concanensis*, *Mundulea suberosa*, *Ochna obtusa* var. *gamblei*, *Cassia glauca*, etc.

In the *Acacia* type of forest, the following trees are common: *Acacia catechu* var. *chundra*, *A. horrida*, *A. leucophloea*, *A. nilotica* subsp. *indica*, *Aegle marmelos*, *Limonia elephantum*, *Capparis divaricata*, *Naringi alata*, *Murraya koenigii*, *Sapindus emarginatus*, *Soymida febrifuga*, *Sterculia urens*, *Tamarindus indica* etc. *Murraya koenigii* is being commercially exploited for its leaves that are used in flavouring curries. The shrubs of these forest include *Ehretia microphylla*, *Rhus mysorensis*, *Securinega virosa*, etc.

Many herbaceous species occupying large areas in different types of forest occur throughout these forest. *Tribulus terrestris* occurs in much disturbed places, often along bridle path..

Climbers, both herbaceous and shrubby, are common in degraded and disturbed areas as well as along bridle path and near villages. *Cissampelos pareira*. is common, as are *Dioscorea pentaphylla* and *D. tomentosa*. *Asparagus racemosus* is commonly seen among bushes. *Cissus quadrangularis* is confined to arid localities, mostly in plains. The common grasses of these areas are: *Aristida depressa*, *A. setacea*, *Melanocenchris monoica*, etc.

2. Deciduous forest

Champion and Seth (1968) treat 3 types of forest under this category. They are southern dry mixed deciduous forest, south Indian moist deciduous forest and slightly moist teak forest.

Southern dry mixed deciduous forest dominantly have the following trees: *Adina cordifolia*, *Anogeissus latifolia*, *Canthium didymum*, *Cassine glauca*, *Dalbergia paniculata*, *Gardenia turgida*, *Hardwickia binata*, *Ixora arborea*, *Mallotus philippensis*, *Semecarpus anacardium*, *Strychnos nux-vomica*, *Terminalia bellirica* and *Ziziphus xylopyra*. Some

of the common shrubs in these forest are *Canthium parviflorum*, *Cissus pallida*, *Desmodium pulchellum*, *Grewia hirsuta*, *Helicteres isora* and *Woodfordia fruticosa*. The common herbs of these forest are *Crotalaria calycina*, *Geodorum densiflorum*, *Globba bulbifera*, *Ludwigia perennis*, *Plumbago zeylanica*, *Triumfetta rhomboidea* and *Uvaria picta*. The herbaceous and shrubby climbers of the dry deciduous forest are *Ampelocissus latifolia*, *Argyreia nervosa*, *Cayratia pedata*, *Celastrus paniculatus*, *Derris scandens*, *Jasminum auriculatum*, *Ventilago maderaspatana* and *Ziziphus rugosa*.

South Indian moist deciduous forest have common trees like *Careya arborea*, *Derris indica*, *Dillenia pentagyna*, *Glochidion zeylanicum*, *Oroxylum indicum* and *Trema orientalis*. The common shrubs of these forest are *Costus speciosus*, *Clerodendrum serratum* etc. *Barleria strigosa*, *Desmodium gangeticum*, *Emilia sonchifolia*, *Oxalis corniculata* and *Pouzolzia auriculata* are some of the common herbs. The bamboo, *Dendrocalamus strictus* though not gregarious makes frequent clumps attaining great height. *Rotala mexicana* subsp. *pusilla* - an ephemeral marshy plant appears in puddles and similar habitats soon after the rains. Some of the grasses in these moist deciduous forest are *Arundinella pumila*, *Bothriochloa glabra*, *Centotheca latifolia* and *Sporobolus wallichii*. The common climbers and lianas of these areas are *Bauhinia vahlii*, *Entada rheedii*, *Pueraria tuberosa*, *Lygodium flexuosum*, *Dioscorea hispida* and *Naravelia zeylanica*.

3. Dry evergreen forest

Dry evergreen forest often have several intermixed evergreen elements. These are confined to places near perennial water courses. *Canthium didymum*, *Drypetes sepiaria*, *Manilkara hexandra*, *Memecylon umbellatum*, *Santalum album*, etc., are found in such forest.

4. Riparian vegetation

Tropical riparian fringing forest are found wherever streams and rivers flow. The plants constituting such forest include *Cleistanthus patulus*, *Glochidion zeylanicum*, *Pongamia pinnata*, *Mangifera indica*, *Barringtonia acutangula*, *Terminalia arjuna*, *Oroxylum indicum*, *Trema orientalis*, *Celtis cinnamomea* and *Homonoia riparia*.

FLORISTIC DIVERSITY AND PHYTOGEOGRAPHY

There is gradual transition in floristic composition from north to south. Mahendragiri appears to be the transitional area where the northern and southern elements are in the ratio of nearly 1 : 1.5 (Kapoor, 1964).

Many plants of the Himalayas, Meghalaya and Assam are found in the hills of Visakhapatnam district and some plants of Assam are found in Kalahandi and Bailadila (Mooney, 1950). Of these, mention may be made of *Saussurea heteromalla*, *Polygala furcata*, *Sloanea sterculiacea* (large trees), *Sapium eugeniaefolium* (small trees), *Bulbophyllum densiflorum*, *Eulophia explanata*, *Forrestia mollissima* var. *glabrata*, *Prunus jenkinsii* (medium-sized tree), *Chirita hamosa*, *Raphidophora decursiva*, *Beilschmiedia sikkimensis* (medium-sized trees), *Parabaena sagittata*, *Mucuna nigricans*, *Anaphalis adnata*, *Lysimachia alternifolia*, *L. decurrens* and *Callicarpa macrophylla* (Balakrishnan, 1964; Subba Rao and Kumari, 1968, 1971, 1972).

Ensete glaucum a relict species found in Meghalaya, Burma, Thailand etc., was recorded from Visakhapatnam Hills by (Subba Rao and Kumari, 1972).

Plants believed to be extant only in the Western Ghats are seen in wild state in Eastern Ghats. Of these, the more significant plants are *Nothopegia racemosa*, *Syzygium malabarica*, *Glochidion ellipticum* and *Debregeasia malabarica* (trees); *Xenacanthus pulneyensis*, *Pouzolzia bennettiana* (shrubs); *Lobelia zeylanica*, *Dicliptera zeylanica*, *Plectranthus mollis*, *Pilea trinervia* (all herbs); *Microstylis versicolor*, *Polystachya flavescens* (orchids).

Recent collections of various workers from the northern regions of Andhra Pradesh, resulted in recording several interesting species that contribute additional data on the extension of their distribution in India from south to north or vice-versa or from the Western Ghats to the Eastern Ghats. In some cases these records help in bridging the present extensive gap in distribution of these plants between the north and the extreme south. These discoveries indicate the possibility of their occurrence in suitable intervening habitats as well. Thus the collection of *Abelmoschus cancellatus*,

A. manihot var. *pungens*, *Cajanus cajanifolia*, *Beilschmiedia sikkimensis*, *Cyperus digitatus*, *Neodistemon indicum*, *Peucedanum nagpurensis* and *Thalictrum foliolosum* from this area establish the continuity of their distribution from extreme south to northern side of South India. *Begonia malabarica*, *Bupleurum andhricum*, *Malaxis versicolor*, *Pilea trinervia*, *Schefflera stellata*, *Balanophora dioica*, *Pecteilis susanne* and *Leucas chinensis* are found to extend their distribution to further south. The other interesting new records from this area are *Commiphora caudata*, *Debregeasia longifolia*, *Tropidia angulosa* and *Elatostema cuneata* bridging the wide gap in distribution between the southern and northern parts of India; *Geophila repens* linking the gap between Western Ghats and Khasi hills of Meghalaya; *Murdannia elata* joining the line of distribution from Eastern India through Andhra Pradesh (Eastern Ghats) to Western Ghats; *Ziziphus glabrata*, the endangered orchid *Vanilla wightiana*, *Amorphophallus paeoniifolius* and *Ludwigia prostrata*, establishing the continuity of their distribution from Western Ghats to Eastern Ghats. It is also interesting to note *Viscum heyneanum* (Peddakond, East Godavari district, ca 1361 m) extending its distribution further north from Chittoor district. *Liparis prazeri*, usually found in restricted habitats on the hill tops of Western Ghats also found on Palagadda hill top of East Godavari District. The discovery of *Acacia decipiens*, formerly known from Myanmar and the Andamans, from Rampa hills and Peddakonda of East Godavari District (Rolla Rao, 1958), is of considerable phytogeographic interest.

Such findings throw light on the urgent need to conduct intensive studies in the forest of Andhra Pradesh that are getting depleted fast. This is important because the data on their plant wealth is quite inadequate at present.

ENDEMISM

Major parts of Eastern Ghats lying in Orissa and Andhra Pradesh are underexplored. As such, specific comments on endemism and speciation in the area cannot be made. Though, Chatterjee (1940) and Nayar (1980) worked on endemism, no mention is made of the endemics of Eastern Ghats, presumably for the reason stated above. There are several endemic taxa in the flora of Eastern Ghats. *Andrographis beddomei*, *A. nallamalayana*, *Argyreia arakuensis*, *Boswellia ovalifoliolata*, *Cycas beddomei*, *Euphorbia senguptae*, *Eriolaena lushingtonii*, *Kalanchoe*

nerukondensis, *Leucas mukerjiana*, *Memecylon madgolense*, *Pimpinella tirupatiensis*, *Phyllanthus narayanaswamii*, *Staurogyne perpusilla*, *Strobilanthes circarensis*, *S. jeyporensis*, *Toxicarpus roxburghii* and *Uvaria eucineta* are some of the endemic species of this state.

THREATENED AND RARE TAXA

Some of the threatened and rare plants of Andhra Pradesh are given below:

Name of the species	Family	Distribution	Remarks
<i>Andrographis beddomei</i>	Acanthaceae	Nallamalai, Kurnool Dt; Sankamalai hills, Cuddapah Dt.	No specimen in MH.
<i>A. nallamalayana</i>	Acanthaceae	Ahobilam, Nallamalai, Kurnool Dt.	
<i>Dicliptera beddomei</i>	Acanthaceae	Nallamalai, Kurnool Dt.	No specimen in MH.
<i>Nilgiranthus circarensis</i>	Acanthaceae	Hills of Visakha- patnam Dt.	
<i>Uvaria eucineta</i>	Annonaceae	Endemic to Ganjam Dt.	Not located after type collection.
<i>Brachystelma glabrum</i>	Asclepiadaceae	Cuddapah hills	No specimen in MH.
<i>B. volubile</i>	Asclepiadaceae	Cuddapah hills	No specimen in MH.

Name of the species	Family	Distribution	Remarks
<i>Boswellia ovalifoliolata</i>	Burseraceae	Tirupathi hills Chittoor Dt. Nallamalai, Kurnool Dt.	
<i>Argyreia arakuensis</i>	Convolvulaceae	Araku valley Visakhapatnam Dt.	
<i>Phyllanthus narayanaswamii</i>	Euphorbiaceae	Dummakonda, East Godavari Dt; Cherukonda, Visakhapatnam Dt.	
<i>Chrysopogon velutinus</i>	Gramineae	Cuddapah	No specimen in MH.
<i>Leucas mukerjiana</i>	Labiatae	Cherukonda, Visakhapatnam Dt; Galikonda, Araku valley.	
<i>Memecylon madgolense</i>	Labiatae	Madgol hills in Visakha- ptnam Dt.	No specimen in MH.
<i>Pimpinella tirupatiensis</i>	Umbelliferae	Japalathirtham, Tirupathi hills, Chittoor Dt.	
<i>Psilotum nudum</i>	Psilotaceae	Galikonda (on way to Araku). Visakhapatnam Dt.	Not common
<i>Gnetum ula</i>	Gnetaceae	Visakhapatnam Dt; Vizianagaram Dt.	

ECONOMIC USES

Name of the species	Parts used
Edible plants	
<i>Polyalthia cerasoides</i>	Fruits
<i>Helicteres isora</i>	Fried seeds
<i>Grewia tiliaefolia</i>	Fruits
<i>Garuga pinnata</i>	Fruits
<i>Ziziphus oenoplia</i>	Fruits
<i>Caesalpinia digyna</i>	Seeds
<i>Casearia tomentosa</i>	Young roots
<i>Melothria heterophylla</i>	Fruits and roots
<i>Webera odorata</i>	Buds and tender leaves
<i>Canthium parviflorum</i>	Fruits and leaves
<i>Aerva lanata</i>	Leaves
<i>Cleome viscosa</i>	Seeds
<i>Mucuna nivea</i>	Cooked fruits
<i>Cassia occidentalis</i>	Leaves
<i>Bauhinia purpurea</i>	Buds and tender leaves
Medicinal Plants	
<i>Cocculus hirsutus</i>	Roots
<i>Cissampelos pareira</i>	Plant
<i>Argemone mexicana</i>	Seed oil
<i>Capparis zeylanica</i>	Roots
<i>C.sepiaria</i>	Bark
<i>Hibiscus vitifolius</i>	Leaves
<i>Tribulus terrestris</i>	Roots
<i>Biophytum sensitivum</i>	Plant
<i>Ailanthes excelsa</i>	Roots
<i>Soymida febrifuga</i>	Roots, bark, fruits
<i>Vicoa indica</i>	Roots

Name of the species	Parts used
<i>Ziziphus oenoplia</i>	Roots
<i>Pongamia pinnata</i>	Leaves, bark, seed oil
<i>Bauhinia purpurea</i>	Roots
<i>Melothria heterophylla</i>	Roots

RESOURCES FOR PLANT BASED INDUSTRY

Plywood industry

Dalbergia sissoo
Lannea coromandelica
Mangifera indica
Terminalia bellirica
Toona ciliata

Helicteres isora
Marsdenia volubilis
Milletia auriculata
Pergularia daemia
Urena lobata

Pencil industry

Paper pulp industry

Bambusa sp.
Pinus sp.
Eucalyptus sp.
Bauhinia vahlii
Cymbopogon flexuosus
Heteropogon contortus
Imperata cylindrica
Phragmites karka
Themeda arundinacea

Alstonia scholaris
Gmelina arborea
Hymenodictyon excelsum

Matchwood industry

Fibre industry

Abutilon sp.
Agave sisalina
Bauhinia vahlii
Ficus benghalensis
F. cunia
Grewia sp.

Albizia lebbeck
Alstonia scholaris
Anthocephalus chinensis
Bombax cebia
Buchanania lanzan
Crataeva magna
Euvodia luna-ankenda
Excoecaria agallocha
Ficus hispida
Garuga pinnata
Polyalthia longifolia
Spondias pinnata
Terminalia alata
Trewia nudiflora

Wood carving and engraving industry*Alstonia scholaris**Crataeva magna**Dalbergia sissoo**Lannea coromandelica**Murraya paniculata**Phyllanthus embelica**Toona ciliata**Wrightia tomentosa***Aromatic plants***Cymbopogon citratus**C. flexuosus**C. maritima var. motia***Oil yielding plants***Derris indica**Pongamia pinnata**Madhuca longifolia**Schleichera oleosa**Shorea robusta***CONSERVATION**

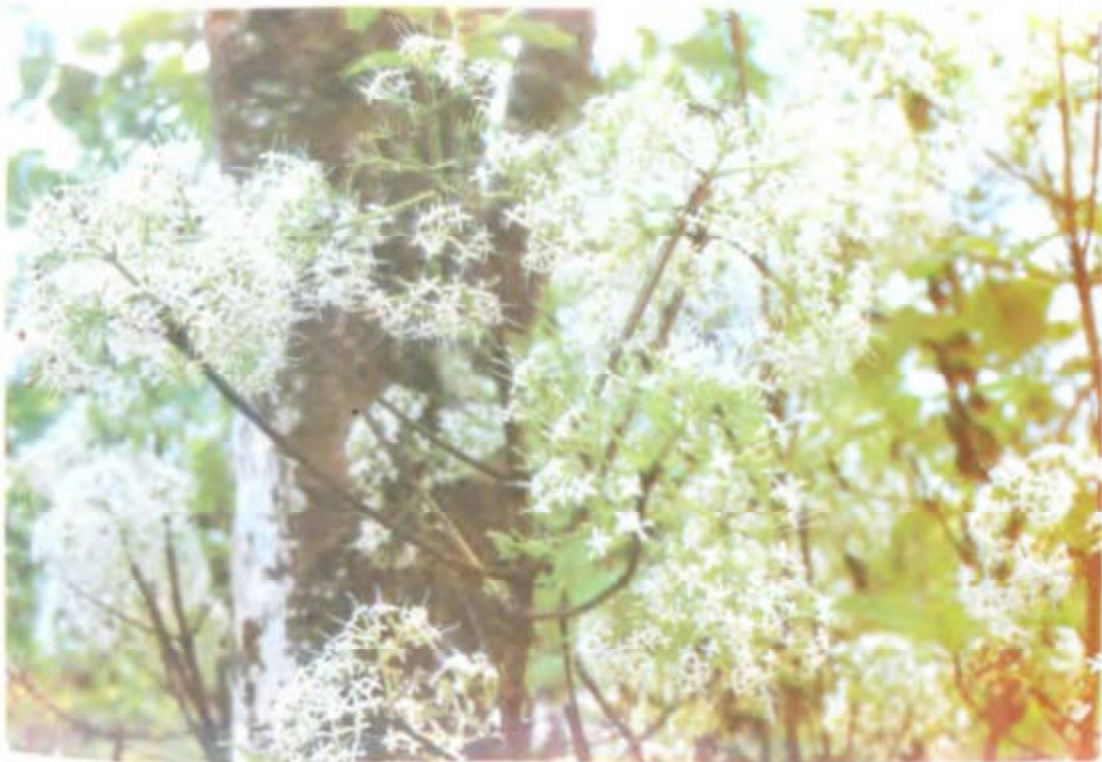
In accordance with the suggestions of the Indian Wildlife Board, almost all State Governments have already set up State Wildlife Boards to promulgate the Wildlife Protection Act. Widespread publicity to remove public apathy towards the cause of conservation of forest and preservation of wildlife is very important. The people down to those in the remotest villages must be made aware of the fact that forest and wildlife have to be considered as valuable national assets and it is in their interest to preserve them. This will yield great results and will be a necessary psychological preparation for the effective protection of forest and wildlife.

REFERENCES

- Balakrishnan, N.P. 1964. New plant records from south India. *Bull. Bot. Surv. India* 6: 81-92.
- Champion, H.G. and S.K. Seth 1968. *A Revised Survey of the Forest types of India*. Govt. of India, New Delhi.
- Chatterjee, D. 1940. Studies on the endemic flora of India and Burma. *J. Asia. Soc. Bengal* 5: 19-68.
- Kapoor, S.L. 1964. A contribution to our knowledge of the Flora of Mahendragiri Hills of Orissa. *J. Bombay Nat. Hist. Soc.* 61: 354-369.
- Mooney, H. 1950. *Supplement to the Botany of Bihar and Orissa*. Catholic Press, Ranchi, Bihar, India.
- Mukherjee, D.B. 1935. Notes on collection of plants from Mahendragiri. *J. Indian Bot. Soc.* 4: 305-311.
- Nayar, M.P. 1980. Endemism and patterns of distribution of endemic genera (Angiosperms) in India. *J. Econ. Tax. Bot.* 1: 99-110.
- Rao, G.V.S. and G.R. Kumari 1968. New records of plants from South India. *Bull. Bot. Surv. India* 9: 186-189.
- Rao, G.V.S. and G.R. Kumari 1970. New records of plants from South India III. *Bull. Bot. Surv. India* 12: 208-209.
- Rao, G.V.S. and G.R. Kumari 1971. New records of plants from South India IV. *Bull. Bot. Surv. India* 13: 155-156.
- Rao, G.V.S. and G.R. Kumari 1972. *Ensete glaucum* - A relict species of the Eastern Ghats. *Bull. Bot. Surv. India* 14: 164-166.
- Rao, R.S. 1958. Observations on the vegetation of the Rampa and Gudam Agency tracts of the Eastern Ghats I. *J. Bombay Nat. Hist. Soc.* 55(3): 429-449.



Capparis zeylanica : a climbing thorny shrub; common in Amangal forest range, Mahabubnagar Dist.



Pavetta indica : a small tree in deciduous forest; Mahabubnagar Dist.



Nagarjuna Sagar- Srisailem Tiger Reserve : Mahabubnagar Dist.



Southern dry deciduous forest : Mahabubnagar Dist.



Thorny scrub forest



Thorny scrub forest : Mahabubnagar forest range

ARUNACHAL PRADESH

H.J. Chowdhery

The land of dawn lit mountains - Arunachal, the NEFA (North East Frontier Agency) of yester years is a thinly populated hilly state in the eastern most corner of India. It is bounded on three sides by the international border with Myanmar (Burma) to the east, China to the north and Bhutan to the west and Indian state of Assam to the south. Arunachal Pradesh extends over an area of 83,743 sq km and is the largest amongst the seven north-eastern states. It's geographical location lies between 26° 28' and 29° 30' north latitude and 90° 30' and 97° 30' east longitude.

Arunachal Pradesh is entirely mountainous except for a narrow strip of plain land, situated adjoining to the state of Assam. The elevation of hills, ranges from 200 m (Siwalik formations) from the plains of Assam to 7750 m (the Himalayas), along the Tibet-China border. Arunachal Pradesh was earlier divided into 1- Aka hills, 2- Daphla hills 3- Miri hills, 4- Abor hills and 5- Mishmi hills on the basis of a particular tribe inhabiting a particular area. However, physiographically it can be divided into three zones from south to north viz., (1) Sub Himalaya, (2) the Lesser Himalaya and (3) the Greater Himalayas. The Sub-Himalayan zone consists of Neogene molassic sediments (Siwaliks) whereas the Lesser Himalayas comprises of Upper proterozoic to Lower Palaeogene shelf sediments (Bomdila Group, Buxa-Miri Formations) and the Greater Himalaya has been characterised by para and ortho metamorphites and acid to intermediate igneous intrusions from precambrian to Tertiary age (Sela Group, Lumla Formation etc.). The greater Himalayas are also characteristic in having high peaks, reaching heights of 6000 m and above. Some of the important peaks of the zone are Gorichen (7300 m), Kangto (7090 m), Namcha Barwa(7756 m), Kulangri (7544 m), Chome Lhari (7344 m), etc.

The six principal rivers in the state namely Kameng, Siang, Lohit, Tirap, Subansiri and Dibang receive water from their tributaries and finally merge with the mighty Brahmaputra in the plains of Assam.

The soils generally are of acidic nature and rich in humus with high percentage of nitrogen. They are sandy or sandy-loam, clay or mixed with heterogenous matrix due to erosion and depositions by the rivers. The soil

in plain areas of the valleys is clay-alluvium with rich organic matter contents where as, the soils in the foothills are loamy or sandy or mixed.

The climate varies from place to place due to varied topography. December and January are the coldest months and the temperature begins to rise from the month of March and continues upto July-August, followed by rainy season. However, in general the major parts of the state have humid subtropical climate with wet summer and winter having average maximum and minimum temperature of 29°C and 17.7° C and cold humid in higher reaches with average maximum temperature of 21° C and minimum being 2.4° C.

The average annual rainfall in the humid subtropical region is about 3000 mm where as it is 2100 mm in the cold humid. East Siang and the adjoining areas of Lohit receive the heaviest annual rainfall whereas, West Kameng experiences the lowest annual rainfall.

Arunachal is the home of more than 25 major tribes whose life is closely associated with the forest through ages.

Nature has been extraordinarily kind and has endowed Arunachal Pradesh with diverse flora. It has the distinction to be referred to as the "Cradle of flowering plants" In addition to the high degree of precipitation and varying degrees of altitudinal variations from foothills to high Himalayan peaks, located at the junction of the Palearctic, Indo-Chinese and Indo-Malayan biogeographic region, the flora is exceedingly rich and varied abounding in some of the tallest trees, tree ferns, bamboos, a large number of spectacular orchids, Rhododendrons, many curious, rare, endemic, primitive plants and a store-house of a large number of economically important species. The wide-ranging ecological habitats support almost all types of vegetation and it is estimated that the flora of this region will have ca 5000 species of flowering plants.

Despite its fabulous plant wealth this region was not able to attract as many plant collectors, explorers as compared to other regions within Eastern Himalaya which may be attributed mainly to its tough and inaccessible terrain. The extensive as well as intensive plant collection and survey work in the state was initiated after the reorganisation of Botanical Survey of India in 1956, however, there are some important explorations conducted prior to 1956 of which mention may be made of the following.

H. Wilcox for the first time explored the Mishmee hills (Dibang valley) in 1826. Griffith's "Flora of Mishmi Hills" was based on the collections made by him during October-December, 1836 which dealt with 900 species of flowering plants and 22 species of ferns and fern-allies. Thomas J. Booth undertook several horticultural explorations between 1840-1850, from Bisnath (Assam) into the hills of Daphlas situated at the south-eastern corner of Bhutan and described some Rhododendrons from this area. With the advent of 20th Century, the plant explorations in this region gained momentum which resulted in the publication of some important floristic accounts of this region viz., "On the Botany of Abor Expedition" I.H. Burkill (1924-1925); " Botanical Expedition in the Mishmi Hills" Kingdon Ward (1929-1931); "Lohit Valley" Kingdon Ward (1953) and "A sketch of the vegetation of Aka Hills" based on the collections of N.L. Bor (1931-1934) and it included 1549 species of flowering plants, 9 species of Gymnosperms and 58 species of Ferns and Fern Allies. S.K. Deka from Assam , Forest Department, in 1951 and K. Srinivasan in early 1955 surveyed along the Rupa valley in Kameng district. In the late 1955, R.S. Rao undertook plant explorations along the Rupa and Dirang valley upto Se La in Kameng district and Apatani valley and surrounding areas in Subansiri district.

With the inception of the Eastern Circle of Botanical Survey of India at Shillong, various parts of Arunachal namely Kameng, Subansiri, Siang, Lohit, Tirap, etc., were surveyed by the botanists of Botanical Survey of India, Shillong for its vegetational wealth, of which Contributions made by R.S. Rao and Panigrahi (1958-1959); R.S. Rao and Joseph (1958); Panigrahi and Naik (1959); D.B. Deb (1961); Sastry (1964, 1965, and 1966); Joseph (1964, 1969); A.S. Rao (1969, 1970) and D.B. Deb and R.M. Dutta and botanists from Botanical Survey of India, Itanagar are worth mentioning.

Apart from these, Sahni (1964,1969) has also made valuable contributions to the Flora of Arunachal Pradesh. The plants of ethnobotanical significance were recorded by various workers Anonymous (1976), Pal (1984), S.K. Jain (1981), Pal and Thothathri (1987), Haridasan *et al.* (1990) and Chowdhery (1996) from the area.

VEGETATION

Based on the climatic conditions and altitude the vegetation of Arunachal Pradesh can broadly be classified into five major types, and a

sixth type being the Secondary forest, which are developed in the place where the primary forest have been lost or degraded due to adverse biotic and abiotic factors. The five main forest/vegetation types, viz. the Tropical forest, Subtropical forest, Pine forest, Temperate forest and Alpine forest, are briefly dealt below.

1. Tropical Forest

These type of forest occur upto 900 m elevation all along the foot hills of the state and are full of economically important plant species. These are further divided into two subtypes.

(a) Tropical Evergreen Forest : Based on the species composition these forests can be further subdivided into South Bank Tropical Wet Evergreen Dipterocarpus forest and North Bank Tropical Evergreen Nahor-Jutli forest as follows.

(i) South Bank Tropical Wet Evergreen Dipterocarpus Forest: Corresponding to Assam Valley, tropical evergreen forest (Champion and Seth, 1968), these forest occur in Tirap and parts of Lohit district on the southern bank of Brahmaputra between 150-600m altitude. These forest are rich in species diversity and have a distinct three storied pattern.

The top canopy is occupied by large trees with an average girth of 2-5m and hight of 30-50m. *Dipterocarpus retusus*, *Shorea assamica*, *Altingia excelsa*, *Tetrameles nudiflora*, *Terminalia myriocarpa*, *Ailanthus integrifolia* etc., are some of the typical elements of this storey.

Second storey is composed of tree species gregariously forming a close canopy are about 20- 30m tall. Some of the common species are *Talauma hodgsonni*, *Mesua ferrea*, *Terminalia citrina*, *Turpinia nepalensis*, *Dysoxylum alliarium*, *Elaeocarpus aristatus*, *E. sphaericus*, *E. rugosus*, *Vatica lanceaefolia*, *Sapium baccatum*, etc.

The third canopy is occupied by species which are upto 5m tall. *Ardisia* spp., *Blastus cochinchinensis* such some species are *Maesa indica*, *Strobilanthes*, *Boehmeria* spp., *Gnetum gnemon*, *Livistona jenkinsiana*, tree ferns (*Cythea* spp.), *Impatiens* spp., *Musa* spp. and members of the family Araceae. Among the lianas and climbers- *Raphidophora* spp., *Mucuna macrocarpa*, *Thunbergia* spp., *Piper* spp., *Dioscorea* spp., *Hodgsonia macrocarpa* are prominent. The epiphytic species are very

common and consist of a large number of Orchids and species of ferns along with *Aeschynanthus* spp., *Hoya* spp., *Dischidia* spp. etc. The abundant growth of herbaceous flora is seen during monsoon season.

(ii) North Bank Tropical Evergreen Nahor-Jutli Forest: These forest corresponds to the Upper Assam Valley Tropical Evergreen forest (Champion and Seth, 1968). Such forest are rich in species diversity and occur upto an elevation of 900m in East and West Kameng, Lower and Upper Subansiri, East and West Siang districts on the northern bank of Brahmaputra. Many trees of these forest are buttressed.

The top storey is occupied by the tree species which are usually 20-40m tall and 2-3.5m in girth. *Altingia excelsa*, *Quercus milroyii*, *Syzygium formosum*, *Mesua ferrea*, *Cinnamomum glaucescens*, *Canarium strictum*, *Engelhardia spicata*, *Sapium baccatum*, *Elaeocarpus* spp., *Castanopsis* spp., *Echinocarpus assamica*, etc., are the dominant species.

The species of the second storey are 15-25m tall and the dominant species are *Mallotus nepalensis*, *Sterculia hamiltonii*, *Gynocardia odorata*, *Turpinia nepalensis*, *Polyalthia jenkinsii*, *Saurauia cerea*, *Antidesma acuminatum*, etc. Similarly the dominant taxa of third storey are upto 5m tall and include species like *Maesa chisia*, *Ixora* spp., *Clerodendrum wallichii*, *C. viscosum*, *Calamus* spp., *Elatostemma* spp., *Polygonum* spp., *Impatiens* spp., *Boehmeria* spp., *Phrynium pubinerve*, *Globba clarkeii*, etc. *Entada* spp., *Chonemorpha fragrans*, *Gnetum scandens*, *Gouania tiliaefolia*, *Beaumontia grandiflora*, *Raphidophora* spp., *Pothos* spp., *Hodgsonia macrocarpa* are other important climbing species in these forest.

The forest with tall, dense tree species provide ideal conditions for the profuse growth of epiphytic flora. Some of the most common species belong to genera *Aerides*, *Coelogyne*, *Cymbidium*, *Dendrobium*, *Eria*, *Oberonia*, *Pholidota*, *Rhynchostylis*, *Phalaenopsis* etc. Similarly common ferns here are the species of *Asplenium*, *Drymoglossum*, *Colysis*, *Nephrolepis* etc.

Apart from the epiphytic species, trees in these forest are infested with lianas and climbers of various kinds. The most significant amongst them are the species of *Acacia*, *Derris*, *Clematis*, *Dischidia*, *Gymnostemma*, *Mucuna*, *Mezoneurom*, *Piper*, *Raphidophora*, *Pothos*, *Thunbergia*, *Tetrastigma*, *Trichosanthes*, *Toddalia*, *Unona*, *Vitis*, etc.

Species of *Calamus* and *Entada* are commonly seen stretching long distances from one tree to another.

The forest floor is covered by a rich growth of herbaceous flora specially during the rainy season. Some of the common herbaceous elements of these forest are *Begonia* spp., *Commelina* spp., *Chirita* spp., *Polygonum* spp., *Oxalis corniculata*, *Deeringia amaranthoides*, *Exacum tetragonum*, *Floscopa scandens*, *Lindenbergia indica*, *Lobelia pyramidalis*, *Murdannia nudiflora*, *Rhynchoglossum obliquum*, *Asystasia neesiana* etc. along with terrestrial orchid species of *Goodyera*, *Calanthe*, *Phaius*, *Malaxis*, *Habenaria* etc. The bamboo orchid *Arundina graminifolia* is common along the road sides on hill slopes. *Angiopteris evecta* an endangered gaint fern is also seen with it fronds measuring upto 5m in length. Other common fern and fern allies are *Pteris*, *Diplazium*, *Lycopodium*, *Selaginella*, *Equisetum* spp. Root parasites like *Balanophora dioica* and saprophytes such as species of *Epipogium*, *Galeola*, *Monotrpa*, occur in moist, shady, humus rich soils.

The other conspicuous elements of these forest are the rhizomatous monocotyledons, which are represented by the species of *Tacca*, *Arisaema*, *Colocasia*, *Gonatanthus*, *Hedychium*, *Zingiber*, *Ammomum*, *Curcuma*, *Phrynium*, *Musa*, etc.

(b) Tropical Semi-Evergreen Forest : These forests occur all along the foot hills and river banks upto an altitude of 600 m in all the districts of the state. The top conopy of these forests is generally consists of deciduous trees, whereas the lower stories are dominated by evergreens. Such forest are known for their commercially important timber species. Based on the floral constituents, this type is again sub-divided into two distinct subtypes, Low hills and Plains Semi-Evergreen forest and Riverine Semi Evergreen forest.

(i) Low Hills and Plains Semi-Evergreen Forest : This type corresponds to Assam alluvial plains semi-evergreen forest and Himalayan light alluvial semi-evergreen forest (Champion and Seth, 1968).

The top canopy is represented by 30-40 m tall trees viz., *Acrocarpus fraxinifolius*, *Ailanthus integrifolia* subsp. *calycina*, *Altingia excelsa*, *Artocarpus lacucha*, *Canarium strictum*, *Castanopsis* spp., *Chukrasia tabularis*, *Bombax ceiba*, *Bischofia javanica*, *Cinnamomum glaucescens*, *Dillenia indica*, *Duabanga grandiflora*, *Dysoxylum* spp., *Elaeocarpus*

aristatus, *Firmiana colorata*, *Gmelina arborea*, *Phoebe goalparensis*, *Pterospermum* spp., *Sterculia villosa*, *Stereospermum chelonoides*, *Terminalia myriocarpa*, *Tetrameles nudiflora*, etc.

The trees of the second storey are 15-25 m tall and represented by dominant species like *Crateva nurvala*, *C. religiosa*, *Croton chlorocalyx*, *Ficus* spp., *Gynocardia odorata*, *Litsea panamoaja*, *Picrasma javanica*, *Meliosma simplicifolia*, *Talauma hodgsonii*, *Saurauia cerea*, *Syzygium* spp., *Turpinia nepalensis*, etc.

The next story of small trees and shrubs upto 10 m tall comprises the prominent species of *Ardisia*, *Boehmeria*, *Capparis*, *Clerodendrum*, *Strobilanthes*, etc.

The ground floor is dominated by a large number of small shrubs and herbs like species of *Phlogacanthus*, *Ageratum*, *Impatiens* spp., *Costus speciosus*, *Arisaema* spp., *Amorphophalus* spp., *Colocasia* spp., *Phrynium* spp., etc.

Entada scandens, *Conocephalus cochinchinensis*, *Gouania tiliaefolia*, *Roydsia suaveolens*, *Thunbergia* spp., *Stixis suaveolens* etc, are some of the common liana and climbers. Epiphytes are not common however, certain species of *Dendrobium*, *Papilionanthe teres*, *Hoya* spp., and some polypodiaceous ferns are found to occur scarcely in such forest.

(ii) Riverine Semi-Evergreen Forest : Corresponding to East Himalayan moist deciduous forest and Eastern hillock forest (Champion and Seth, 1968), these forests occur along the river banks, riverine plains and swamps. The trees in these forest are generally deciduous, buttressed and lack a dense canopy.

The upper storey of these forest having 25-40 m tall trees comprises the common species such as *Albizia* spp., *Artocarpus* spp., *Bischofia javanica*, *Bombax ceiba*, *Canarium strictum*, *Dalbergia sissoo*, *Dillenia indica*, *Daubanga grandiflora*, *Lagerstroemia speciosa*, *Radermachera gigantea*, *Sterculia villosa*, *Terminalia bellirica*, *T. myriocarpa*, etc.

The second storey is generally not found in such forest but sometimes small trees which are 10-20 m tall may form a second storey. The dominant species in such cases are species of *Magnolia*, *Ficus*, *Litsea*, *Meliosma*, *Turpinia nepalensis*, *Talauma hodgsonii*, etc.

The forest floor covered with profuse growth of shrubs and herbs usually comprises the species of *Murraya*, *Randia*, *Costus*, *Hedychium*, *Calamus* and various grasses.

2. Subtropical Forest

These forests occur in all the districts between the altitude of 900-2000 m and also floristically are rich in species diversity.

The top canopy of such forest is occupied by 25-40 m tall trees, dominated by species like *Acer oblongum*, *Actinodaphne obovata*, *Alnus nepalensis*, *Beilschmiedia roxburghiana*, *Byttneria grandifolia*, *Callicarpa arborea*, *Castanopsis indica*, *Dichroa febrifuga*, *Engelhardia spicata*, *Ficus* spp., *Kydia calycina*, *Magnolia pterocarpa*, *Manglietia insignis*, *Prunus nepaulensis*, *Quercus* spp., *Saurauia panduana*, *Schima wallichii* var. *khasiana*, *Sterculia hamiltonii*, *Ulmus lancifolium*, etc.

The next storey is composed of 10-20 m tall trees and dominated by the members of the family Araliaceae and Saurauiaceae associated with the species of *Hydrangea*, *Turpinia*, *Capparis multiflora*, *Lepisanthes senegalensis*, *Photinia integrifolia*, etc.

The third storey consists of small trees and shrubs that are upto 10 m tall. Some such species are *Eurya acuminata*, *Myrsine semiserrata*, *Ardisia* spp., *Camellia caudata*, *Symplocos* sp., *Luculia* sp., *Oxyspora* spp., etc.

The ground flora formed by the dense growth of small shrubs and herbs is represented by the species like *Cassia mimosoides*, *Dianella ensifolia*, *Drymaria diandra*, *Eurya acuminata*, *Lasianthus longicauda*, *Mahonia acanthifolia*, *Plectranthus griffithii*, *Rosa indica*, *Solanum erianthum*, *Sophora acuminata*, *Tephrosia candida*, *Vernonia saligna*, *Viburnum foetidum*, *Begonia* spp., *Impatiens* spp., *Oxalis* spp., *Campanula* spp., *Lobelia* spp., *viola* spp., etc. Species of *Clematis*, *Naravelia*, *Jasminum*, *Codonopsis*, *Crawfordia* and *Holboellia latifolia*, *Tinospora sinensis* are some of the common climbers of these forest. Among the straggling shrubs met are *Actinidia callosa*, *Argyreia wallichii*, *Clerodendrum* spp., *Combretum pilosum*, *Maesa* spp., *Phlogacanthus* spp., *Rubia cordifolia*, *Rubus moluccanus*, *Zanthoxylum oxyphyllum* etc.

The prominent herbs are *Anaphalis adnata*, *A. busua*, *A. contorta*, *Anemone vitifolia*, *Campanula khasiana*, *Cardamine hirsuta*, *Cynoglossum glochidiatum*, *Exacum tetragonum*, *Inula cappa*, *Justicia khasiana*, *Osbeckia stellata*, *Plantago major*, *Polygonum* spp., *Potentilla* spp., *Viola* spp. and species of terrestrial orchids like *Goodyera*, *Habenaria*, *Malaxis*, *Phaius*, *Diplomeris*, *Calanthe*, etc. and many species of ferns and grasses.

These forests also abound in good diversity of epiphytic flora, comprising a variety of ferns such as the species of *Asplenium*, *Drynaria*, *Lepisorus*, etc., and a large number of orchids species like of *Cymbidium*, *Bulbophyllum*, *Dendrobium*, *Coelogyne*, *Cleisostoma*, *Otochilus*, *Ritia*, *Oberonia*, etc.

3. Pine Forest

These forest occur between 1000- 1800 m elevation and extend both in the subtropical and temperate belts mostly in the rain shadow areas. The three different species of *Pinus* found in these forest are *Pinus roxburghii*, *P. wallichiana*, *P. merkusii* which form either pure stands or in association with *Quercus* spp., *Prunus* sp., *Alnus nepalensis*, *Betula alnoides*, *Tsuga dumosa*, etc. However, these forest are poor in species diversity.

The species of the top storey are *Pinus roxburghii*, *P. wallichiana*, *Pinus mercusii*, *Tsuga dumosa*, *Betula alnoides*, etc.

The next storey species are 10-15 m tall and represented by *Lyonia ovalifolia*, *Alnus nepalensis*, *Rhus javanica*, *Quercus* spp., etc.

Amongst the available shrubs and herbs the species of *Rubus*, *Ajuga*, *Desmodium*, *Coriaria*, *Luculia*, *Elsholtzia*, *Indigofera*, *Pogostemon*, *Prunella*, *Potentilla*, *Plectranthus*, etc., are more prominent. The climbers are not common but species of *Clematis*, *Smilax*, *Vitis* are occasionally seen. The epiphytic species are extremely rare except for few species of orchids and ferns.

4. Temperate Forest

These forests occur in all the districts in the form of a continuous belt between 1800-3500 m altitude. Based on the constituent species these forest divided into two types.

(a) **Temperate Broad Leaved Forest** : These forests corresponds to East Himalayan wet Temperate forest with its subtypes e.g. Lauraceae forest; Bak oak forest; High level oak forest and Naga hill wet temperate forest as classified by Champion and Seth (1968). Such forest occur between 1800-2800 m in colder regions.

The top canopy is represented by 20-30 m tall tree species like *Quercus lamellosa*, *Acer hookeri*, *A. oblongum*, *A. pectinatum*, *Betula alnoides*, *Exbucklandia populnea*, *Castanopsis* spp., *Quercus glauca*, *Magnolia campbellii*, *Michelia* spp., *Rhododendron arboreum*, *Populus ciliata*, *Euonymus* sp. etc.

The middle storey is dominated by 3-15 m tall tree and shrubby species like *Illicium griffithii*, *Acer* spp., species of *Pyrus*, *Prunus*, *Spiraea*, *Acer*, *Symplocos* and *Rhododendron*, *Lyonia ovalifolia*, *Corylopsis himalayana*, *Myrsine semiserrata*, *Berberis wallichii*, *Mahonia* spp., *Ardisia* spp., *Caryopteris odorata*, *Debregeasia longifolia*, *Vaccinium sprengelii*, etc.

The ground flora is mainly consist of herbaceous species belonging to genera *Begonia*, *Carydalis*, *Sedum*, *Arisaema*, *Drymaria*, *Polygonum*, *Potentilla*, *Fragaria*, *Cardamine*, *Carpesium*, *Oenanthe*, *Pilea*, *Rorippa*, *Stellaria*, *Rhodiola* etc. Climber and twiners are extremely rare in these forest except for *Clematis* spp. and *Holbelia latifolia* which are occasionally seen in such forest.

(b) **Temperate Coniferous Forest** : These forest generally occur between 2800-3500 m altitude. They are termed as East Himalayan mixed coniferous forest, *Abies delavayi* forest and East Himalayan subalpine birch/fir forest by Champion and Seth (1968). These forest are dominated by mixed coniferous species and show a succession of forest association like (i) *Tsuga dumosa* - *Pinus wallichiana* - *Rhododendron*, *Tsuga dumosa* - *Abies spectabilis*, *Tsuga dumosa* - *Taxus wallichiana* - *Abies spectabilis* or sometimes pure stands of *Cupressus torulosa* are encountered, (ii) *Abies spectabilis* - *Taxus wallichiana*, *Abies delavayi*, (iii) *Picea spinulosa* - *Larix griffithiana*, *Picea spinulosa* - *Abies delavayi*, *Abies spectabilis*, (iv) *Abies-Juniperus*.

The shrubby layer in such forest is represented by *Berberis asiatica*, *B. wallichiana*, *Mahonia* spp., *Euonymus* spp., *Eurya acuminata*,

Gaultheria fragrantissima, *Photinia integrifolia*, *Vaccinium venosum* and *Viburnum odorsatissimum* etc.

The herbaceous flora is mostly seasonal due to heavy snow fall during winter months. The most common species belong to genera *Corydalis*, *Cassiope*, *Primula*, *Pedicularis* etc.

The temperate coniferous forest are always found above the temperate broad leaved forest but it is surprising to observe a nearly reverse sequence of association at Tale Valley lower subansiri where broad leaved elements occur at higher elevations and conifers at the valley bottom.

5. Alpine Forest

These occur between 4000-5500 m altitude and correspond to Alpine pasture, Dry alpine scrub, Dwarf Juniper scrub etc., of Champion and Seth (1968). However, between the temperate forest and alpine zone there exist subalpine zone (between 3500-4000 m). This subalpine zone is characterised by tree species like *Abies*, *Cupressus*, *Juniperus*, *Larix*, *Pinus*, *Rhododendron*, *Taxus*, *Tsuga* and shrubs like *Berberis*, *Eurya*, *Gaultheria*, *Photinia*, *Vaccinium* etc. Beyond 4000 m for the major part of the year the alpine region remains covered under thick snow cover and the plant activity is restricted for a very short period when this snow cover melts. The vegetation in this region is scarce and is in the form of bushy, low lying or creeping shrubs/bushes, and a large number of herbs and grasses with brightly coloured, attractive flowers giving this region a unique appearance. Among the bushes and shrubs *Rhododendron anthopogan*, *R. nivale*, etc., are prominent. The herbaceous diversity is represented by the species of *Saxifraga*, *Sedum*, *Primula*, *Polygonum*, *Arenaria*, *Gentiana*, *Rheum*, *Aconitum*, *Meconopsis*, *Saussurea*, *Aster*, *Rhodiola*, *Anemone*, *Anaphalis*, *Epilobium*, *Pedicularis*, *Cypripedium* and many others.

Beyond alpine zone plant life virtually ceases and barren snow capped peaks are seen.

Secondary Forest

The impact of various adverse factors both biotic and abiotic on virgin forest has resulted into a vegetation, having different type of

composition from that of primary ones is referred usually as secondary vegetation or forest. Depending upon their floristic components these are further grouped into (i) Degraded forest (ii) Bamboo forest and (iii) Grass lands as follows

(a) Degraded Forest : As compared to the original primary forest these degraded ones have a very low species diversity and are generally dominated by weedy shrubs and inferior quality of trees. Of the common trees the species of, *Bauhinia*, *Callicarpa*, *Glochidion*, *Macaranga*, *Mallotus* are more prominent, whereas, *Capparis*, *Clerodendrum*, *Croton*, *Eurya*, *Randia*, *Rubus*, *Viburnum* species are common shrubs associated with weeds like *Ageratum*, *Eupatorium*, *Mikania*, etc.

(b) Bamboo Forest : These type of secondary forest mostly occur in the areas which were abandoned after "Jhum" cultivation. The common bamboo species are *Arundinaria* sp., *Bambusa pallida*, *B. tulda*, *Cephalostachyum latifolium*, *Chimonobambusa callosa*, *Dendrocalamus hamiltonii*, *D. hookeri*, *D. strictus*, *Phyllostachys* spp., *Pseudostachyum polymorphum*, etc.

(c) Grasslands: Generally formed due to the practice of "Jhum" cultivation or sometimes due to forest fires at higher altitudes or over grazing. More commonly seen grasses here are *Arundinella bengalensis*, *Chrysopogon aciculatus*, *Eragrostis tenella*, *E. uniolodes*, *Hackelochloa granularis*, *Imperata cylindrica*, *Paspalum* spp. *Saccharum arundinaceum*, *S. spontaneum*, *Sacciolepis interrupta*, *Setaria palmifolia*, *Themeda caudata* and *Thysanolaena maxima* found in association with sedge like *Cyperus* spp., *Fimbristylis* sp., *Scirpus* sp., etc.

Aquatic Vegetation

Alisma plantago, *Eriocaulon puzulaefolium*, *Monocharia vaginalis*, *Polygonum alatum*, *Potamogeton nodosus*, *Sagittaria sagittifolia*, *Sanicula europea*, *Utricularia bifida*, etc., are some of the common hydrophytes growing in the marshes, roadside pools, nallas and paddy field. *Zeylanidium* the liverwort like plant of the family Podostemaceae grows underwater on the stones and boulders in the fast running streams at lower altitudes. Its occurrence in Arunachal Pradesh represents the northernmost distribution of this family in India.

Weeds

In areas where the primary vegetation has been destroyed or modified due to various adverse factors or lands abandoned after "Jhum" cultivation, a variety of weedy species make their appearance and colonize. Some of the most common weeds in such places are *Adenostemma lavenia*, *Ageratum conizoides*, *Bidens biternata*, *Cuphea salicifolia*, *Cuscuta reflexa*, *Cyperus brevifolius*, *Emelia sonchifolia*, *Erigeron bonariensis*, *Eupatorium odoratum*, *Galinsoga parviflora*, *Gynura crepidioides*, *Hedyotis scandens*, *Laggera crispata*, *Lantana camara*, *Ludwigia octovalvis*, *Mikania cordata*, *Mitracarpus verticillatus*, *Polygonum* spp., *Richardia scabra*, *Scoparia dulcis*, *Sida rhombifolia*, *Solanum khasianum*, *Spilanthes paniculata*, *Urena lobata*, *Vernonia cinerea*, etc.

GYMNOSPERMS

As compared to the cold loving and drought resistant flora of Western Himalaya where large populations of conifers like *Pinus*, *Cedrus*, *Abies*, *Picea* etc. occur, the Eastern Himalayan (Arunachal Pradesh) flora is warm and moist loving due to which pure stands of coniferous forest are not common still it is the only state which has the maximum number of living collection of Gymnosperms. The sub-tropical and temperate belt provide the most suitable habitat for their growth and abundance.

Eighteen genera and 33 species of Gymnosperms have been reported from Arunachal Pradesh of which about 8 genera and 12 species are introduced and cultivated. Some of the known Gymnosperms taxa from the state are *Cupressus cashmeriana*, *C. corneyana*, *C. torulosa*, *Juniperus indica*, *J. recurva*, *Cephalotaxus griffithi*, *Gnetum montanum*, *Abies delavayi*, *A. densa*, *A. spectabilis*, *Cedrus deodara*, *Larix griffithiana*, *Picea brachystyla*, *P. spinulosa*, *Pinus armandi*, *P. bhutanica*, *P. merkusii*, *P. roxburghii*, *P. wallichiana*, *P. wallichiana* var. *parva*, *Tsuga dumosa*, *Podocarpus neriifolius*, *Amentotaxum assamica* and *Taxus wallichiana*.

PHYTOGEOGRAPHICAL AFFINITIES

Clarke (1889) based on his studies on the distribution of the family Cyperaceae (*Carex*) suggested that Eastern Himalaya and Assam are

distinct subareas. Hooker (1906) in his botanical divisions of India treated Eastern Himalaya as a separate area while he placed major parts of Assam in Gangetic Plains and merged remaining hilly parts of Assam, Shillong plateau, Naga and Manipur hills with Myanmar. He concluded that the rich floristic diversity of the Indian subcontinent is mainly due to the migration of plant species from different adjoining countries like China Malaya in eastern and southern; Europe, Siberia and Tibet in northern and Africa, Oriental and Europe in the western region. He recognized 3 main phytogeographical divisions of India.

1. Himalayan division - with European and Siberian elements.
2. Eastern division - with Chinese and Malayan elements.
3. Western division - with African, Oriental and European elements.

Rao (1974) phytogeographically considered Arunachal Pradesh as a part of Assam. He has drawn close affinities between the flora of Assam and Myanmar and treated them as a part of the Eastern border lands comprising mostly the tertiary mountains with highly humid tropical climate and remarkably diverse flora and vegetation. Biogeographically Assam and north Myanmar represent a highly transitional region where large scale commingling of the Asiatic and Indian Peninsular Floras has occurred. Takhtajan (1986) placed Arunachal Pradesh in the Eastern Himalayan Province within Eastern Asiatic region of Boreal sub-kingdom along with parts of eastern Nepal in the west upto Kali river valley, Darjeeljing, Sikkim, Bhutan, large parts of Assam Himalaya, certain extreme south and southern parts of Tibet.

The flora of Arunachal Pradesh has close affinities with tropical South-East Asian-Malayan, temperate Himalayan-Chinese and Japanese floras and has some elements common with peninsular India, Sri Lanka Tibet and Euro-Siberian region.

South-East Asian-Malaysian affinities : The flora of Arunachal Pradesh abounds in species which are typical of tropical South-East Asian region viz., Myanmar, Thailand, Indo-China, Malaysia and Indonesia. Those elements gradually decline as one moves westwards. Following are some of the species which occur in Arunachal Pradesh as well as South-East Asian region.

Actinidia callosa, *Ampelocissus barbata*, *Antidesma accuminatum*, *Bauhinia purpurea*, *Bischofia javanica*, *Brassaiopsis glomerulata*, *Carallia brachiata*, *Crateva religiosa*, *Debregeasia longifolia*, *Dendrobium aggregatum*, *Duabanga grandiflora*, *Engelhardia spicata*, *Eria paniculata*, *Exbucklandia populnea*, *Firmiana colorata*, *Hedychium coccineum*, *Hodgsonia macrocarpa*, *Lepisanthes senegalensis*, *Lithocarpus elegans*, *Mangifera indica*, *Meliosma simplicifolia*, *Michelia champaca*, *Mucuna nigricans*, *Musa balbisiana*, *Oroxylum indicum*, *Procris crenata*, *Spondias pinnata*, *Talauma hodgsonii*, *Tetrameles nudiflora*, *Toona sureni*, *Trevesia palmata*, *Vernonia volkammeriaefolia*, etc.

Himalayan-Chinese-Japanese affinities : Arunachal Pradesh harbours many 'Himalayan' 'Chinese' and 'Japanese' phytogeographic elements which overlap between these regions making it difficult to draw clearcut boundaries. Stanton (1972) has shown that even within Himalayan region there exist distinct 'Eastern' and 'Western' elements. The eastern elements are mostly confined to Eastern Himalaya and have many species common with China and the number of such species increases eastwards and sharply decreases westwards. Species like, *Betula alnoides*, *Callicarpa rubella*, *Cardamine griffithii*, *Cinnamomum obtusifolium*, *Dalbergia mimosoides*, *Helwingia himalaica*, *Litsea cubeba*, *L. kingii*, *L. sericea*, *Lonicera adenophora*, *Magnolia campbellii*, *Meconopsis napaulensis*, *Michelia doltsopa*, *Millettia cinerea*, *M. pachycarpa*, *Neillia rubiflora*, *Osmanthus suavis*, *Panax pseudoginseng*, *Potentilla griffithii*, *Rhododendron micromeres*, *R. neriiflorum*, *Rubus fragarioides*, *Salix sikkimensis*, *Shuteria hirsuta*, *Smilax ferox*, *Tetracentron sinense* etc., common with China while *Cornus controversa*, *Mucuna macrocarpa*, *Taxillus keempferi*, *Stachyurus*, *Helwingia* etc. extends as far as into Japan. Species like *Anisadenia saxatilis*, *Arisaema intermedium*, *Dalbergia sericea*, *Eriobotrya dubia*, *Gardneria angustifolia*, *Lindera pulcherrima*, *Mohonia napaulensis*, *Michelia kisopa*, *Pinus roxburghii*, *P. wallichiana*, *Premna interrupta*, *Rhododendron anthopogon*, *R. barbatum*, *R. campanulatum*, *Rhus wallichii*, *Rosa macrophylla*, *Rubus nepalensis*, *Sorbus cuspidata*, *Spiraea canescens*, *Tsuga dumosa*, etc., are of common occurrence between North-Western Himalaya and Eastern Himalaya but unknown from China and Japan however, there are several species which are distributed from North-Western Himalaya to China and even upto Japan. Apart from these common elements there are many species which are restricted to Eastern Himalaya only. Some of these species which

also occur in Arunachal Pradesh are *Agapetes serpens*, *Capparis sikkimensis*, *Elatostema imbricans*, *Eriobotrya hookeriana*, *Ichnocarpus himalaicus*, *Impatiens longipes*, *Primula whitei*, *Rhododendron camelliflorum*, *R. falconeri*, *R. glaucophyllum*, *R. grande*, *R. hodgsonii*, *R. keysii*, *R. lindleyi*, *R. pendulum*, *R. smithii*, *R. succothii*, *R. wallichii*, *R. wightii*, *Rubus fragarioides*, etc.

As compared to very close links with China, Myanmar Malaya, the flora of Arunachal Pradesh also has some elements common with Peninsular India, Sri Lanka, Tibet and Europe, Siberia. *Capparis olacifolia*, *Casearia zeylanica*, *Dendrophthoe falcata*, *Ficus benghalensis*, *F. drupacea*, *Leucas ciliata*, *Murraya koenigii*, *Palmbago zeylanica*, *Pterolobium hexapetalum*, *Tamarix indica*, *Thunbergia coccinea*, *Tylophora rotundifolia*, *Woodfordia fruticosa*, etc., are typical 'Deccan' elements occurring in Arunachal Pradesh. *Goodyera repens*, *Hedera* sp., *Juncus inflexus*, *Lithospermum officinale*, *Polygala sibirica*, *Prunella vulgaris*, *Ranunculus scleratus*, *Stellaria uliginosa*, *Thlaspi arvense*, *Vernonia anagallis-aquatica*, *Viola biflora*, etc. are characteristic Euro-Siberian elements which are found in Arunachal Pradesh.

FLORISTIC DIVERSITY

Arunachal Pradesh is situated in the Eastern Himalayan province, which is the richest biogeographical province of the Himalayan zone.

The terrain of Arunachal Pradesh with its complex system of hills and ridges of varying elevations ranging from 50m to 7000 m, criss-crossed by many rivers and rivulets; high rainfall from 1000 mm in the higher reaches to about 5750 mm in the foot hills spreading over a period of 8-9 months of a year and the climate ranging from warm tropical in the foot hill regions to moderate in the mid hills, cool and temperate in high hills has given rise to many macro- and micro-habitats.

This diversity of topographical and climatic conditions has been instrumental for the growth and development of luxuriant forest harbouring myriad plant and animal forms (Table I).

Table I
District-wise Forest Area via-a-vis Geographical Area

Sl. No.	District	Geographical area (sq km)	Forest area (sq km)	% of Forest area to geographical area
1.	Lohit	11402	7145	62.66
2.	Dibang valley	13029	8160	66.62
3.	East Siang	6512	5123	87.33
4.	West Siang	12006	10487	87.34
5.	Upper Subansiri	7032	3618	51.45
6.	Lower Subansiri Papum Pare	13010	6697	51.47
7.	East Kameng	4131	2129	51.53
8.	Tawang and West Kameng	9594	4946	51.55
9.	Tirap and Chang- lang	7024	3235	46.05
Total		83740	51540	61.54

Source: Geographical area : Census of India 1981, series 25 Arunachal, Arunachal Pradesh Paper 1 of 1981.

Studies conducted on the floristic diversity of Eastern Himalaya by workers like Bor, 1938, 1953; Biswas, 1941; Rao and Panigrahi, 1961; Champian and Seth, 1968; A.S. Rao, 1974; Sahni, 1981; Mehra *et al.* 1983; Rao and Hajra, 1986; Kaul and Haridasan, 1987; Deori and Haridasan, 1988; Rao and Murti, 1990; Khashoo, 1992, 1993; Rao, 1993, 1994 and Chowdhery *et al.*, 1996. have revealed that, out of the total number of about 17000 flowering plant species estimated to occur in India (Source: Botanical Survey of India) about 50% (\pm 8500 species) hail from this region representing more than 200 families.

A conspectus of flowering plants showing diversity of genera and species in different families in Arunachal Pradesh is presented in the (Table II).

Table II
Families showing approximate number of
Genera and Species

Family	Genera	Species
DICOTYLEDONS		
Ranunculaceae	13	53
Circiasteraceae	1	1
Dilleniaceae	2	5
Magnoliaceae	4	23
Illiciaceae	1	4
Schisandraceae	2	6
Teracentraceae	1	1
Eupteleaceae	1	1
Annonaceae	11	30
Menispermaceae	14	30
Berberidaceae	3	11
Podophyllaceae	1	1
Lardizabalaceae	3	5
Nymphaeaceae	1	2
Papaveraceae	3	6
Fumariaceae	3	12
Brassicaceae	14	27
Capparaceae	4	11
Violaceae	2	17
Flacourtiaceae	1	2
Pittosporaceae	1	2
Polygalaceae	3	17
Xanthophyllaceae	1	3
Caryophyllaceae	9	21
Portulacaceae	1	1
Tamaricaceae	2	2
Hypericaceae	1	9
Clusiaceae	3	12

Family	Genera	Species
Theaceae	5	17
Actinidiaceae	2	9
Stachyuraceae	1	1
Dipterocarpaceae	4	7
Malvaceae	10	21
Bombacaceae	1	1
Sterculiaceae	10	21
Tiliaceae	4	13
Elaeocarpaceae	2	18
Linaceae	3	4
Malpighiaceae	2	5
Averrhoaceae	1	1
Geraniaceae	1	4
Balsaminaceae	1	33
Oxalidaceae	2	4
Rutaceae	15	36
Simaroubaceae	3	4
Ochnaceae	1	1
Burseraceae	2	4
Meliaceae	11	24
Dichapetalaceae	1	1
Olacaceae	3	6
Icacinaceae	4	5
Opiliaceae	1	1
Cardiopteridaceae	1	1
Aquifoliaceae	1	9
Celastraceae	7	24
Hippocrateaceae	1	3
Rhamnaceae	7	16
Vitaceae	5	25
Leeaceae	1	9
Hippocastanaceae	1	1
Sapindaceae	8	15

Family	Genera	Species
Aceraceae	1	15
Staphyleaceae	1	2
Sabiaceae	2	8
Anacardiaceae	12	17
Coriariaceae	1	1
Moringaceae	1	1
Connaraceae	2	2
Papilionioideae	52	133
Caesalpinioideae	9	35
Mimosoideae	6	28
Rosaceae	18	102
Saxifragaceae	7	12
Grossulariaceae	2	4
Hydrangeaceae	4	8
Crassulaceae	4	9
Droseraceae	1	1
Hamamelidaceae	4	4
Haloragidaceae	1	1
Rhizophoraceae	1	1
Combretaceae	4	15
Hernandiaceae	1	2
Myrtaceae	7	22
Lecythidaceae	2	2
Melastomataceae	9	24
Crypteroniaceae	1	1
Lythraceae	4	8
Sonneratiaceae	1	1
Punicaceae	1	1
Onagraceae	1	11
Trapaceae	1	1
Passifloraceae	3	7
Caricaceae	1	1
Cucurbitaceae	18	30

Family	Genera	Species
Begoniaceae	1	11
Cactaceae	1	1
Molluginaceae	1	2
Apiaceae	17	23
Araliaceae	15	31
Cornaceae	4	5
Alangiaceae	1	2
Caprifoliaceae	6	24
Rubiaceae	52	158
Valerianaceae	2	3
Dipsacaceae	1	2
Asteraceae	68	186
Campanulaceae	8	15
Ericaceae	8	149
Pyrolaceae	1	2
Monotropaceae	1	1
Plumbaginaceae	1	1
Primulaceae	4	56
Myrsinaceae	8	45
Sapotaceae	7	9
Ebenaceae	1	8
Styraceae	5	6
Symplocaceae	1	13
Oleaceae	8	32
Apocynaceae	24	30
Asclepiadaceae	19	40
Loganiaceae	3	5
Buddlejaceae	1	8
Gentianaceae	9	27
Hydrophyllaceae	1	1
Boraginaceae	11	21
Convolvulaceae	6	24
Cuscutaceae	1	1

Family	Genera	Species
Solanaceae	10	32
Scrophulariaceae	23	65
Orobanchaceae	2	3
Lentibulariaceae	2	4
Gesneriaceae	15	56
Bignoniaceae	5	7
Pedaliaceae	1	1
Acanthaceae	24	85
Verbenaceae	14	55
Lamiaceae	11	16
Chenopodiaceae	1	2
Phytolaccaceae	1	1
Polygonaceae	7	30
Podostemaceae	1	1
Rafflesiaceae	1	1
Aristolochiaceae	2	6
Piperaceae	2	25
Saururaceae	1	1
Chloranthaceae	2	2
Myristicaceae	2	5
Lauraceae	11	62
Proteaceae	1	3
Thymelaeaceae	4	9
Elaeagnaceae	1	4
Loranthaceae	8	24
Santalaceae	2	2
Balanophoraceae	2	2
Euphorbiaceae	38	90
Urticaceae	18	61
Moraceae	4	58
Cannabaceae	1	1
Ulmaceae	3	7
Juglandaceae	2	3
Myricaceae	1	1

Family	Genera	Species
Fagaceae	3	27
Betulaceae	3	4
Salicaceae	2	10
Ceratophyllaceae	1	1
MONOCOTYLEDONS		
Hydrocharitaceae	3	3
Orchidaceae	121	530
Zingiberaceae	13	54
Costaceae	1	2
Marantaceae	1	2
Musaceae	2	10
Cannaceae	1	1
Iridaceae	2	2
Taccaceae	1	1
Dioscoreaceae	1	25
Stemonaceae	2	3
Liliaceae	25	64
Smilacaceae	2	21
Pontederiaceae	1	2
Commelinaceae	11	44
Juncaceae	2	9
Arecaceae	10	20
Pandanaceae	1	2
Araceae	18	58
Lemnaceae	1	1
Alismataceae	2	3
Butomaceae	1	1
Aponogetonaceae	1	1
Potamogetonaceae	1	2
Eriocaulaceae	1	5
Cyperaceae	22	95
Poaceae	71	145

Generic Diversity vis-a-vis Family in Arunachal Pradesh Flora

Families with	1	genus	71
Families with	2	genera	27
Families with	3	genera	14
Families with	4-5	genera	18
Families with	6-10	genera	22
Families with	11-15	genera	15
Families with	16-25	genera	11
Families with	26-50	genera	1
Families with	51-75	genera	4
Families with	76-100	genera	
Families with more than	100	genera	1

Species Diversity vis-a-vis Family in Arunachal Pradesh Flora

Families with	1	species	41
Families with	2-10	species	73
Families with	11-30	species	46
Families with	31-50	species	9
Families with	51-75	species	10
Families with	76-100	species	3
Families with more than	100	species	6

Species Diversity within the Genera of Different Families of Arunachal Pradesh

Genera with	1	species	41
Genera with	2	species	19
Genera with	3	species	8
Genera with	4	species	15
Genera with	5	species	4
Genera with	6-10	species	21
Genera with	11-20	species	50
Genera with	21-30	species	8
Genera with	31-50	species	7
Genera with	51-75	species	3
Genera with	75-100	species	1
Genera with more than	100	species	

Table III
Comparative account of dominant families in Arunachal Pradesh,
Eastern Himalaya and adjacent regions

Sl. No.	Arunachal Pradesh (Chowdhery <i>et al.</i> 1996)	E. Himalaya (Hooker, 1906)	N.E. Region (Rao and Murti, 1990)	India (Hooker 1906)	Myanmar (Hooker, 1906)
1.	Orchidaceae	Orchidaceae	Gramineae (Poaceae)	Orchidaceae	Orchidaceae
2.	Leguminosae	Gramineae	Orchidaceae	Leguminosae	Leguminosae
3.	Compositae (Asteraceae)	Leguminosae	Leguminosae	Gramineae	Gramineae
4.	Rubiaceae	Compositae	Compositae	Rubiaceae	Rubiaceae
5.	Ericaceae	Cyperaceae	Cyperaceae	Euphorbiaceae	Euphorbiaceae
6.	Gramineae	Urticaceae	Labiatae	Acanthaceae	Acanthaceae
7.	Urticaceae (including Moraceae)	Scrophulariaceae	Scrophulariaceae	Compositae	Cyperaceae
8.	Rosaceae	Rosaceae	Acanthaceae	Cyperaceae	Urticaceae
9.	Cyperaceae	Rutaceae	Euphorbiaceae	Labiatae	Compositae
10.	Euphorbiaceae	Euphorbiaceae	Rubiaceae	Urticaceae	Scitamineae

The floristic analysis of Arunachal Pradesh shows the dominance of Dicotyledons over Monocotyledons. A comparative statement of 10 dominant families of flowering plants represented in Arunachal Pradesh, Eastern Himalaya, North-East India, India and Burma (Myanmar) presented in Table III. indicates that the 10 dominant families are more or less same but their position varies according to their dominance in each region. Further, the family Ericaceae which ranks 5th in order of dominance in Arunachal Pradesh does not figure among 10 dominant families of the remaining 4 regions. The family Rosaceae which occupies 7th position in Arunachal and Eastern Himalaya finds no place within 10 dominant families of N.E. - region, India and Myanmar.

Twenty dominant families and twenty dominant genera of Arunachal Pradesh are shown in Table IV and Table V accordingly.

Table IV
Twenty Dominant Families

Sl. No.	Family	Arunachal Pradesh		India	
		Genera	Species	Genera	Species
1.	Orchidaceae	121	530	184	1229
2.	Leguminosae	67	196	167	1141
3.	Asteraceae	68	186	167	803
4.	Rubiaceae	52	158	113	616
5.	Ericaceae	8	149	15	199
6.	Poaceae	71	145	245	1194
7.	Rosaceae	18	102	40	432
8.	Cyperaceae	22	95	38	545
9.	Euphorbiaceae	38	90	84	523
10.	Acanthaceae	24	85	92	500
11.	Scrophulariaceae	23	65	62	368
12.	Liliaceae	25	64	54	249
13.	Lauraceae	11	62	17	212
14.	Araceae	18	58	29	126
15.	Moraceae	4	58	13	122
16.	Gesneriaceae	15	56	24	114
17.	Verbenaceae	14	55	25	145

Sl. No.	Family	Arunachal Pradesh		India	
		Genera	Species	Genera	Species
18.	Zingiberaceae	13	54	23	189
19.	Ranunculaceae	13	53	28	191
20.	Myrsinaceae	8	45	12	109

Table V
Twenty Dominant Genera

Sl.No.	Name of the Genus	No. of Species
1.	<i>Rhododendron</i>	89
2.	<i>Bulbophyllum</i>	62
3.	<i>Ficus</i>	51
4.	<i>Dendrobium</i>	47
5.	<i>Primula</i>	40
6.	<i>Agapetes</i>	34
7.	<i>Impatiens</i>	33
8.	<i>Eria</i>	31
9.	<i>Carex</i>	30
10.	<i>Rubus</i>	29
11.	<i>Litsea</i>	25
12.	<i>Coelogyne</i>	23
13.	<i>Piper</i>	22
14.	<i>Hedychium</i>	21
15.	<i>Elatostema</i>	21
16.	<i>Cyperus</i>	20
17.	<i>Desmodium</i>	20
18.	<i>Cymbidium</i>	19
19.	<i>Liparis</i>	18
20.	<i>Begonia</i>	18
	<i>Jasminum</i>	18
	<i>Ophiorrhiza</i>	18

It is evident from the tabulated data that the family Orchidaceae is the largest family (about 530 species) in Arunachal Pradesh followed by

Leguminosae and Compositae whereas, Tetracentraceae, Coriariaceae etc. are monotypic families with one genus and a single species. The genus *Rhododendron* is the largest being represented by more than 89 species followed by *Bulbophyllum* (with 62 species), *Ficus* (with 51 species) *Dendrobium* (with 47 species) and *Primula* (with 40 species). The diversity of Arunachal Pradesh flora is enormous and it is not possible to highlight the diversity of their total flora however, some selected groups have been discussed in detail in the following pages.

Interesting Plant Species

Certain plants on account of their special structure and other morphological characters evoke attention and interest among the biologists and students.

The rich and diverse flora of Arunachal Pradesh also harbours some such interesting and biologically curious plants. Amongst interesting and rare root parasites mention may be of *Sapria himalayana*, one of the largest root parasites first reported by Griffith from Mishmi hills in Lohit district and subsequently by Bor (1938) from Aka hills in Kameng district and *Ropalocnemis phalloides* in Namadapha in Changlang district. *Balanophora dioica* is commonly found associated with the roots of several tree species in dense humid forest whereas, *Aeginetia indica* is a common root parasite on grasses. Similarly *Boschniaekia himalaica*, a parasite on the roots of *Rhododendron* spp., is found in the alpine meadows.

Among the common saprophytes, *Monotropa uniflora* and species of orchids like, *Epipogium* and *Galeola* are found in dense humid forest on organic matter and humus rich soil. Unusual plant forms of high altitude regions which form cushions, snowballs, etc., like *Thylacospermum*, *Acantholemon* and *Saussurea gossypiflora*.

Certain plants viz., *Saussurea obvallata*, *Rheum nobile*, etc., have flowers which act as hot houses as the flowers are enclosed by large, transparent, leafy bracts. The flowers open inside the bracts, with in these bracts insects take shelter for warmth during chilly winter nights and at the same time pollinating the flowers.

Primitive Angiosperms

Arunachal Pradesh can be considered as a sanctuary of primitive angiosperms. A large number of primitive species that occur in Arunachal Pradesh are presented in Table VI.

Table VI
Primitive flowering plants

Name of the species	Family	Distribution
<i>Magnolia griffithii</i>	Magnoliaceae	Arunachal, N.E.India, Bangladesh, Myanmar
<i>M. gustavii</i>	Magnoliaceae	Arunachal, Assam
<i>M. hodgsonii</i>	Magnoliaceae	Arunachal, N.E.India, Sikkim, W.Bengal, Nepal, Bhutan, Bangladesh, Myanmar
<i>M. hookeri</i>	Magnoliaceae	Arunachal, N.E.India, Myanmar
<i>M. insignis</i>	Magnoliaceae	Arunachal, N.E.India
<i>Tetracentron sinens</i>	Tetracentraceae	Arunachal, Sikkim, Nepal, N.Myanmar, S.W.China
<i>Euptelea pleiosperma</i>	Eupteleaceae	Arunachal, S.W. and C.China, Japan
<i>Decaisnea insignis</i>	Lardizabalaceae	Arunachal, Sikkim, Bhutan, China
<i>Holboellia latifolia</i>	Lardizabalaceae	Arunachal, Uttar Pradesh, Sikkim, N.E.India, Nepal, Bhutan, Myanmar
<i>Parvattia brunoniana</i>	Lardizabalaceae	Arunachal, N.E. India, Bangladesh
<i>P. elliptica</i>	Lardizabalaceae	Arunachal, Assam, Meghalaya
<i>Altingia excelsa</i>	Hamamelidaceae	Arunachal, Assam, China, Japan, Java
<i>Loropetalum chinensis</i>	Hamamelidaceae	Arunachal, Meghalaya, China

Name of species	Family	Distribution
<i>Exbucklandia populnea</i>	Hamamelidaceae	Arunachal, Assam, Myanmar
<i>Corylopsis himalayana</i>	Hamamelidaceae	Arunachal, N.E.India
<i>Houttuynia cordata</i>	Saururaceae	Arunachal, Himalaya, N.E. India, Thailand
<i>Chloranthus offinalis</i>	Chloranthaceae	Arunachal, Meghalaya
<i>Myrica esculenta</i>	Myricaceae	Arunachal, Himalaya, Myanmar, W.S.China, Malaysia
<i>Haematocarpus validus</i>	Menispermaceae	Arunachal, Malaysia, New Guinea
<i>Aspidocarya uvifera</i>	Menispermaceae	Arunachal, S.E.Asia
<i>Pycnarrhena pleniflora</i>	Menispermaceae	Arunachal, N.W.Australia
<i>Betula alnoides</i>	Betulaceae	Arunachal, Himalaya, E.Asia
<i>Alnus nepalensis</i>	Betulaceae	Arunachal, Himalaya, China

The presence of such a large number of primitive plants led Takhtajan (1969) to suggest this region as the "Cradle of flowering plants" where the evolutionary development of flowering plants might have taken place.

ENDEMISM

The high mountain ranges of Arunachal Pradesh ranging from 700 m to 7089 m at Kangto and the parallel deep valleys in between the mountains have created a number of ecological niches and isolated geographical islands. In addition, the presence of lofty mountain ranges and dry Tibetan plateau in the north, warm alluvial plains of Brahmaputra in the south act as natural barriers for plants to migrate.

The important microcentres of endemism in Arunachal are Abor, Dafla and Mishmi hills; Tirap; Dibang; Namadapha; Tale Valley; Tawang' Sela range; Dirang etc. Some of the endemic species occurring in Arunachal Pradesh are presented in (Table VII).

Table VII
Endemic Species

Name of the species	Family
<i>Acanthus leucostachys</i>	Acanthaceae
<i>Acer oblongum</i> var. <i>microcarpum</i>	Aceraceae
<i>A. sikkimensis</i> var. <i>serrulatum</i>	Aceraceae
<i>Aconitum assamicum</i>	Ranunculaceae
<i>A. lethale</i>	Ranunculaceae
<i>Aconogonum pangianum</i>	Polygonaceae
<i>Aglaia edulis</i>	Meliaceae
<i>Agapetes aborensis</i>	Ericaceae
<i>A. disper</i>	Ericaceae
<i>A. refracta</i>	Ericaceae
<i>A. subansirica</i>	Ericaceae
<i>Albizia arunachalensis</i>	Mimosoideae
<i>Anemone howellii</i>	Ranunculaceae
<i>A. trullifolia</i>	Ranunculaceae
<i>Anoectochilus sikkimensis</i>	Orchidaceae
<i>Aeschynanthus parasiticus</i>	Gesneriaceae
<i>Aspidopterys glabriuscula</i> var. <i>lohitensis</i>	Malpighiaceae
<i>Baliospermum micranthum</i>	Euphorbiaceae
<i>Bauhinia khasiana</i>	Caesalpinioideae
<i>B. ovalifolia</i>	Caesalpinioideae
<i>Begonia aborensis</i>	Begoniaceae
<i>B. iridescens</i>	Begoniaceae
<i>B. scintillans</i>	Begoniaceae
<i>B. silhetensis</i>	Begoniaceae
<i>Beilschmiedia aborensis</i>	Lauraceae
<i>B. deomalica</i>	Lauraceae
<i>Berberis dasyclada</i>	Berberidaceae
<i>Blechnidium melanopus</i>	Blechnaceae
<i>Boehmeria tirapensis</i>	Urticaceae

Name of the species	Family
<i>Bulbophyllum ornatissimum</i>	Orchidaceae
<i>Bulleyia yunnanensis</i>	Orchidaceae
<i>Calamus leptospadix</i>	Arecaceae
<i>Calanthe densiflora</i>	Orchidaceae
<i>Caltha palustris</i> var. <i>purpurea</i>	Ranunculaceae
<i>Camellia siangensis</i>	Theaceae
<i>Capparis acutifolia</i>	Capparidaceae
<i>C. pachyphylla</i>	Capparidaceae
<i>Cardamine scoriarum</i>	Brassicaceae
<i>Ceratostylis subulata</i>	Orchidaceae
<i>Cheirostylis munnacampensis</i>	Orchidaceae
<i>C. sessanica</i>	Orchidaceae
<i>Chirita macrophylla</i>	Gesneriaceae
<i>C. mishmiensis</i>	Gesneriaceae
<i>Cissus assamica</i>	Vitaceae
<i>Cleisostoma tricallosum</i>	Orchidaceae
<i>Clerodendrum lasiocephalum</i>	Verbenaceae
<i>Coelogyne arunachalensis</i>	Orchidaceae
<i>Coffia khasiana</i>	Rubiaceae
<i>Coptis teeta</i>	Ranunculaceae
<i>Corydalis oligacantha</i>	Fumariaceae
<i>Cotoneaster assamensis</i>	Rosaceae
<i>Curculigo crassifolia</i>	Hypoxidaceae
<i>Cymbidium eburneum</i>	Orchidaceae
<i>Dalbergia oliveri</i>	Fabaceae
<i>Dendrobium cathcartii</i>	Orchidaceae
<i>D. nareshbahaduri</i>	Orchidaceae
<i>D. sulcatum</i>	Orchidaceae
<i>D. hookerianum</i>	Orchidaceae
<i>Desmodium dioicum</i>	Fabaceae
<i>D. likabaliun</i>	Fabaceae
<i>Dicentra roylei</i>	Fumariaceae
<i>Didymosperma nana</i>	Arecaceae

Name of the species	Family
<i>Dioscorea wattii</i>	Dioscoreaceae
<i>Dumasia villosa</i>	Fabaceae
<i>Diplomeris pulchella</i>	Orchidaceae
<i>Dysoxylum pallens</i>	Meliaceae
<i>D. reticulatum</i>	Meliaceae
<i>Echinocarpus tomentosus</i>	Elaeocarpaceae
<i>Elaeocarpus dubius</i>	Elaeocarpaceae
<i>Embelia subcoriacea</i>	Myrsinaceae
<i>Epipogium indicum</i>	Orchidaceae
<i>E. sessanum</i>	Orchidaceae
<i>Eranthemum leptanthus</i>	Acanthaceae
<i>Eria clausa</i>	Orchidaceae
<i>E. ferruginea</i>	Orchidaceae
<i>E. jengingensis</i>	Orchidaceae
<i>E. lohitensis</i>	Orchidaceae
<i>E. sharmae</i>	Orchidaceae
<i>Euonymus glaber</i>	Celastraceae
<i>E. fortunei</i>	Celastraceae
<i>Eurya arunachalensis</i>	Theaceae
<i>Galeola falconeri</i>	Orchidaceae
<i>Gastrodia arunachalensis</i>	Orchidaceae
<i>Garcinia acuminata</i>	Clusiaceae
<i>Gleditsia assamica</i>	Caesalpinioideae
<i>Globba multiflora</i>	Zingiberaceae
<i>Glycosmis boriانا</i>	Rutaceae
<i>G. cymosa</i>	Rutaceae
<i>Glycopetalum griffithii</i>	Celastraceae
<i>Gomphogyne macrocarpa</i>	Cucurbitaceae
<i>Gomphostemma aborensis</i>	Lamiaceae
<i>Grewia denticulata</i>	Tiliaceae
<i>Haematocarpus validus</i>	Menispermaceae
<i>Hedychium longipedunculatum</i>	Zingiberaceae
<i>H. radiatum</i>	Zingiberaceae

Name of the species	Family
<i>Hedychium robustum</i>	Zingiberaceae
<i>H. wardii</i>	Zingiberaceae
<i>Herminium longilobatum</i>	Orchidaceae
<i>Hopea shingkeng</i>	Dipterocarpaceae
<i>Hypericum griffithii</i>	Hypericaceae
<i>H. wightianum</i>	Hypericaceae
<i>Illicium cambodianum</i>	Illiciaceae
<i>Impatiens assamica</i>	Balsaminaceae
<i>I. bracteolata</i>	Balsaminaceae
<i>I. citrina</i>	Balsaminaceae
<i>I. laevigata</i>	Balsaminaceae
<i>I. latiflora</i>	Balsaminaceae
<i>I. mishmiensis</i>	Balsaminaceae
<i>I. porrecta</i>	Balsaminaceae
<i>I. racemulosa</i>	Balsaminaceae
<i>Indigofera nigressens</i>	Fabaceae
<i>Jasminum lanceolarium</i>	Oleaceae
<i>Lagenandra undulata</i>	Araceae
<i>Lasianthus sikkimensis</i>	Rubiaceae
<i>L. tubiflorus</i>	Rubiaceae
<i>Leycesteris dibangvalliensis</i>	Caprifoliaceae
<i>Lindera neesiana</i> var. <i>griffithii</i>	Lauraceae
<i>Liparis assamica</i>	Orchidaceae
<i>L. distans</i>	Orchidaceae
<i>L. plantaginea</i>	Orchidaceae
<i>Lithocarpus kamengensis</i>	Fagaceae
<i>Litsea membranifolia</i>	Lauraceae
<i>L. mishmiensis</i>	Lauraceae
<i>Livistona jenkinsiana</i>	Arecaeae
<i>Lobelia mishmica</i>	Campanulaceae
<i>Loxostigma griffithii</i>	Gesneriaceae
<i>Luculia pinceana</i>	Rubiaceae
<i>Lysimachia santapaui</i>	Primulaceae
<i>Maesa arunachalensis</i>	Myrsinaceae

Name of the species	Family
<i>Maesa nayarii</i>	Myrsinaceae
<i>M. truncata</i>	Myrsinaceae
<i>Magnolia baillonii</i>	Magnoliaceae
<i>M. caveana</i>	Magnoliaceae
<i>M. griffithii</i>	Magnoliaceae
<i>M. gustavi</i>	Magnoliaceae
<i>M. insignis</i>	Magnoliaceae
<i>Mapania arunachalensis</i>	Cyperaceae
<i>Michelia doltsopa</i>	Magnoliaceae
<i>M. wardii</i>	Magnoliaceae
<i>Miliusa dolicantha</i>	Annonaceae
<i>Musa velutina</i>	Musaceae
<i>Mycetia listeri</i>	Rubiaceae
<i>M. mukherjiana</i>	Rubiaceae
<i>Mycetia radiceflora</i>	Rubiaceae
<i>Oberonia acaulis</i>	Orchidaceae
<i>O. sulcata</i>	Orchidaceae
<i>Ophiorrhiza calcarata</i>	Rubiaceae
<i>O. hispida</i>	Rubiaceae
<i>O. talevalliensis</i>	Rubiaceae
<i>Orthosiphon wattii</i>	Lamiaceae
<i>Paphiopedilum fairieanum</i>	Orchidaceae
<i>P. wardii</i>	Orchidaceae
<i>Paravatia elliptica</i>	Lardizabalaceae
<i>Pauiia belladona</i>	Solanaceae
<i>Peliosanthes tetra ssp. humilis</i>	Liliaceae
<i>Petasites kamengicus</i>	Asteraceae
<i>Phanera khasiana</i>	Leguminosae
<i>Phlogacanthus gracilis</i>	Acanthaceae
<i>P. parviflorus</i>	Acanthaceae
<i>P. tubiflorus</i>	Acanthaceae
<i>Pholidota convallariae</i>	Orchidaceae
<i>P. pygmea</i>	Orchidaceae

Name of the species	Family
<i>Pholidota wattii</i>	Orchidaceae
<i>Pilea insolens</i>	Urticaceae
<i>Pileostegia subansiriana</i>	Hydrangeaceae
<i>Piper anisotis</i>	Piperaceae
<i>P. petiolatum</i>	Piperaceae
<i>Podochilus khasianus</i>	Orchidaceae
<i>Polyura geminata</i>	Rubiaceae
<i>Pratia longipedicellata</i>	Campanulaceae
<i>Premna milleflora</i>	Verbenaceae
<i>Prenanthes scandens</i>	Asteraceae
<i>Primula euosma</i>	Primulaceae
<i>P. mishmiensis</i>	Primulaceae
<i>P. subansirica</i>	Primulaceae
<i>Psychotria aborensis</i>	Rubiaceae
<i>P. burkillii</i>	Rubiaceae
<i>Pternopetalum senii</i>	Apiaceae
<i>Pueraria bella</i>	Fabaceae
<i>Pyrenaria barringtonifolia</i>	Theaceae
<i>Renanthera imschootiana</i>	Orchidaceae
<i>Rhaphidophora hookeri</i>	Araceae
<i>Rhododendron beanianum</i>	Ericaceae
<i>R. dalhousiae</i> var. <i>rhabdatum</i>	Ericaceae
<i>R. falconeri</i> ssp. <i>eximium</i>	Ericaceae
<i>R. megacalyx</i>	Ericaceae
<i>R. nuttallii</i>	Ericaceae
<i>R. pocophorum</i>	Ericaceae
<i>R. pemakoense</i>	Ericaceae
<i>R. pruniflorum</i>	Ericaceae
<i>R. santapaui</i>	Ericaceae
<i>R. subansiriense</i>	Ericaceae
<i>R. tanastylum</i>	Ericaceae
<i>R. tawangensis</i>	Ericaceae

Name of the species	Family
<i>Rhododendron tephropeplum</i>	Ericaceae
<i>R. walongensis</i>	Ericaceae
<i>Rhynochoglossum lazulinum</i>	Gesneriaceae
<i>Rhynochoticum calycinum</i>	Gesneriaceae
<i>Rubus burkillii</i>	Rosaceae
<i>R. ghanakantae</i>	Rosaceae
<i>Sadira erecta</i>	Myrsinaceae
<i>S. subbessilifolia</i>	Myrsinaceae
<i>S. boweri</i>	Myrsinaceae
<i>Sapria himalayana</i>	Rafflesiaceae
<i>Sarcoglyphis arunachalensis</i>	Orchidaceae
<i>Sauroupus stipulatus</i>	Euphorbiaceae
<i>Saxifraga assamensis</i>	Saxifragaceae
<i>Schisandra pleana</i>	Schisandraceae
<i>Schizopon wardii</i>	Cucurbitaceae
<i>Senecio mishmi</i>	Asteraceae
<i>Shorea assamica</i>	Dipterocarpaceae
<i>Silene chodatii</i>	Caryophyllaceae
<i>Skimmia aborescens</i>	Rutaceae
<i>Sonerila arunachalensis</i>	Melastomataceae
<i>Spiraea arunachalensis</i>	Rosaceae
<i>Strobilanthes aborensis</i>	Acanthaceae
<i>S. secundus</i>	Acanthaceae
<i>Strychnos quintriplinervis</i>	Strychnaceae
<i>Symplocos glauca</i>	Symplocaceae
<i>Synotis borii</i>	Asteraceae
<i>S. brevipappa</i>	Asteraceae
<i>S. saluensis</i>	Asteraceae
<i>Syzygium aborensis</i>	Myrtaceae
<i>S. mishmiense</i>	Myrtaceae
<i>Tetrastigma obovatum</i>	Vitaceae
<i>Tricarpelema glanduliferum</i>	Commelinaceae
<i>Trichodesma khasianum</i>	Boraginaceae

Name of the species	Family
<i>Trichosanthes khasiana</i>	Cucurbitaceae
<i>Trollius farreri</i>	Ranunculaceae
<i>Tylostylis discolor</i>	Orchidaceae
<i>Viburnum corylifolium</i>	Caprifoliaceae
<i>Viola pogonantha</i>	Violaceae
<i>Vitis planicaulis</i>	Vitaceae
<i>Wallichia triandra</i>	Arecaceae
<i>Xanthophyllum burkillii</i>	Xanthophyllaceae
<i>Zalacca secunda</i>	Araceae
<i>Zanthoxylum burkillianum</i>	Rutaceae
<i>Z. pseudoxyphyllum</i>	Rutaceae
<i>Zeuxine lindleyana</i>	Orchidaceae

ECONOMIC USES

The varied topography, climatic conditions, geography have blessed Arunachal with more than 61% geographical area covered under forest. The different forest types of Arunachal Pradesh with more than 4500 species of flowering plants exhibit enormous floristic diversity and may be regarded as a store house of innumerable types of economic plants. The majority of the population living in this state is tribal belonging to 26 major tribes and many subtribes leading a life of hunter gatherer, totally dependent on the forest. Their knowledge about the wild plants is immense. They use wild plants in their daily life as food plants, medicinal, fuel, fodder plants and various minor forest products, poison, fibers, plants for local festivals, rituals and other religious functions. Some of the important groups of economic plants are

1. Edible Plants

Arunachal Pradesh with more than 80% tribal population are primarily dependent on forest for day-to-day needs as the small land holding and poor agricultural practices (Jhum) yield very meagre produce and the natives collect a large number of wild plants in the form of tubers, rhizomes, shoots, flowers, fruits, berries, seeds etc, which are consumed raw, boiled, cooked, roasted, pickled or dried. They have evolved

techniques for their safe consumption through ages of using these food plant. If a plant is poisonous or toxic, it is not eaten raw, and as per the case it is either thoroughly washed or boiled to remove toxic or poisonous effect. It is interesting to note that these wild edible species are very rich in Carbohydrate, Starch, Protein, Sugar and Oil which are essential and important constituent of our food. Some of the commonly used plants are as follows.

Fruits : A large number of wild fruits are eaten raw or cooked as vegetable viz., *Antidesma acuminatum*, *Artocarpus chaplasha*, *Baccaurea ramiflora*, *Debregeasia longifolia*, *Dillenia indica*, *Dryptes assamica*, *Eriobotrya bengalensis*, *Garcinia pedunculata*, *Ficus spp.*, *Gmelina arborea*, *Grewia denticulata*, *Horsfieldi kingii*, *Madhuca butyraceoides*, *Mangifera sylvatica*, *Prunus cerasoides*, *Saurauia nepalensis*, *Terminalia citrina*, *Toddalia asiatica*, *Turpinia pomifera* *Elaeocarpus floribundus*, *Zanthoxylum armatum*, *Taxus wallichiana*, *Rubus spp.*, *Hodgsonia macrocarpa*, *Gaultheria fragrantissima* etc.

Rhizomes and tubers : Some of the species commonly used for vegetable are *Alocasia indica*, *Alpinia alughas*, *Amorphophalus campanulatus*, *Dioscorea spp.*, *Hedychium coronarium*, *Lasia spinosa*, *Imperata cylindrica*, *Tacca integrifolia*, *Zingiber zerumbet*, *Colocasia spp.* etc.

Leaves, young shoots and stems : The following species are commonly used as vegetable either raw or cooked *Alernanthera sessilis*, *Amaranthus spp.*, *Amplectrum assamicum*, *Ardisia crispa*, *Athyrium latifolium*, *Bidens pilosa*, *Bigonia spp.*, *Chenopodium spp.*, *Capparis acutifolia*, *Cardamine hirsuta*, *Caryota urens*, *Centella asiatica*, *Clerodendrum spp.*, *Debregeasia longifloia*, *Deeringia amaranthoides*, *Diplazium esculentum*, *Embellia subcoriacea*, *Emilia sonchifolia*, *Entada phaseoloides*, *Floscopa scandens*, *Dendrocalamus hamiltonii*, *Laportea crenulata*, *Mikania cordata*, *Monochaira hastata*, *Oxalis spp.*, *Mussaenda roxburghii*, *Olax acuminata*, *Phytolacca acinosa*, *Pilea glaberrima*, *Pogonantherum crinitum*, *Rumex nepalensis*, *Spilanthes paniculata*, *Stellaria media*, *Toddalia asiatica*, *Trichosanthes tricuspidata*, *Zanthozylum alatum* etc.

Flowers : Flowers and flower buds of several species are also consumed as vegetable. Some of the commonly used plant species are

Agapetes variegata, *Bauhinia purpurea*, *Bombax ceiba*, *Dillenia pentagyna*, *Oroxylum indicum*, *Gmelina arborea*, etc.

2. Wild Relatives of Cultivated Plants

Many of the species from which the crop plants were selected continue to grow and survive in nature as wild plants along with other closely related species. This "gathering" of wild plant species is known as "wild relatives of crop plants." They continue to struggle for survival in nature by adjusting themselves to the demanding climatic conditions like droughts, floods, extreme heat or cold, etc., through the process of evolution which is lacking in the common cultivated crop plants. While surviving in the wild they also develop resistance to diseases and pests which entail heavy losses to the related cultivated crops. Thus, these traits from a wild relative can immensely help in developing much improved and more resistant, high yielding varieties.

The Himalayan region apart from harbouring a large array of economically important plants is also a store house of a large number of wild relative of crop plants which occur from subtropical to alpine region.

Distribution of wild relatives of crop plants in the Himalayan region

Crop group	Species represented (no.)		
	Western Himalaya	Eastern Himalaya	North eastern region
Cereals and millets	29	7	16
Legumes	9	5	6
Vegetables	25	12	27
Fruits	37	32	51
Oilseeds	6	3	1
Fibers	4	4	5
Spices and condiments	10	9	13
Miscellaneous	5	10	13
Total species diversity	125	82	132

vide Arora and Nayar, (1984) "Wild relatives of crop plants on India."

The north-eastern region of India which is referred as "Hindustan Centre for the Origin of Cultivated Plants" forms one of the major centres for the origin of many tropical and subtropical fruits, cereals, vegetables, etc. This region forms the richest reservoir of genetic variability of many groups of crop plants. Some of important and worth mentioning crops are *Musa*, *Citrus*, *Malus*, *Pyrus*, *Prunus*, Legumes, *Allium*, *Mangifera*, Cucurbits, *Capsicum*, Ginger, *Curcuma*, Cardamom, *Colocasia*, *Piper*, Tea, Cotton tree, *Amaranthus*, *Brassica*, Cereals mainly Rice, Maize Millets etc. (Maheshwari and Singh, 1964, Arora *et al.* 1984 and Paroda and Arora, 1991, Rao, 1994).

3. Medicinal Plants

Since the time immemorial medicinal plants are being utilized by various systems of medicines like Ayurveda, Unani, Sidha, Homoeopathy, folk medicines, in popular house hold remedies and now in the modern system of medicine i.e. Allopathy also because, the plant based medicines provide sure and much safer means of curing and alleviating the diseases that too without any side effect. Arunachal Pradesh can be termed as a nature's repository of medicinal plants (Haridashan *et al.*, 1996). The people inhabiting this remote state with their ingenious skill and close association with plants have accumulated an enviable treasure of knowledge related to the utilization of plants surrounding their settlements. It is a well known fact that now this traditional knowledge of medicinal plant is fast becoming a potential source of better health care products in the modern medicine. Most of the raw materials are collected in bulk from the wild by the Pharmaceutical Industry. Such large collections leads to depletion of wild population and have made a large number of species rare and threatened.

Some of the important medicinal plants of Arunachal Pradesh are *Abroma augusta*, *Acorus calamus*, *Abutilon indicum*, *Aconitum ferox*, *A heterophyllum*, *Achyranthus aspera*, *Alpinia galanga*, *Aquilaria malaccensis*, *Baliospermum montanum*, *Bergenia ciliata*, *Artemisia spp.*, *Berberis asiatica*, *Boerhavia diffusa*, *Canarium strictum*, *Cassia fistula*, *C. occidentalis*, *Centela asiatica*, *Clerodendrum colebrookianum*, *Copits teeta*, *Costus speciosus*, *Croton tiglium*, *Curcuma spp.*, *Cymbopogon spp.*, *Dactylorhiza hatayria*, *Dioscorea spp.*, *Gloriosa superba*, *Gmelina arborea*, *Gynocardia odorata*, *Hedychium spicatum*, *Holarrhena pubescens*, *Hydnocarpus kurzii*, *Illicium griffithii*, *Justicia adhatoda*, *Lyonia ovalifolia*, *Litsea cubeba*, *Mucuna pruriens*, *Mesua ferrea*.

Nardostachys jatamansi, *Paederia foetida*, *Panax pseudoginseng*, *Piper spp.*, *Podophyllum hexandrum*, *Rauvolfia serpentina*, *Rheum australe*, *Rhus succedanea*, *Solanum spp.*, *Spilanthes paniculata*, *S. acuminata*, *Strychnos nuxvomica*, *Gentiana spp.*, *Swertia chirayita*, *Taxus wallichiana*, *Satyrium nepalense*, *Sterospermum chelonoides*, *Terminalia spp.*, *Valeriana hardwickii*, *Vernonia cinerea*, *Viola spp.*, *Viscum betonicifolium*, *Vitex negundo*, *Withania somnifera*, *Woodfordia floribunda*, *Zanthoxylum spp.*, *Zingiber zerumbet*, *Vetiveria zizanoides* etc.

4. Timber Resources

Endowed with more than 61 % forest covered area, Arunachal is an abode of many valuable timber species. Timber from Arunachal has a ready market throughout the country. As reported by A. Roychowdhury (1992) timber worth Rs. 200.00 crore was supplied for 1982, Delhi- 'ASIAD' and between year 1982-1984, 40% of the sleeper requirements of the Indian Railways were met by Arunachal Forest alone. Some important commercial timber species of the state are listed below

Important Timber yielding plants

Name of the species	Local name	Family
<i>Ailanthus grandis</i>	Borpat	Simaroubaceae
<i>Albizia lucida</i>	Moz	Leguminosae
<i>Adina oligocephala</i>	Halud-Sopa	Rubiaceae
<i>Alstonia scholaris</i>	Satiana	Apocynaceae
<i>Anthocephalus chinensis</i>	Kadam	Rubiaceae
<i>Artocarpus chaplasha</i>	Sam, Cham	Moraceae
<i>Altingia excelsa</i>	Jutuli	Hamamelidaceae
<i>Amoora wallichii</i>	Amari	Meliaceae
<i>Actinodaphne obovata</i>	Pajihuta	Lauraceae
<i>Artocarpus lacucha</i>	Dewa-Chali	Moraceae
<i>Bombax ceiba</i>	Simul	Bombacaceae
<i>Bischofia javanica</i>	Urium	Euphorbiaceae
<i>Beilschmiedia sp.</i>	Bonjolokia	Lauraceae
<i>Bauhinia variegata</i>	Kanchon	Leguminosae
<i>Betula alnoides</i>	Birch	Betulaceae

Name of the species	Local name	Family
<i>Cana rium bengalensis</i>	Dhuna	Burseraceae
<i>C. resiniferum</i>	Dhuna	Burseraceae
<i>Chukrasia tabularis</i>	Bogipoma	Meliaceae
<i>Cinnamomum cecicodaphne</i>	Gonsoroi	Lauraceae
<i>Castanopsis indica</i>	Hingori	Fagaceae
<i>Dipterocarpus macrocarpus</i>	Hollong	Dipterocarpaceae
<i>Dysoxylum gobara</i>	Lali	Meliaceae
<i>D. alliarium</i>	Gondhaki-Poma	Meliaceae
<i>Dysoxylum binectariferum</i>	Bandardima	Meliaceae
<i>Dillenia indica</i>	Outenga	Dilleniaceae
<i>Duabanga grandiflora</i>	Khokon	Lythraceae
<i>Evodia frainifolia</i>	Maiphak	Rutaceae
<i>Eurya acuminata</i>	Murmura	Theaceae
<i>Gmelina arborea</i>	Gomari	Verbenaceae
<i>Garcinia</i> sp.	Thekera	Guttiferae
<i>Gynocardia odorata</i>	Bandapele, Chalmugra	Flacourtiaceae
<i>Kydia calycina</i>	Pichola	Malvaceae
<i>Lannea coromandelica</i>	Jia	Anacardiaceae
<i>Lagerstroemia speciosa</i>	Jarul, Ajaar	Lythraceae
<i>Michelia baillonii</i>	Tita-Sopa, Khorika-Sopa	Magnoliaceae
<i>M. champaka</i>	Champ	Magnoliaceae
<i>Mesua ferrea</i>	Nahar	Guttiferae
<i>Morus laevigata</i>	Bola	Moraceae
<i>Magnolia pterocarpa</i>	Baramphuri-Sopa	Magnoliaceae
<i>M. hodgsonii</i>	Boromthuri, Dat-bhda	Magnoliaceae
<i>Pterospermum acerifolium</i>	Hatipolia	Sterculiaceae
<i>Phoebe paniculata</i>	Mekahi	Sterculiaceae
<i>Pinus roxburghii</i>	Chir Pine	Pinaceae
<i>P. wallichiana</i>	Blue Pine	Pinaceae
<i>Picea morinda</i>	Spruce	Pinaceae
<i>Quercus</i> sp.	Oak	Fagaceae

Name of the species	Local name	Family
<i>Sloanea sterculiacea</i> <i>var. assamica</i>	Joba-Hingori	Elaeocarpaceae
<i>Syzygium cumini</i>	Jamuk	Myrtaceae
<i>Shorea assamica</i>	Mekai	Dipterocarpaceae
<i>Sterculia villosa</i>	Udal	Sterculiaceae
<i>S. indica</i>	Pahari	Sterculiaceae
<i>Schima wallichii</i>	Makrisal, Gogra	Theaceae
<i>Terminalia myriocarpa</i>	Hollock	Combretaceae
<i>T. bellirica</i>	Bohera	Combretaceae
<i>T. chebula</i>	Hilika	Combretaceae
<i>Tetrameles nudiflora</i>	Bhelu	Combretaceae
<i>Toona ciliata</i>	Toon, Poma	Meliaceae
<i>Talauma phellocarpa</i>	Titasopa, Khorikasopa	Magnoliaceae
<i>Trewia nudiflora</i>	Bhelkar, Merua	Euphorbiaceae

COMMON BAMBOOS

<i>Bambusa pallida</i>	Makal	Poaceae
<i>B. tulda</i>	Bijili	Poaceae
<i>Dendrocalamus hamiltonii</i>	Kakua	Poaceae
<i>D. strictus</i>	Katabans	Poaceae
<i>Pseudostachium polymorphum</i>	Bajal	Poaceae
<i>Melocana bambusoides</i>	Muli	Poaceae

COMMON CANES

<i>Calamus tenuis</i>	Jati Bet	Palmae
<i>C. floribundus</i>	Lejai Bet	Palmae
<i>C. flagellum</i>	Raidang Bet	Palmae
<i>C. latifolius</i>	Hauka Bet	Palmae

COMMON 'SLEEPER' SPECIES

<i>Albizia procera</i>	Koroi	Leguminosae
<i>Altingia excelsa</i>	Jutuli	Hamamelidaceae
<i>Amoora wallichii</i>	Lali	Meliaceae

Name of the species	Local name	Family
<i>Artocarpus chaplasha</i>	Sam	Moraceae
<i>Castanopsis hystrix</i>	Hingori	Fagaceae
<i>Dillenia indica</i>	Outenga	Dilleniaceae
<i>Dipterocarpus macrocarpus</i>	Hollong	Dipterocarpaceae
<i>Syzygium cumini</i>	Jamun	Myrtaceae
<i>Mesua ferrea</i>	Nahar, Mesua	Guttiferae
<i>Schima wallichii</i>	Gogra Makrisal	Theaceae
<i>Shorea assamica</i>	Mekai	Dipterocarpaceae
<i>Sterospermum chelonoides</i>	Paroli	Bignoniaceae
<i>Terminalia bellirica</i>	Bohera	Combretaceae
<i>T. myriocarpa</i>	Hollock	Combretaceae

5. Wild Ornamental Plants

Most of our today's ornamental plants (both foliage and flowering) are collections from the wild which have been developed and improved by selection and breeding techniques. But a large number of potential ornamental species still remain untraced and untapped. Their adoption and introduction as ornamental plants will not only enrich our ornamental collection but will also greatly help in providing them effective conservation and protection. Some of the potential ornamental resources worth mentioning are

Orchids: Orchids are one of the most amazing and spectacular creation of the nature and need no introduction. They are well known for their longlasting, attractive flowers of alluring colours. Out of \pm 1200 species known from India, Arunachal alone has more than 530 species of which *Dendrobium*, *Coelogyne*, *Calanthe*, *Cymbidium*, *Phaius*, *Pleione*, *Rhynchostylis* (Foxtail orchid), *Vanda*, *Phalenopsis*, *Aerides*, *Arundina* (Bamboo orchid), etc., are some popular orchid groups for home growing.

Rhododendrons: Rhododendrons one of the most popular flowering trees/shrubs are horticulturally important and many species from the wild have been introduced into cultivation. Arunachal has the maximum

concentration of *Rhododendron* spp., which can be commercially exploited as garden ornamentals in cooler climates.

Hedychiums : *Hedychium* popularly known as the garland flower, ginger lily or butterfly lily are well known for their ethereal beauty and enchanting fragrance. Arunachal Pradesh has the largest germplasm of *Hedychium*. Most of the species are ornamental however, *Hedychium spicatum* and *H. coronarium* have medicinal uses too.

Apart from these above cited well known groups of ornamental plants, a large number of other wild plant species have a high potential for their exploitation as ornamentals such as.

Begonia: Begonias are ideal to be grown as indoor plants having delicate, variously shaped, coloured, velvety foliage with very attractive flowers. They can be easily multiplied and are fast growing.

Impatiens: (Balsams) : They occur abundantly in warm moist shady places and some of them have large, attractive, variously coloured flowers. They can be grown easily through cuttings.

In addition to the above mentioned important flowering ornamental types, a large number of other trees, shrubs, bushy trees, herbs are also available in the tropical, subtropical, temperate and alpine regions of Arunachal which unleash a spell of enchanting beauty when bloom, *Meconopsis*, *Magnolia*, *Michelia*, *Hypericum*, *Aster*, *Erigeron*, *Clerodendrum*, *Ixora*, *Anemone*, *Saxifraga*, *Primula*, *Jasminum*, *Mussaenda*, *Camellia*, *Mahonia*, *Melastoma*, *Cassia*, *Caesalpinia*, *Benthamidia*, *Erythrina*, *Agapetes*, *Phlogacanthus*, *Lagerstroemia*, *Bauhinia*, *Tacca*, *Arisaema* (cobra lily) are some such plants while, *Ipomoea*, *Thunbergia*, *Aristolochia*, *Clematis*, *Combretum*, *Hedera*, *Rhaphidophora*, etc., can easily be trained as ornamental climbers.

THREATENED AND RARE TAXA

Extinction is an universal process where in a species disappears from the earth as a result of the evolutionary process of the Nature where "Survival of the Fittest" is the Rule. However, the single major cause of untimely extinction of various species of Flora and Fauna is surprisingly not the Nature but the Man. The indiscriminate exploitation and the de-

struction of habitat by his various activities (mentioned elsewhere in the text) have led to the extinction of many species and a large number of them have become rare or threatened or vulnerable and await a similar fate. Certain groups of plants like orchids etc., and the endemic species are considered rare. In Arunachal too, a large number of species falls in the Rare or Threatened or Vulnerable category. Some of them are *Abies delavayi*, *Aconitum* spp., *Alniphyllum fortunei*, *Angiopteris evecta*, *Aquillaria malaccensis*, *Ardisia rhynchophylla*, *Balanophora dioica*, *Bergenia ciliata* forma *ligulata*, *Boehmeria tirapensis*, *Boschniakia himalaica*, *Buddleja yunnanensis*, *Bulbophyllum depressum*, *B. mishmeense*, *B. virens*, *Bulleyia yunnanensis*, *Cephalotaxus griffithii*, *Coptis teeta*, *Costus speciosus*, *Cyathea* spp., *Cymbidium eburneum*, *C. hookeri*, *Dioscorea laurifolia*, *D. orbiculata*, *Diplomeris hirsuta*, *D. pulchella*, *Dipteris wallichii*, *Drosera* spp., *Eria discolor*, *E. ferruginea*, *Galeola falconeri*, *Gastrochilus inconspicuous*, *Hudendron biaristatum*, *Ilex venulosa*, *Leptodermis scabrida*, *Luisia inconspicuum*, *Nertera sinensis*, *Nomocharis synaptica*, *Oberonia sulcata*, *Paphiopedilum fairteanum*, *P. wardii* (considered to be extinct), *Pauia belladona*, *Podocarpus neriifolius*, *Renanthera imshootiana*, *Rheum nobile*, *Rhododendron santapau*, *Rhopalocnemis phalloides*, *Sapria himalayana*, *Saurauia griffithii*, *Saussurea obvallata*, *Taxus wallichiana*, *Tetracentron sinense* and *Vanda coerulea*.

MAJOR THREATS

Importance of plants to human beings needs no introduction. Apart from providing food, fodder, medicine, shelter and cloths to us, they protect soil from erosion, play an important role in influencing the weather system and also forms one of the key components of our natural environment. In addition, people delight in the charm of numerous ornamental species cultivated in the garden or in wild.

Extinction is perhaps more tragic with plants than with other life forms as a much greater number of species are likely to be lost before their possible value to society is known. Our present day agriculture is based on less than 30 species of plants out of about 250,000 vascular plant species that exist on this earth. We must keep this in mind that many of the threatened species may be potential crop plants of tomorrow. It is alarming to note that out of 250,000 species of plants nearly 20-25000 i.e. an average of 1 in 10 are rare or coming under severe threat and the

causal agent is MAN as most of the environmental problems are because of human breed and greed.

Some of common threats posed to the flora as a result of human activity are :

Industrialization and Urbanisation.

Clearing of vegetation for agriculture, including 'Jhum' cultivation.

Browsing and overgrazing by domestic cattles.

Logging and exploitation of forest for timber and fuel wood.

Hydro electric schemes/construction of Dams and Reservoir.

Mining and Quarrying.

Drainage and water pollution.

Construction of roads.

Tourism.

Fires.

Selective removal of plants species (economically important groups).

Pressure from introduce plants and weeds.

Traditional rural uses greatly increased as a result of increase in population.

Critically low population/restricted distribution of plants species.

Collection of botanical specimens, flowers and horticulture (usually uprooting the plant).

CONSERVATION

Like any other corner of the country in Arunachal Pradesh too the maximum threat to the flora or plant life lies in the areas which are subjected to various development activities. Forest and other types of vegetational cover near the villages or human settlements are vulnerable because of grazing by cattles, "Jhum Cultivation", fodder, fuel and timber wood extraction and over exploitation of economic plants like medicinal, edible, etc. This rapid depletion of flora means the loss of genetic diversity and wild relative to crop plants which are essential for future breeding

programmes to produce new and improved crops to feed the vast population. In an effort to protect and conserve the nature and natural resources 11 (eleven) Wild Life Sanctuaries /National Parks have been set up in Arunachal Pradesh so far (Table VII).

Area covered under National Parks and Sanctuaries in Arunachal Pradesh

Total Geographical Area of the state	—	83740 sq km
Total Forest Area	—	51540 sq km (61.54 %)
Reserve Forest	—	9815 sq km
Wild Life sanctuaries	—	6677.75 sq km
National Parks	—	2468.23 sq km
Orchid Sanctuary	—	100.00 sq km
Dihang-Dibang Biosphere Reserve (Proposed)	—	8200 sq km

The local population which mostly practice traditional Jhum cultivation has far reaching adverse effect on the forest conservation. The State Forest Department has involved the people in the forest management safeguarding their customary right over the forest/land. With the advent of peoples participation forestry is catching up as a land use practice, waste land development and in community lands. This has succeeded in reducing the pressure on the forest for fuel, fodder, timber extraction. The local population has already realised the direct and indirect importance of developing and conserving the forest.

The State Forest Research Institute, Govt. of Arunachal Pradesh has been instrumental in conserving and preserving the germplasm of a large number of economically important plant species. It maintains the largest living collection of bamboos (over 40 species), seed orchards for commercial production of important tree species.

The state abounds in Orchids which have high commercial potential. In order to propagate rare, endangered and ornamental orchid

Table VII
Wildlife Sanctuaries and National Parks

Sl. No.	Name of Sanctuary/ National Park	District	Divisional Head quarters	Area in sq km
Wildlife Sanctuary				
1.	Pakhui Wildlife Sanctuary	East Kameng	Seijosa	861.95
2.	Itanagar Wildlife Sanctuary	Lower Subansiri	Nahartagan	140.30
3.	'D' Ering Memorial Wildlife Sanctuary	East Siang	Pasighat	190.00
4.	Mehao Wildlife Sanctuary	Dibang Valley & Lohit	Roing	281.50
5.	Kamlang Wildlife Sanctuary	Lohit	Miao	783.00
6.	Eagle Nest Wildlife Sanctuary	East Kameng	Seijosa	217.00
7.	Kane Wildlife Sanctuary	West Siang	Pasighat	55.00
8.	Dibang Wildlife Sanctuary	Dibang Valley	Anini	4149.00
				6677.75

Sl. No.	Name of Sanctuary/ National Park	District	Divisional Head quarters	Area in sq km
National Park and Tiger Project				
1.	Namdhapa National Park (Tiger Project)	Tirap	Miao	1985.23
2.	Mouling National Park	East Siang	Jenggin	483.00
	Sessa Orchid Sanctuary	West Kameng	Tipi	100.00
			Total	9245.98

Source : Arunachal Pradesh Environment and Forest Department, Itanagar, Arunachal Pradesh.

species, an Orchid Research-cum-Development Centre was established at Tipi in 1972. A chain of orchidaria has been set up to store the germplasm of Orchid species at Tipi, Dirrang, Roing, Jengging and Itanagar. An Orchid Sanctuary covering an area of about 100 sq km has also been set up at Sessa for *in-situ* conservation of orchid species.

In addition a series of forest parks, gardens, zoos and recreation centres have been established by the forest department in practically all the districts of the state which apart from providing recreational facilities to the common man also help in promoting environmental education and awareness.

India being regarded as one of the 12 World's top megadiversity nations will have worldwide implications if the conservation of its biodiversity is not given immediate attention as out of the 25030 cultivated plant species, 320 (12.8%) have come from Indo-Chinese-Indonesian region. The Indian region alone contributes about 167 species (67%) that include some major important crops such as rice, sugarcane, millets, brassicas, pulses, citrus, mango, bannana, cardamom, jute, cucurbits, bamboos, umbellifers, turmeric, pepper, ginger, betelvines, betal nuts, orchids, various kinds of herbal drugs, a variety of vegetables, fruits and many other important economic plants (Khoshoo, 1991). Therefore there is an urgent need to conserve those ecosystems where such species are concentrated and Arunachal Pradesh is one such region which requires immediate attention on following lines.

First and foremost priority should be given to make an overall assessment of the taxonomic and floristic knowledge of this state along with a thorough assessment of the natural plant resources, identification and status of conservation of fragile ecosystems/floristic niches/endemic areas and species so that priority and special attention can be given to protect the endangered ecosystems having maximum/diversity.

A comprehensive inventory of plant and animal species which occur in the protected areas should be prepared so that the exact number of wild crop relatives, wild relatives of other economic plants, endemic, rare and threatened species existing in a particular protected area is available as a ready reference.

The conservation of genetic resources of bannana, citrus, bamboo etc. which are so abundant in Arunachal Pradesh should be immediately

undertaken. For which more Protected areas should be declared/constituted for their *in-situ* conservation and through their introduction in the Botanic Gardens.

Taxa of significant utility falling under rare, threatened, endemic categories may be tested for their multiplication through tissue culture/clonal propagation.

Facilities should be generated for genetic conservation through establishment of gene banks for agri-horticultural plants, species of forestry interest and other economically important plants.

More priority need to be given for the preservation of the diversity in medicinal plants particularly those which are supplied in bulk as raw material to pharmaceutical industry directly collected from the wild. Such species needs to be brought under commercial cultivation with improved geno-types for better yield.

It is high time to realise that how important it is to protect these life support systems on which all of us depend and if humanity is to survive we must learn to live in harmony with nature and to take due measures to conserve its living resources before it is too late as stated by Prof. V.H. Heywood, "Already we are too late to prevent very substantial losses of plant resources remaining to us. But we can still do much to safeguard at least part of our heritage if we take urgent action now. The next 25 years will be critical. If we fail, the world we pass on to our children may well be very different from the one we know today and probably very unpleasant, monotonous and even dangerous."

REFERENCES

- Arora, R.K., K.L. Mehra and E. Roshini Nayar 1984. Conservation of wild relatives of crop plants in India. N.B.P.G.R. Sci. Monograph 6: 1-14. New Delhi.
- Biswas, K. 1941. The Flora of Aka hills. *Indian For. Rec. Bot.* 3 : 1-62.
- Bor, N.L. 1938. A Sketch of the vegetation of the Aka hills, Assam a synecological study. *Indian For. Rec. (N.S.) Bot.* 1(4) : 103-222.
- Bor, N.L. 1953. The Botany of Abor expedition. *Rec. Bot. Surv. India* 10 (1).
- Champion H.G. and S. K. Seth 1968. *A revised survey of the forest types of India.* New Delhi.
- Chowdhery, H. J., G.S. Giri, G.D. Pal, A. Pramanik and S.K. Das 1996. Materials for the Flora of Arunachal Pradesh. (eds.) Hajra *et al.* B.S.I., Calcutta.
- Clarke, C.B. 1898. Subareas of British India illustrated by the detailed distribution of the Cyperaceae in that Empire. *Jour. Linn. Soc. London* 34 : 1-146.
- Deori, M.L. and K. Haridasan 1988. A report on Medicinal Plants in Arunachal Pradesh. *Arunachal Forest News* 6 (1) : 19-26.
- Hooker, J.D. 1906. A sketch of the flora of British India. London.
- Kaul, R.N. and K. Haridasan 1987. Forest types of Arunachal Pradesh a preliminary study. *Jour. Econ. Tax. Bot.* 9(2) : 379-389.
- Khoshoo, T.N. 1991. A case for conservation. In Survey of the Environment, 125-127. *The Hindu*, Madras.
- Khoshoo, T.N. 1992. Plant diversity in the Himalaya : Conservation and utilization. G.B. Pant Memorial Lecture II, G.B. Pant Institute of Himalayan Environment and Development Almora pp. 1-129.

- Khoshoo, T.N. 1993. Himalayan Biodiversity Conservation an overview; in Himalayan Biodiversity Conservation strategies. (ed.) U. Dhar (Almora) pp. 5-35.
- Malhotra, C.L. and P.K. Hajra. 1977. Status of floristic studies in Arunachal Pradesh. *Bull. Bot. Surv. India* **19** (1-4) : 61-63.
- Mehra, P.N., K.S. Bawa, P.K. Khosla and A.S. Hans 1983. Floristic account of some forest types of Eastern Himalayas. *Bull. Bot. Surv. India* **25** : 1-18.
- Paroda, R.S. and R.K. Arora (eds.). 1991. Plant Genetic Resources-conservation and management. N.B.P.G.R., New Delhi.
- Rao, A.S. 1974. The vegetation and phytogeography of Assam Burma. In *Ecology and Biogeography in India*. M.S. Mani (ed.) Netherlands (Haguc), 204-246.
- Rao, R.R. 1993. Floristic diversity of Eastern Himalaya a national heritiage for conservaion; in *Himalayan Biodiversity Conservation Strategies*. U. Dhar (ed.) (Almora) pp. 134-151.
- Rao, R.R. 1994. *Biodiversity in India*. Dehra Dun. pp. 315.
- Rao, R.R. and P.K. Hajra 1986. Floristic diversity of the eastern Himalaya in a conservation perspective. *Proc. Ind. Sci. (Anim. Sci./Plant Sci.) Suppl.* (November). pp. 103-125.
- Rao, R.R. and S.K. Murti 1990. North east India a major Centre for plant diversity in India. *Indian Jour. Forest.* **13** (3) : 214-222.
- Rao, R.S. and G. Panigrahi 1961. Distribution of Vegetational types and their dominant species in Eastern India. *Jour. Ind. Bot. Soc.* **40**: 174-285.
- Roychowdhury, A. 1992. Chopping down the future. *Down to Earth* **1**(1): 27-31.
- Sahni, K.C. 1981. Botanical Panorama of Eastern Himalaya; In: J.S. Lall (ed.) *The Himalaya Aspects of change*. New Delhi pp. 32-49.

Stainton, J.D.A. 1972. *Forest of Nepal*. London.

Takhtajan, A. 1986. *Floristic regions of the world*. (Indian Edn.) Dehra Dun, India.



River Kameng



Riverine forest (E. Kameng)



Pine forest (W. Kameng)



Tropical forest : lush green lower storey



Plectocomia assamica : a palm like giant cane



Trichosanthes tricuspidata



Abelmoschus manihot



Phalaenopsis mannii



Bulbophyllum delitescens



Vanda stangeana



Dendrobium devonianum



Dendrobium fimbriatum var. *oculatum*



Datura suaveolens



Mussaenda roxburghii



Erythrina stricta



Gmelina arborea



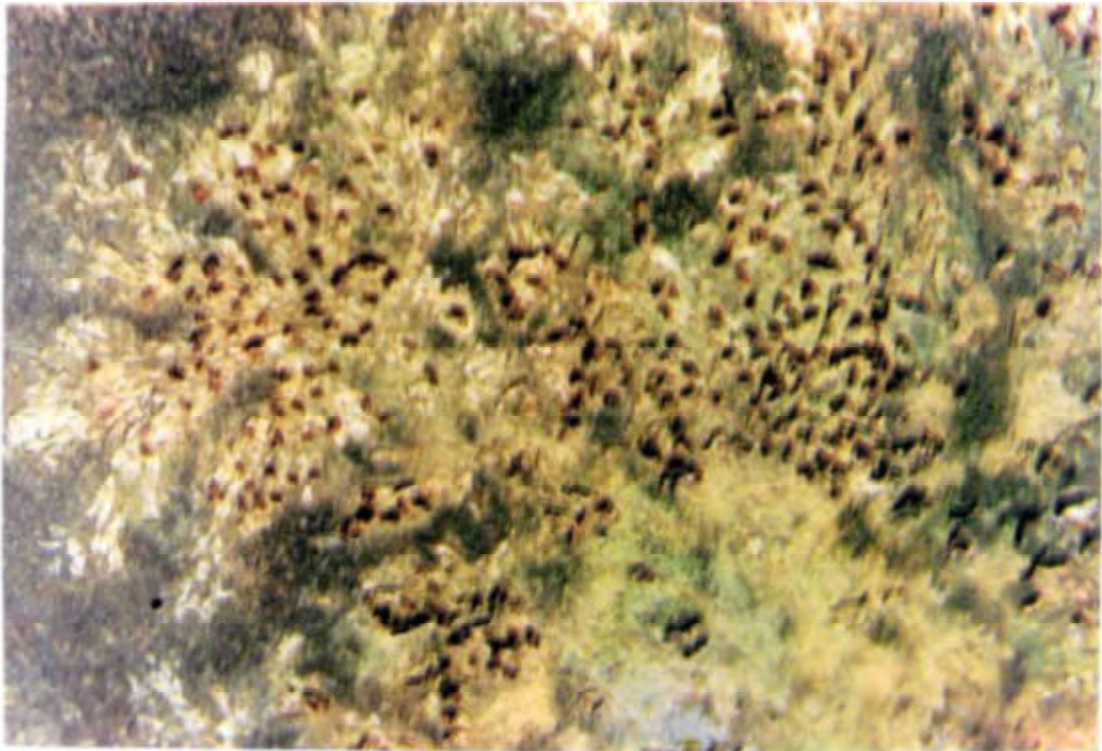
Phlogacanthus thyrsiflorus



Phlogacanthus pubinervius



Impatiens latiflora



Zeylanidium olivaceum



Epipogium indicum



Jhum cultivation : burning of forested area



Hedychium coronarium



Capsicum sp. naturalized in Arunachal.

ASSAM

A.K. Baishya

The North Eastern India comprising Assam and six other states is regarded as the biogeographical 'gateway' for much of India's biological resources. It represents nearly 50% of the flora of the Indian subcontinent and is botanically very interesting due to occurrence of varied kinds of floristic elements. This is the place where Takhtajan (1969) found the 'cradle of flowering plants' on the basis of concentration of a number of primitive land plants particularly of Angiosperms. The region is known for its verdant rainforest and rich vegetation with unique ecosystem which is least explored by the naturalists and botanists. Utility of a vast majority of the plant species are still remained untapped, because most of the areas are still without communication and inhabited by most back-ward ethnic groups of people.

Nestling between the eastern Himalayan foot hills and the Patkoi and Barail ranges of hills, Assam is one of the largest north eastern states of India. Situated between 24°2' - 27°6' N latitude and 89°8' - 96° E longitude, the political boundary of Assam extends to an area of 78,523 sq km of which total forest area is about 22, 177.72 sq km. This area excludes the unclassified state forest which is approximately 9248.32 sq km.

Physiographically, the state comprises of low lying alluvial land with occasional low hilly terrains. The mighty river Brahmaputra traverse the land of Assam from east to west covering a distance more than 1300 km thereby separating the sub-Himalayan region of Assam from the southern parts and forms the gorgeous Brahmaputra valley, while the extreme southern parts forming a loop is again traversed by the river Barak forming the Barak valley. Numerous turbulent hilly rivers and rivulets further add to the network of water resources in both the valleys which often cause severe flood havoc during the monsoon period. The isolated horse-shoe shaped hilly terrain forming the central Assam range act as the watershed between the two river valleys. The altitude of the easternmost town of Sadiya is 122 m while that of the westernmost town of Dhubri is only 30 m. In the Barak valley the altitude remains at an average of 50 m, while the highest elevation is located near Haflong (1713 m) at the Barail ranges.

The state experiences heavy monsoon rain with an average annual rainfall in between 1000 mm to 3000 mm in the plains, while it rises upto 3500 mm in the central Assam hill ranges. The climate remains warm and humid throughout the year with maximum temperature raising upto 40°C in the peak summer months and the minimum temperature in the winter months falls down to 5°C. Relative humidity varies from 73% to 95% in a year.

The occurrence of heterogenic physiography coupled with varied climatic conditions on and around the state have made the vegetation luxuriant and diverse. Due to uniqueness in its flora, the north-eastern states of Assam (now separated to seven separate states) has been a centre of attraction of various 19th century British explorers and plant collectors. I.H. Burkill (1965) and more recently, Shukla (1993) provide the chronological details of botanical works in this region. The floristic studies in Assam, in true sense, have started after the appointment of "Assam Tea delegation" comprising N. Wallich, W. Griffith and J. McClelland in 1823, who explored the Brahmaputra valley to its upper ridges in search of Tea plant. Many of the plants collected during the exploration were the novelties recorded in Wallich (1820, 1820-32), Griffith (1848). However, the first kind of the floristic account of this region is given by Robinson (1841). Further, Hooker (1854 and 1906) presents a very detailed account of vegetation and flora of the region. Dawn of 20th century saw vigorous activities of plant explorations and publications of several tour reports from the region. Although majority of them were concentrated on the neighbouring hill states of Assam, Carter (1921) published an account on the plants of Lakhimpur district (*s.l.*) and described 239 species of plants which was further updated with 604 species by Rao and Verma (1969). F. Kingdom Ward (1960) provides a glimpses on the vegetation of Balipara frontier tract of present day Sonitpur district. The last of the regional flora of India that came out, after the publication of the monumental 'Flora of British India' by Sir J.D. Hooker *et al* (1872-1892), is that of Assam (Kajjilal *et al*, 1934-1939 and N.L. Bor, 1940) which contains the first hand account of the ligneous vegetation of the state in 5 volumes.

With the reorganisation of the Botanical Survey of India and establishment of Eastern Circle at Shillong in 1956, several scientists have contributed significantly to the understanding of the flora of Assam (Rao and Verma, 1969-1982 ; Kar and Panigrahi, 1963 ; Katak and Panigrahi, 1964

Panigrahi and Kar, 1966 ; Rao and Rabha, 1966 ; Jain and Hajra, 1975; Rao, 1974; etc.). Besides, researchers from various colleges and universities and other research organisations have also contributed significantly to the knowledge of flora and vegetation of the state (Islam, 1990 ; Barua *et al.*, 1988; Sas Biswas *et al.*, 1990 etc.). Few doctoral thesis on the floristics of different districts of Assam have also been completed (Gogoi, 1976; Baruah, 1978; Hajra, 1978; Sarmah, 1989; Barua, 1992; Sarkar, 1993; Singh, 1993; etc.).

VEGETATION

Numerous forest types and sub types with characteristic floristic compositions are observed in the forest of north-eastern region by various 20th Century foresters and botanists (Rao and Panigrahi, 1961; Champion and Seth, 1968; Sahni, 1981; Jain, 1983; 1990; Mehra *et al.*, 1983; Rao and Hajra, 1986; etc). But all these observations are too general to determine the actual status of the vegetation and forest type within the political boundary of Assam. However, Rowntree (1954) made a preliminary study on the vegetation of Assam valley. Das and Rajkhowa (1968) classified the evergreen and deciduous forest of Assam into 14 different biotic formations.

The variations in forest types and their vegetation composition in Assam occur mainly due to the range of climatic conditions and to certain extent due to local edaphic changes. As the altitude remains *ca* 100 m in an average height in the plains, it has very little to play any significant role in determining the forest types in Assam except in the Karbi-Anglong (Mikir) and North Cachar hills districts.

The vegetation of Assam is primarily of tropical type which covers a large areas and embraces evergreen, semievergreen, deciduous forest and grasslands. Stretches of riparian forest along the bank of rivers and gorges are also very prominent. On the basis of floristic composition these forest can broadly be classified as follows

1. TROPICAL FOREST

- (a) Tropical wet evergreen forest
- (b) Tropical semi-evergreen forest
- (c) Tropical moist deciduous forest

- (d) Grasslands
- (e) Riparian forest
- (f) Swamps

2. SUBTROPICAL FOREST

- (g) Subtropical Broad-leaved forest
- (h) Subtropical Pine forest
- (i) Bamboo and cane brakes.

(a) Tropical wet evergreen forest

These forest occur along the foot hill regions of Arunachal Pradesh in Lakhimpur, Tinsukia, Dibrugarh districts, and southern parts of Sibsagar districts adjoining Nagaland and the Barak valley, the foot hills of Barail ranges and south-eastern parts of Cachar comprising Lohar-band R.F. The rainfall in these areas is very high and ranges from 2500 mm to 3500 mm. Corresponding to Champion and Seth (1968) Type 1B/C₁/C₂/C₃), these forest show a great species diversification, which are often not common to many areas. Often, single species dominance in the top canopy are observed such as, *Dipterocarpus retusus*, *Kayea assamica*, *Mesua ferrea*, *Shorea assamica*, etc. in upper Assam while, *Dipterocarpus turbinatus*, *Kayea floribunda*, *Palaquium polyanthum*, etc in the Barak valley regions.

Characteristic floristic elements are *Dipterocarpus retusus*, *D. turbinatus*, *Shorea assamica*, *Mesua ferrea*, *Altingia excelsa*, *Dysoxylum procerum*, *D. binectiferum*, *Arotocarpus chaplasha*, *Stereospermum personatum*, *Amoora wallichii*, *Kayea assamica*, *K. floribunda*, *Terminalia chebula*, *Magnolia* spp., *Michelia doltsopa*, *Quercus* spp., *Garcinia* spp., *Sapium baccatum*, *Phoebe* spp., *Canarium strictum*, *Vatica lanceacfolia*, etc. are the tree species forming the main canopy.

Smaller trees and shrubs species includes *Clerodendrum*, *Ixora*, *Bauhinia*, *Cinnamomum*, *Saurauja roxburghii*, *Pavetta indica*, *Holarrhaena pubescens* besides clumps of *Dendrocalamus hamiltonii*, *Bambusa pallida*, *Pseudostachyum polymorphum*, *Melocana baccifera* and *Bambusa balcoa*, etc.

Numerous lianas and climbers includes *Entada pursaetha*, *Gnetum montanum*, *Combretum flagocarpum*, *Dalbergia* spp., *Acacia* spp.,

Mezoneuron cuculatum, *Vitis* spp., *Thunbergia grandiflora*, *Pothos* spp., *Aristolochia* spp., etc.

Patches of wild species of *Musa*, *Phrynum* and several species of Palm like *Arenga*, *Calamus* and *Pinanga* are very common in damp slopes. Along the river bank slopes, *Cyathea gigantea*, *C. henryi* and *Angiopteris evecta* are often very common in these forest.

(b) Tropical semievergreen forest

These forest are found throughout the state along the foot hills of Indo-Bhutan, Arunachal Pradesh, Meghalaya regions and Karbi hills in the Brahmaputra valley and along the foot hills of Barail ranges and Manipur hills in the Barak valley. In these region, the rainfall ranges between 2000 mm to 3000 mm, and the forest are characterised by the emergent deciduous species. Common tree species in these forest are *Phoebe goalparensis* in the lower Assam districts, and *Phoebe cooperiana* and *P. attenuata* in Sibsagar and other similar localities. Amongst other tree species, *Amoora wallichii*, *Dysoxylum procerum*, *Dillenia indica*, *D. scabrella*, *Toona ciliata*, *Ailanthus grandis*, *Castanopsis indica*, *Michelia champaca*, *Magnolia insignis*, *Artocarpus chaplasha*, *Talauma hodgsonii*, *Mangifera sylvatica*, *Syzygium* spp., etc. along with deciduous species like *Bauhinia purpurea*, *Dillenia pentagyna*, *Shorea robusta*, *Albizia lebbek*, *A. procera*, *Sapium baccatum*, etc are the common ones. In these forest, *Tetrameles nudiflora* is the most prominent deciduous elements in the top canopy, while *Gmelina arborea* is prominent in the middle canopy. The under story of these forest are very rich due to rich humus deposits and harbours great varieties of herbs and shrubs. *Gnetum gnemon*, *Clerodendrum viscosum*, *Coffea benghalensis*, *Morinda augustifolia*, *Litsaea* spp. etc. are few among the shrubby species while, *Elatostemma* spp., *Pouzolzia* spp., *Impatiens* spp., *Costus speciosus*, *Curcuma* spp. and many other species belonging to Commelinaceae, Acanthaceae, Scrophulariaceae, Rubiaceae, Poaceae and Cyperaceae are very common herbs. *Apostasia odorata* and *A. nuda* are two interesting ground orchids which often from dense and pure formations is the ground vegetation with very limited distribution in the forest of Garampani and Jeypore.

Epiphytic flora is rich in these forest. Numerous species of Orchidaceae, Asclepiadaceae and Piperaceae etc. are common epiphytes.

Besides, *Lycopodium squarrosum* and *L. phlegmarium* are the common lycopods often seen on the branches of tall and majestic *Ficus* and *Dillenia* trees.

(c) Tropical moist deciduous forest

This type is characterised by the average annual rainfall of 1000 to 2000 mm and comprises the 'Sal forest' and major parts of scrub forest in the state which are seen in the districts of Kokrajhar, Goalpara, Kamrup, Nowgong, N.C. Hills and in the plains of Barak valley.

The dominant species in the Sal areas is *Shorea robusta*. Other important trees are *Schima wallichii*, *Derris robusta*, *Lagerstroemia parviflora*, *L. speciosa*, *Toona ciliata*, *Bombax ceiba*, *Terminalia belerica*, *Persea* spp., etc. accompanied with the smaller trees like, *Gmelina arborea*, *Mallotus philippensis*, *Macaranga denticulata*, *Dillenia pentagyna*, *Caesaria glomerata*, *Bridelia retusa*, *Cassia fistula*, etc.

The areas where *Shorea robusta* disappears (drier parts of Nowgong and Cachar districts, N.C. Hills and Karbi hills) the floristics consists of *Bombax ceiba*, *Garuga pinnata*, *Adina cordifolia*, *Mitragyna* spp., *Ficus* spp., and *Sarcocephalus* spp. and many of the Sal associates.

Woody climbers and lianas are scarce. The common ones are *Combretum decandrum*, *Bauhinia vahli* and several species of *Dioscorea*. *Mikania micrantha* and *Cuscuta reflexa* are the most obnoxious weeds often reaches over the top canopy in these forest.

(d) Grasslands

The grasslands occur in alluvial plains and riparian flats throughout the State and are generally inundated every year during monsoon period. Species of *Arundo*, *Erianthus*, *Phragmites*, *Saccharum*, etc. represents a combination of swamps and marshy vegetation. Such are often found in Manas, Kaziranga, Pobitora, Pava, Laokhowa and Orang wild life sanctuaries where the grasses are tall and reaches to a height of 3-4 m high. A few prominent ones are *Erianthus longistosus*, *Thysanolaena maxima*, *Arundo donax*, *Saccharum spontaneum*, *Sclerostachya fusca* etc.

(e) Swamps

Throughout the state, there are numerous stagnant ponds and poddles locally termed as 'Beel'. Aquatic families such as Araceae, Cyperaceae, Eriocaulonaceae, Lemnaceae, Najadaceae Nymphaeaceae are common in these beels. Extensive growth of *Eichhornia crassipes* and floating herbs like *Ottelia*, *Nymphaea*, *Jussiaea* are also found in these swamps. *Monocharia hastata* and several sedges belonging to *Cyperus*, *Kyllingia*, *Scirpus* species are widely spread. Clumps of tall *Typha elephantina* and *Phrynum* species often form pure formations in several places. *Ipomoea carnosae* also has extended its formations throughout the state as one of the obnoxious weeds.

(f) Riparian forest

These forest occur all over the evergreen and semi-evergreen zones in Assam along river banks and extended in several areas. In low lying areas, *Dillenia indica*, *Anthocephalus indicus*, *Semecarpus anacardium*, *Albizia lebbek*, *Dalbergia stipulacea*, *Bischofia javanica*, *Duabanga grandiflora*, *Lagerstroemia speciosa* are the common species most frequently met with. On slightly higher level, *Mesua ferrea* appears and often forms pure patches. The intermediate stage is occupied by *Altingia excelsa*, *Albizia lucida*, *Artocarpus lakoocha*, *Alstonia scholaris*, *Cedrela toona*, *Carallia integerrima*, *Dalbergia assamica*, *Pterospermum acerifolium*, etc.

(g) Subtropical Broad-leaved forest

This is found only in the Bairal ranges of N.C. Hills district. The common tree species here are, *Schima wallichii*, *S. khasiana*, *Shorea assamica*, *Mesua ferrea*, *Michelia doltopsa*, *Englhardtia spicata*, *Prunus* sp. and several species of *Cinnamomum* and *Machilus*. These forest are rich in epiphytic and ground vegetation. A variety of orchids and ferns are the major component in the epiphytic flora.

(h) Subtropical Pine forest

The extension of Meghalayan Pine forest covers a large areas in the western parts of N.C. Hills and Karbi-Anglong districts. *Pinus kesiya* associates with *Schima wallichii*, *S. khasiana*, *Ligustrum* spp., *Eurya* spp., *Machilus* spp. forms the main components in these forest.

i. Bamboo and cane-brakes

Although *Bambusa tulda*, *B. balcoa* and *Dendrocalamus hamiltonii* etc. form gregarious formations in the evergreen and semievergreen zones of the state, there are extensive pure formations of *Melocana bambusoides* in Cachar and N.C. Hills which extends for several kilometers in the valley. Other important species of Bamboos are *Dendrocalamus calostachyus*, *D. giganteus*, *D. longispathus*, *Bambusa cacharensis*, *B. mastersii*, *B. nutans*, *Melocana baccifera* and several other species of *Schizostachyum*, *Chimonobambusa* etc.

Similarly, in slightly more wet places different species of *Calamus* such as, *C. tenuis*, *C. floribundus*, *C. erectus* and *C. flagellum* form extensive thickets in Karbi and N.C. Hills.

FLORISTIC DIVERSITY

Angiosperms

The origin and evolution of the flora of Assam can be studied on the basis of the presence of as many as 47 genera belonging to 15 families of primitive angiosperms and gymnosperms (Table I) in the state. The evolution of angiosperms from gymnosperms is an established fact and occurrence of such gymnospermous stalk in its wild state should have an impact on the geological history of the area, particularly Assam. *Podocarpus neriifolia* and *P. wallichiana* of Conifer, considered as residual elements of the Late Permian flora, are having scattered distribution in Darrang, Sonitpur, Dibrugarh, Sibsagar, and Cachar, whereas *Cycas pectinata* of Cycads distributed only in Kamrup and Nowgong districts. *Gnetum gnemon* with its limited distribution in Eastern Asiatic region has been found in Sonitpur, Golaghat, Karbi hills and in Cachar districts, while the other species *G. montanum* is an important floristic elements in the evergreen belt of Assam. Occurrence of these species briefly indicate that the geological history of Assam is as primitive as can be calculated with the Late Permian in Paleozoic era and probably angiosperms arose in such a situation which definitely confirmed the views forwarded by Takhtajan (1969). Further, adequate exploration of fossil floras of Assam indeed be needed to supplement the idea of the 'cradle of angiosperms'

Table I
Primitive genera

Name of the family	Genera	No. of species in Assam
Magnoliaceae	<i>Magnolia</i>	9
	<i>Michelia</i>	8
	<i>Pachylarnax</i> Dandy	1
Annonaceae	<i>Alphonsea</i>	2
	<i>Annona</i>	3
	<i>Artabotrys</i>	2
	<i>Cyathocalyx</i>	1
	<i>Desmos</i>	4
	<i>Fissistigma</i>	4
	<i>Friesodielsia</i>	1
	<i>Goniothalamus</i>	2
	<i>Miliusa</i>	2
	<i>Mitrephora</i>	1
	<i>Orophea</i>	1
	<i>Poyalthia</i>	5
	<i>Trivalvaria</i>	2
	<i>Unona</i>	1
<i>Uvaria</i>	4	
Schizandraceae	<i>Kadsura</i>	1
Menispermaceae	<i>Aspidocarya</i>	1
	<i>Haematocarpus</i>	1
	<i>Pycnarrhena</i>	1
Lardizabalaceae	<i>Holboellia</i>	1
	<i>Parvatia</i>	3
Hamamelidaceae	<i>Altingia</i>	1

Name of the family	Genera	No. of species in Assam
Chloranthaceae	<i>Chloranthus</i>	1
Myristicaceae	<i>Horsfieldia</i>	2
	<i>Knema</i>	2
	<i>Myristica</i>	3
Lauraceae	<i>Actinodaphne</i>	5
	<i>Beilschmiedia</i>	6
	<i>Cinnamomum</i>	8
	<i>Cryptocarya</i>	2
	<i>Dehaasia</i>	1
	<i>Endiandra</i>	1
	<i>Lindera</i>	5
	<i>Litsea</i>	19
	<i>Machilus</i>	5
	<i>Neocinnamomum</i>	1
<i>Persea</i>	5	
<i>Phoebe</i>	5	
Piperaceae	<i>Houttuynia</i>	1
Myricaceae	<i>Myrica</i>	
Betulaceae	<i>Alnus</i>	1
Gnetaceae	<i>Gnetum</i>	3
Podocarpaceae	<i>Podocarpus</i>	2
Cycadaceae	<i>Cycas</i>	1

The flora of Assam is an admixture of Indian, Malayan and Chinese elements. The difference in the floral compositions of the two valleys are readily apparent with the localised elements not found anywhere else in the state. Das (1942) observed that the Brahmaputra valley harbours more of giant and diverse tree species than in the Barak valley (Table II).

Table II
Comparison of Evergreen species distributed in Brahmaputra
and Barak Valley (after Das, 1994)

Brahmaputra Valley	Barak Valley
Magnoliaceae	
<i>Magnolia griffithii</i>	absent
<i>M. hookeri</i>	absent
<i>M. caveana</i>	absent
<i>M. pealiana</i>	absent
<i>M. pterocarpa</i>	absent
<i>M. insignis</i>	absent
<i>M. hodgsoni</i>	<i>Magnolia rabaniana</i>
<i>Pachylarnax pleiocarpa</i>	absent
<i>Kadsura roxburghiana</i>	absent
Anonaceae	
<i>Polyalthia simiarum</i>	absent
absent	<i>Cyathocalyx malabaricus</i>
Flacourtiaceae	
<i>Hydnocarpus kurzii</i>	absent
Clusiaceae	
<i>Garcinia affinis</i>	absent
absent	<i>Mammea suriga</i>
<i>Mesua assamica</i>	<i>Mesua floribunda</i>
Theaceae	
<i>Adinandra griffithii</i>	absent
<i>Camellia caudata</i>	absent
Dipterocarpaceae	
<i>Dipterocarpus retusus</i>	<i>D. turbinatus</i>
<i>D. mannii</i>	absent
<i>Shorea assamica</i>	absent
<i>Hopea shingkeng</i>	absent

Brahmaputra Valley	Barak Valley
Leguminosae	
(nom. alt. Fabaceae)	
<i>Dalbergia assamica</i>	<i>D. reniformis</i>
<i>Derris ferruginea</i>	absent
absent	<i>Maniltoa polyandra</i>
Hamamelidaceae	
<i>Altingia excelsa</i>	absent
Combretaceae	
absent	<i>Anogeissus acuminata</i>
Myrtaceae	
<i>Eugenia formosa</i>	absent
Lythraceae	
<i>Crypteronia paniculata</i>	absent
Sapotaceae	
<i>Palaquium obovatum</i>	<i>P. polyanthum</i>
Ebenaceae	
absent	<i>Maba cacharensis</i>
Apocynaceae	
<i>Chonemorpha griffithii</i>	absent
Asclepiadaceae	
<i>Cryptolepis buchanani</i>	absent
Lauraceae	
<i>Beilschmiedia roxburghiana</i>	absent
<i>B. assamica</i>	absent
<i>B. pseudomicropara</i>	absent
absent	<i>Endiandra firma</i>
absent	<i>Cinnamomum cacharensis</i>
<i>Alseodaphne petiolaris</i>	<i>A. owdenii</i>

Brahmaputra Valley	Barak Valley
absent	<i>Alseodaphne andersonii</i>
<i>Persea bombycina</i>	absent
<i>P. globularia</i>	absent
<i>Phoebe goalpurensis</i>	absent
<i>P. cooperiana</i>	absent
Euphorbiaceae	
<i>Aporosa wallichii</i>	absent
absent	<i>Drypetes eglandulosa</i>
Fagaceae	
<i>Lithocarpus elegans</i>	absent
Podocarpaceae	
<i>Podocarpus neriifolius</i>	<i>P. neriifolius</i>
absent	<i>P. wallichianus</i>
Gnetaceae	
<i>Gnetum gnemon</i>	absent

The exact number of species occurring in the state is uncertain due to incomplete exploration in certain areas (namely, N.C. Hills comprising Bairal ranges of hills, Tinsukia district which has large areas of tropical rain forest and Kokrajhar districts). However, with the available specimens an enumeration list has been compiled with 3017 species belonging to 1115 genera and 211 families for the flora of Assam (Table III). This constitutes about 86% of The Kanjilal's Flora of Assam which dealt around 3500 dicotyledonous woody plants from the entire N.E. region. of which, Kanijilal *et al.* recorded only 1583 species and 45 varieties belonging to 669 genera from the present day state of Assam. Further, various researchers of the local university and other research organizations have prepared several district floras (Sarmah, 1989; Sarkar, 1993; Rao and Verma, 1969). Numbers of species dealt in such floras are Sibsagar (1115 spp.), Kamrup (1309 spp.), Karbi Hills (431 spp.), Lakhimpur (604 spp.), etc. which have add to our knowledge on the floristics of the region.

Table III
Statistics of the Flora

	Family	Genera	Species
Angiosperms	207	1111	3010
Dicots	170	824	2251
Monocots	37	287	759
Gymnosperms	4	4	7
Total	211	1115	3017

This account of the flora of Assam is mainly concerned with the flowering plants and the statistics, and mentioned in the table indicate the ratio between the monocot to dicot as 1:2.96 and genera to species on 1:2.7. This shows an interesting variation in comparison with the British India where Hooker (1906) estimates the monocot to dicot ratio as 1:2.3 and for genera to species as 1:7. This indicates the significant occurrences of Monocotyledonous plants and more numbers of species with in a genus in the floristics of Assam.

The diversity in the flora of Asam is very high. A comparative statistics of genera and species pertaining to 20 dominant families are presented in Table IV.

Table IV
Statistics of genera and species under 20 dominant families

Sl.No.	Family	Assam		India	
		genera	Species	genera	species
1.	Poaceae	83	212	264	1291
2.	Orchidaceae	81	191	184	1229
3.	Leguminosae	68	171	167	1141
4.	Asteraceae	66	127	166	803
5.	Rubiaceae	55	127	113	616
6.	Euphorbiaceae	45	102	84	523
7.	Cyperaceae	15	81	38	545

Sl.No.	Family	Assam		India	
		genera	Species	genera	species
8.	Araceae	18	47	29	126
9.	Cucurbitaceae	23	46	39	99
10.	Lauraceae	10	45	17	212
11.	Verbenaceae	15	42	25	145
12.	Malvaceae	13	42	22	93
13.	Annonaceae	14	41	24	120
14.	Moraceae	4	39	13	122
15.	Urticaceae	22	39	27	151
16.	Arecaceae	16	37	24	94
17.	Commelinaceae	12	37	14	90
18.	Acanthaceae	18	37	92	500
19.	Zigiberaceae	13	36	23	189
20.	Myrtaceae	4	36	14	146

In order of dominance at the family level, Poaceae ranks first as the largest family with 83 genera and 212 species. Maximum species diversity occurs in the genus *Panicum* with 14 species out of 18 species recorded from the north-east, this followed by *Brachiaria* with 8 spp. out of 9 spp. in NE India. In the tribe Bambusae, out of 23 genera and 140 spp. in India 9 genera and 33 species occurs in Assam. The genus *Bambusa* has 11 spp and 2 varieties against 25 species in India, of which *B. cacharensis* and *B. mastersii* are the endemic in the Barak valley. While *B. nana* and *B. vulgaris* var. *striata* are the two introduced species in the state. Other genera of the tribe are *Dendrocalamus* (7 spp.), *Dinochloa* (3 spp.), *Gigantochloa* (3 spp.), *Schizostachyum* (4 spp.), *Melocanna* (2 spp) and *Chimnobambusa*, *Oxytenanthera*, *Phylostachys* are having single species in the state. Out of 17 species of *Saccharum* in India, 8 species with a variety occur in Assam. The monotypic genera like *Desmostachys*, *Spharocaryum* and *Zea* also occur in the state.

Orchidaceae, a family of horticultural importance for their eye catching flowers, represents as second largest family with 81 genera comprising 191 species. B.N. Baruah (1978) enumerated 115 species with 4 varieties under 50 genera from the Brahmaputra valley. A variety of

epiphytic genera, such as *Dendrobium* (22 spp.), *Eria* (10 spp.), *Coelogyne* (8 spp.), *Bulbophyllum* (7 spp.), *Oberonia* (5 spp.) and *Cymbidium* (4 spp.) show high species diversity over the terrestrial ones, such as *Eulophia* (5 spp.), *Habenaria* (5 spp.), *Acampe* (4 spp.), *Anoecotochilus* (4 spp.), *Goodyera* (4 spp.), *Zeuxine* (4 spp.). *Acanthephipium silhetense* is one of the most endangered species found in Garampani wild life sanctuary. In the similar locality, *Vanilla pififera* which has very limited distribution in the western ghats, found only in two patches. This is the lone species of orchid with climbing habit. *Paphiopedilum*, a much priced genus is represented by *P. spicerianum* and *P. villosum* in the Barak valley. *Apostaria odorata* and *A. muda* are the primitive ground orchids occur in the evergreen zone of upper Assam. Among the saprophytic genera, *Galeola* is represented by 2 species in limited localities of N.C. Hills.

The family Leguminosae with their members ranging from lofty trees to low herbs and giant lianas to soft twinner, shows a lot of species diversity. The tree species namely, *Albizia* (7 spp.) and *Dalbergia* (8 spp.) have more species diversity than the others. *Bauhinia* and *Acacia* on the other hand have 11 spp. each. Among the herbs and shrubs, *Desmodium* with 15 species shows great diversity followed by *Crotalaria* (11 spp.). Among the woody lianas, *Entada pursaetha* is the important tropical element widely spread throughout the evergreen and semievergreen zones. Besides, there are many species of economic importance including a number of medicinal plants such as *Flemingia*, *Milletia*, *Mimosa*, *Saraca* etc. and wild relative of cultivated plants such as *Dolichos*, *Glycine*, *Tephrosia*, *Vigna*, etc.

Herbaceous family of Asteaceae is well represented by 127 species under 66 genera. Although the species diversity is at low level, *Blumea* shows the highest diversity with 18 spp. followed by *Vernonia* with 10 spp. Most of the genera comprises of one or two species each. *Eupatorium* is a weed genus with 5 species common at all level of altitudes. Such is the case with *Mikania micsantha*.

Rubiaceae is another family which shows high species diversity. Like Leguminosae, it also comprises of members ranging from lofty tree to soft herbs. The genus *Canthium*, *Ixora*, *Lasianthus*, *Ophiorrhiza*, *Psychotria*, *Randia*, *Spermacoce*, *Webera* and *Wendlandia* have more than 5 species each. *Coffea*, a genus of wild relative of commercial coffee

plant, is well represented by 4 species. *Anthocephalus indicus* is a widely distributed timber tree in the state.

Nearly 50% of the genera under the family Euphorbiaceae are represented in the floristics of Assam. Most of the genera are dominant in almost all types of vegetation. The genus *Glochidion* with 13 species against 30 species in the country is very prominent in the semi evergreen forest followed by *Phyllanthus* (11 spp) against 40 species in the country). The genera like *Antidesma* (7 spp.) *Croton* (7 spp.) *Bridellia* (6 spp.) are equally important ones with wide distribution. There are 31 genera under this family with only single representative.

The sedge family of Cyperaceae is an important ones and contributes great diversity in species compositions. Within this family, *Cyperus* is a genus of much diversity. It has 35 species and 4 varieties in the state and grows in all habitats, followed by *Fimbristylis* (11 spp.), *Carex* (10 spp.), *Scleria* (7 spp.) and *Scirpus* (5 spp.). As many as 81 species of this family are occurring in the state.

The family Araceae is yet another important component in the floristics of the state. Within the family, the genus *Arisaema* exhibits more species diversity with 11 species and 4 varieties against 42 species in India. It is distributed from the wasteland vegetation to the evergreen forest. Species belonging to *Pothos* (3 spp.) and *Raphidophora* (4 spp.) are represented as creepers in the evergreen forest, because of their attractive foliage, most of these species have found places in the courtyards and green houses as pot plants in the recent times. *Pistia* is represented with single species in the aquatic ecosystem mostly in the upper Assam belt as a free floating weed plants. *Homalomena aromatics* is widely distributed medicinal arum in the semievergreen belt. The genera like *Acorus* (1 sp.) and *Lasia* (2 spp.) are the important companions in the cane-brakes.

Cucurbitaceae is a family which provides most of the vegetables for human consumption. Chakravarti (1982) recorded ca 100 species belonging to 36 genera of this family in India, of which 46 species belonging to 23 genera are occurring in Assam. Although, most of the species are widely known to grow in wild, several species belonging to genera like *Trichosanthes*, *Luffa*, *Cucurbita*, *Cucumis*, *Momordica*, *Lagenaria*, *Benincara*, *Sechium*, etc. have been domesticated. As a result, the rural economy is stabilised to a certain extent in the state.

Lauraceae is represented with 46 species belonging to 10 genera. Most diverse genus is *Litsaea* with 13 species in the family. *Cinnamomum* is a genus with 7 species as against 16 species in India which constitute a major component in the evergreen belt. Most of the species of *Cinnamomum* are medicinal and the present status of the genus is being studied in the Regional Research Laboratory, Jorhat (Dr. S.C. Nath, the investigator of the project). *Machilus*, *Phoebe* and *Beilschmiedia* are the other important genera with 5 species each. Out of 5 species of *Phoebe*, 3 species namely, *P. goalparensis*, *P. cooperiana* and *P. peeliana* are the endemic timber species in the state.

The family Malvaceae and Verbenaceae are represented by 42 species each. The genus *Hibiscus* with 14 species shows maximum diversity. *H. mutabilis*, *H. rosa-sinensis*, *H. sabdariffa*, *H. schizopetalus* are widely cultivated for their showy flowers while, *H. cannabinus* is a supplementary cash-crop in the state. In the family Verbenaceae, the genus *Clerodendrum* shows maximum diversity with 16 species. All this species of *Clerodendrum* are forming either roadside vegetation or forming thickets along the forest edge. *Cleoderdrum coolebrokianum* is an important medicinal plant often cultivated in rural areas of the state.

The family Annonaceae is represented by 41 species in the state. The frequency of each species of this family is very high. Species belonging to *Desmos* (5 spp.), *Fissistigma* (8 spp.) *Polyalthia* (5 spp.), *Goniothalamus* (2 spp.) are very widely distributed in the forest of Assam. *Annona reticulata* and *A. squamosa* are commonly cultivated for their delicious fruits in the villages.

Although Moraceae and Urticaceae are represented by 39 species each in the state, the family Moraceae has the maximum species diversity. *Ficus* is a genus with 32 species and 3 varieties. It constitutes almost 50% of the total species in India. Most of the species are majestic and significantly large, and grow in every places from open field to evergreen forest. *Artocarpus* with 4 species is well represented. While, most of the species of Urticaceae are herbaceous and belongs to 22 genera. Of which the *Boehmeria* (6 spp.) and *Pouzolzia* (4 spp.) are the diverse genera in the family. *Conocephalus suaveolens* and *Laportea crenulata* are often forming pure patches in gorges and wasteland.

Arecaceae, the palm family, is represented by 37 species under 16 genera. The genus *Calamus* has 12 species and 2 varieties and shows

maximum diversity. *Calamus tenuis* is often form pure formation in certain areas. This is one of the most economically exploited genus in the state.

Commelinaceae and Acanthaceae are also equally diverse families with 37 species each. The members of these families contribute widely in formation of the ground vegetation. Few of the species belonging to genera *Adhatoda*, *Justicia*, *Thunbergia* of Aanthaceae and *Commelina* and *Floscopa* of commelinaceae are having ethnomedicinal values.

Zingiberaceae is also a diverse family with 36 species. *Amomum*, *Globba*, *Zingiber* are the genus having 5 species each. *Hedychium* is represented by 4 species while *Costus speciosus* is a wide spread medicinal species considered threatened in the recent times. *Parakacmpferia synantha* is a endemic from the state distributed in Lakhimpur district.

In order of dominance at generic level, 20 largest genera of the state are represented by 13-35 species each (Table V). Out of which, 12 genera namely, *Cyperus*, *Polygonum*, *Dendrobium*, *Piper*, *Strobilanthes*, *Panicum*, *Blumea*, *Clerodendrum*, *Desmodium*, *Hibiscus*, *Vitis*, and *Leea* are herbaceous. This signifies that herbaceous flora is very rich. Even then, the remaining 8 large genera comprising tree species shows significant dominance in the vegetation. More than 800 genera have either 1 or 2 species eachs. But their frequency is so high that often there are pure formation of single species. *Depterocarpus retusus*, *Shorea robusta*, *S. assamica*, *Bombax ceiba* formations are the prominent.

Table V
Dominant genera

Sl. No.	Genera	No. of species
1.	<i>Cyperus</i>	35
2.	<i>Ficus</i>	32
3.	<i>Polygonum</i>	26
4.	<i>Eugenia</i>	25
5.	<i>Dendrobium</i>	22
6.	<i>Elaeocarpus</i>	20
7.	<i>Piper</i>	19

Sl.No.	Genera	No. of species
8.	<i>Strobilanthes</i>	19
9.	<i>Panicum</i>	18
10.	<i>Blumea</i>	18
11.	<i>Clerodendrum</i>	16
12.	<i>Premna</i>	15
13.	<i>Smilax</i>	15
14.	<i>Desmodium</i>	15
15.	<i>Garcinia</i>	14
16.	<i>Grewia</i>	14
17.	<i>Hibiscus</i>	14
18.	<i>Vitis</i>	14
19.	<i>Leea</i>	13
20.	<i>Glochidion</i>	13

Eugenia is a genus with 25 species shows maximum diversity in the family Myrtaceae. It is distributed throughout the state as an evergreen element. *Terminalia* has 6 species, which forms association with other evergreen elements to determine the forest types in Assam.

Besides the above mentioned, the other tree species which shows maximum diversity in the floristics of Assam are *Dipterocarpus* a genus with 5 species out of 10 species in India constitute a major component in the evergreen belt, mostly in upper Assam and in cachar district. *Dipterocarpus mannii* is an endemic species of Assam. Next to it, the genus *Magnolia* is very significant. 9 out of 11 species of the genus are found in the state. Presence of such a large number of species belonging to a primitive genus signify the originality of the flora of Assam. *Eleaeocarpus* is yet another genus with so much species diversity. 20 out of 29 species are found in the state. *Garcinia* is another genus with 14 species out of 35 species in India which testify the affinity of the flora of Assam towards Malayasia and Africa. *G. keeniana* is an endemic in Barak Valley.

An analysis of diversity at species level in the floristic of Assam leads to the following 9 categories (Table VI). It is interesting to note that majority of the genera belong to 1,2,3,4 and 6-10 species categories. The maximum species diversity occurs in the genera belonging to 8,9 and 7 species categories.

Table VI
Species diversity

No. of categories	No. of species	No. of genera
1.	1	609
2.	2	202
3.	3	96
4.	4	60
5.	5	46
6.	6-10	75
7.	11-20	32
8.	21-30	3
9.	31-50	2

Gymnosperms

Gymnosperms are very poorly represented in the flora of Assam. *Cycas pectinata*, once very common in south Kamrup, Nowgong and N.C. Hills districts, is under the threat of extinction. Although, *Gnetum gnemon* and *G. montanum* are very significant floristic elements in the evergreen zone, *Podocarpus neriifolia* in upper Assam and *P. wallichianus* in the Barak valley are scarcely distributed. *Agathis lanceolata*, a native of south America, is an interesting element in Jeypore R.F. bordering Arunachal Pradesh. If this species is an introduced one in our country, than the full grown patch in the above locality is a matter of concern.

Pinus kesiya, being sporadically distributed in the western parts of Central Assam zone, has been brought under the aforestation programme by the Forest department in many of the hilly areas. Besides, as avenue tree, one species each of genera like *Cryptomeria*, *Juniperus* and *Thuja* have been introduced in several cities and towns of the state.

Cryptogams

Cryptogamic flora of the state is very rich with diverse species composition. However, no any significant studies have been carried out to study this flora in detail, except for a few sporadic observations.

It has been reported as many as 17 species of Blue-green algae belonging to 11 genera such as, *Aphanothece*, *Anabaena*, *Chlorococcus*, *Chlorogloea*, *Oscillatoria*, *Microcoleus*, *Phormidium*, *Lyngbya*, *Spirulina*, and *Schizothrix* from a single habitat of 'Hot-spring' in Garampani W.L. sanctuary (Hazarika *et al.*, 1985), besides numerous species belonging to Chlorophyceae. In view of the importance of algae in soil formation and their role as primary colonisers as well as nitrogen fixing agent, there is an ample need for study of this group of plants in detail.

The lichen flora of Assam is also very rich. It is due to occurrence of diverse habitats ranging from Areca plant to Tea plant besides numerous lithophytic and terrestrials. So far only 102 spp. of foliose lichens are recorded from the state (Singh and Sinha, 1995), the number will be more if proper studies are undertaken in this regard.

Pteridophytes are the important companions in the floristics of Assam. Bir *et al.* (1990) has recorded 297 species of ferns and fern-allies from the state. In order of dominance the family Polypodiaceae shows maximum diversity. Their members mostly epiphytic, belong to the genera like *Pyrrosia*, *Microsorium*, *Polypodium*, etc. Thelypteridaceae Pteridaceae and Athyriaceae are the other dominant families of the terrestrial habitats. Among the climbing ferns, besides 3 species of *Lygodium*, *Stenochlaena palustris* is very widely distributed species in the state. There are 3 genera namely, *Azolla*, *Ceratopteris* and *Salvinia*, forming an integral component in the aquatic ecosystem in the state. Rare occurrence of the 3 primitive genera namely, *Christensenia*, *Psilotum* and *Schizaea* are the distinctive feature of the Pteridophytic flora in regard to its phytogeographical affinities.

PHYTOGEOGRAPHICAL AFFINITY

'Because of its distinctive flora', Assam has been treated as distinct Phytogeographical area (Chatterjee, 1940; Clarke, 1898; Hooker, 1906; Sahni 1981, Jain, 1990, etc.) which forms an integral part of north-eastern extension of the eastern himalaya. It provides the meeting ground of the Indo-Malayasian and Sino-japanese floras. Occurrence of several relict genera like, *Schizaea*, *Psilotum*, *Cycas*, *Podocarpus*, *Gnetum*, etc provide glimpses on the flora of the past. Further the presence of living tertiary floristic elements like, *Dipterocarpus*, *Elaeocarpus*, *Mangifera*, *Spondius*, etc. testify the migration of these elements from south-east Asian region

during Miocene while, *Magnolia*, *Kadsura*, etc were migrated from the north-east Asian region during the Himalaya building activities at that time. Lacking fossil evidence or a fragmentary knowledge about the occurrence of fossil angiosperms, the genus *Laurinoxylon* of Lauraceae (Lakhanpal, 1970) in Assam region provides a thin picture on the palaeogeography of the Eocene and Miocene epochs. However, detail studies on the palaeobotany and palaeogeography of the state are indeed be needed to arrive at the probable conclusion on the study of phytogeography in Assam.

In a comparative assessment of the flora, Arora (1964) estimates that of the 110 and 103 families of woody dicots in Assam and western ghats respectively 98 are common to both the areas. This indicate that the flora of Assam has affinity with that of Western ghats. The presence of Rainforest in the tropical belt of Assam has the affinity towards such forest of Tropical east Africa and western ghats as these areas were drifted as a result of Continental drift of the Gondwana landmass.

ENDEMISM

There is no any comprehensive account of the endemic flora of Assam. Hence it is not proper to furnish a final report on it on the basis of incomplete floristic studies. As has been stated in the introductory paragraph, a large stretch of evergreen belt which is a part of active speciation zone of the north-eastern India, require thorough explorations to arrive at a conclusion on the status of endemism in the state.

However, a search on the endemic species within the political boundary of the state of Assam reveals that as many as 102 species belonging to 75 genera as occurring in the state (Table VII) as compared to 57 endemic genera in the western ghats and 84 from the rest of India (Nayar, 1980). In order of dominance of endemic taxa, the family Poaceae ranks highest with 16 species belonging to 13 genera while Lauraceae has 9 species under 5 genera. Orchidaceae has 7 endemic species while the sino-himalayan family Magnoliaceae has 6 species under 3 genera. Out of 8 species of *Magnolia* occurring in the region, 3 are endemic to Assam. The family Annonaceae has 5 species representing 5 genera while the family Piperaceae is represented by 6 endemic species of *Piper*. The families Apocynaceae and Rubiaceae are represented by 4 endemic species each. While, Clusiaceae, Celastraceae and genera like *Calamus* and

Dioscorea of Arecaceae and Dioscoreaceae respectively are represented by 3 species each.-Asclepiadaceae, Combretaceae, Hypericaceae and Myrtaceae are represented by a single endemic species in Assam.

Table VII
Endemic Taxa

Name of the species	Family
<i>Acacia diadenia</i>	Mimosoideae
<i>A. pennata</i> ssp. <i>herrii</i>	Mimosoideae
<i>Adhatoda cymosa</i>	Acanthaceae
<i>Agapetes kanjilali</i>	Viccinaceae
<i>A. variegata</i> var. <i>bhareliana</i>	Viccinaceae
<i>Allophyllus chartaceus</i>	Sapindaceae
<i>Ardisia pardalina</i>	Mysinaceae
<i>Artabotrys cubittii</i>	Annonaceae
<i>Bambusa cacharensis</i>	Poaceae
<i>B. mastersii</i>	Poaceae
<i>Begonia tessaricarpa</i>	Begoniaceae
<i>Beilschmiedia gammieana</i>	Lauraceae
<i>B. pseudomicropora</i>	Lauraceae
<i>Bousigonia angustifolia</i>	Lauraceae
<i>Camellia sinensis</i> var. <i>assamica</i>	Theaceae
<i>Calamus floribundus</i> var. <i>drepauperatus</i>	Arecaceae
<i>C. kingianus</i>	Arecaceae
<i>C. nambariensis</i>	Arecaceae
<i>Celastrus paniculatus</i> var. <i>venulosoides</i>	Celastraceae
<i>Chonemorpha assamensis</i>	Apocynaceae
<i>Chrysoglossum assamicus</i>	Orchidaceae
<i>Cinnamomum cacharensis</i>	Lauraceae
<i>Citrus assamensis</i>	Rutaceae
<i>Cymbopogon jwaracus</i> var. <i>assamensis</i>	Poaceae
<i>Dalbergia rimosa</i> var. <i>griffithii</i>	Papilionoideae

Name of the species	Family
<i>Dendrocalamus patellaris</i>	Poaceae
<i>Dendrobium assamicum</i>	Orchidaceae
<i>D. aurantiacum</i>	Orchidaceae
<i>Derris cuneifolia</i> var. <i>cuneifoliaforma assamica</i>	Papilionoideae
<i>Dinochloa indica</i>	Poaceae
<i>Dioscorea cumingii</i> var. <i>inacquefolia</i>	Dioscoreaceae
<i>D. pentaphylla</i> var. <i>communis</i>	Dioscoreaceae
<i>D. pentaphylla</i> var. <i>kussok</i>	Dioscoreaceae
<i>Diospyros cacharensis</i>	Ebenaceae
<i>D. kika</i>	Ebenaceae
<i>Dipterocarpus mannii</i>	Dipterocarpaceae
<i>Dischidia albiflora</i>	Asclepiadaceae
<i>Drypetes assamica</i>	Euphorbiaceae
<i>Ecdysanthera lakhimpurensis</i>	Apocynaceae
<i>Eria calmifolia</i>	Orchidaceae
<i>Eulophia santapau</i>	Orcidaceae
<i>Euonymous assamicus</i>	Celastraceae
<i>E. vagans</i> ssp. <i>macrophyllus</i>	Celastraceae
<i>Fimbristylis circumciliata</i>	Cyperaceae
<i>Fissistigma santapau</i>	Annonaceae
<i>Flacourtia helferi</i>	Flacourtiaceae
<i>Garcinia keeniana</i>	Clusiaceae
<i>G. lanceafolia</i> var. <i>oxyphylla</i>	Clusiaceae
<i>Gigantochloa macrostachya</i>	Poaceae
<i>Glochidion assamicum</i>	Euphorbiaceae
<i>Glycosmis singuliflora</i>	Rutaceae
<i>Heritiera dubia</i>	Sterculiaceae
<i>Homalium ceylanicum</i> var. <i>debbermani</i>	Flacourtiaceae
<i>Hymenachne assamica</i>	Poaceae
<i>Hypericum assamicum</i>	Hypericaceae

Name of the species	Family
<i>Illigera gammiei</i>	Hernandiaceae
<i>Ixora goalparensis</i>	Rubiaceae
<i>Justicia craibii</i>	Acanthaceae
<i>Litsaea assamica</i>	Lauraceae
<i>Maba cacharensis</i>	Ebenaceae
<i>Maesa kurzii</i>	Myrsinaceae
<i>M. maxima</i>	Myrsinaceae
<i>Magnolia baillonii</i>	Magnoliaceae
<i>M. caveana</i>	Magnoliaceae
<i>M. gustavi</i>	Magnoliaceae
<i>Mesua assamica</i>	Chusiaceae
<i>Michelia mannii</i>	Magnoliaceae
<i>M. montana</i>	Magnoliaceae
<i>Mussaenda intuspilosa</i>	Rubiaceae
<i>Myristica clarkeana</i>	Myristicaceae
<i>Pachylarnax pleiocarpa</i>	Magnoliaceae
<i>Pandanus assamensis</i>	Pandanaceae
<i>Parakaempfera synantha</i>	Zingiberaceae
<i>Paspalum longifolium</i> var. <i>lorirhachis</i>	Poaceae
<i>Pavetta assamica</i>	Rubiaceae
<i>Persia dubia</i>	Lauraceae
<i>P. globularia</i>	Lauraceae
<i>Phoebe cooperiana</i>	Lauraceae
<i>P. goalparensis</i> var. <i>marliniana</i>	Lauraceae
<i>P. goalparensis</i> var. <i>boriana</i>	Lauraceae
<i>Phyllostachys assamica</i>	Poaceae
<i>Physurus hirsutus</i>	Orchidaceae
<i>Piper clarkei</i>	Piperaceae
<i>P. crassistipes</i>	Piperaceae
<i>P. gullatlyi</i>	Piperaceae

Name of the species	Family
<i>P. gammei</i>	Piperaceae
<i>P. jenkinsii</i>	Piperaceae
<i>P. listeri</i>	Piperaceae
<i>Poa wardiana</i>	Poaceae
<i>Polygonum sarbhanganicum</i>	Polygonaceae
<i>Rotboellia goalparensis</i>	Poaceae
<i>Salacia jenkinsii</i>	Celastraceae
<i>Schizostachyum dullooa</i>	Poaceae
<i>S. griffithii</i>	Poaceae
<i>S. pergracile</i>	Poaceae
<i>Sclerostachya milroyi</i>	Poaceae
<i>Syzygium assamicum</i>	Myrtaceae
<i>S. cyanophyllum</i>	Myrtaceae
<i>Thamnocalamus prainii</i>	Poaceae
<i>Trachelospermum assamense</i>	Apocynaceae
<i>Typhonium listeri</i>	Araceae
<i>Uvaria hamiltonii</i> var. <i>kurzii</i>	Annonaceae

Most of these endemic species are with highly restricted distribution in the state, such as, *Mangolia* in upper Assam belt, *Calamus*, *Cinnamomum*, *Diospyros*, *Maba* and bamboos like *Phyllostachys*, *Schizostachyum*, etc. are restricted to the Cachar and North Cachar regions. However, due to rapid urbanisation and several other biotic influences on the environment of such localised areas would make the habitat of many specific endemics which have already rendered threat-prone and as such would hasten them towards total extinction.

ECONOMIC IMPORTANCE

Economic importance of the flora of Assam has been discussed by several workers (Rao and Hajra, 1986 etc.). Assam abounds in various economically important plants resources. Proper exploitation of which may lead to the development of forest-based cottage industries. The various

forest produce includes timber, raw materials for paper and pulp, gums and resins, essential oils and oil seeds, fibre, aromatic and medicinal plants etc. A few important economic plants are listed below.

Timber plants: *Albizia lebbek*; *A. odoratissima*, *Altingia excelsa*, *Artocarpus chaplasha*, *Chukrussia tubularis*, *Duabanga grandiflora*, species of *Dipterocarpus*, *Lagerstroemia speciosa*, *Mesua ferrea*, *Michelia champaca*, species of *Magnolia*, *Talauma hodgsonii*, *Palaquium polyanthum*, *Schima wallichii*, *Phoebe*, spp., *Shorea* spp., *Terminalia* spp., etc.

Raw materials for paper and pulp: Apart from different species of Bamboos, the other plants species are *Garuga pinnata*, *Bombax ceiba*, *Helicteres* spp., *Kydia calycina*, etc.

Gums and resins: *Canarium strictum* is the important resin plant of Assam.

Essential oils: The region is rich in species of *Cymbopogon* yielding citronella oil. Other oil yielding species are, *Hydnocarpus kurzii*, *Gynocardia odorata*, *Dipterocarpus turbinatus*, *Mesua ferrea*, *Shorea robusta*, etc. *Aquillaria agallocha* is the most important oil yielding plant in Assam.

Fibre yielding plants: The main fibre yielding species are, *Sterculia villosa*, *Bombax ceiba*, *Corchorus* spp., *Boehmeria nivea*, *Butea monospoma*, *Bauhinia* spp., *Grewia* spp., *Firmiana colorata*, *Hibiscus* spp. etc.

Bamboos and canes: 12 species of *Calamus* and 33 species of bamboos are of great importance in developing forest based cottage industries in the state.

Medicinal plants: There are large numbers of medicinal plants of commercial importance. Besides, numerous plants are used by the local people for treating their ailments. Proper exploration in this field will certainly yield much more new informations. A few important medicinal plants are *Adhatoda vasica*, *Centella asiatica*, *Clerodendron colebrookianum*, *Costus speciosus*, *Dioscorea prazeri*, *Holarraena antidysenterica*, *Paederia foetida*, *Phyllanthus emblica*, *Eclipta alba*, *Asparagus racemosus*, *Terminalia* spp., etc.

Plants of horticultural importance: The forest of Assam are quite rich in orchids which can be a good source of earning. The most ornamental orchids are, *Arundina bambusifolia*, *Rhynchostylis retusa*, *Papilionanthe teres*, *Cymbidium aloifolium*, *Dendrobium* spp., *Paphiopedilum* spp. etc. Besides orchid there are numerous other plants of horticultural importance such as, *Allamanda cathartica*, *Azadirachta indica*, *Albizia lebbek*, *Bauhinia purpurea*, *B. variegata*, *Canna indica*, *Cassia fistula*, *C. nodosa*, *Celosia argentia*, *Cestrum nocturnum*, *Clerodendrum* spp., *Cyperus alternifolius*, *Ficus* spp. *Hedychium* spp., *Holmskioidea sanguinea*, *Ixora* spp. *Saraca indica*, etc.

RARE AND ENDANGERED PLANTS

Due to the lack of adequate information on the complete flora of the state, it is difficult to ascertain the exact number of rare, endangered or threatened taxa from the area. Jain and Sastry (1973) while trying to assess the status of 135 taxa for the country made a mention of 14 such taxa from Assam. However, Vol. 1 and 2 of the Indian Red data Book mention about 43 species from Assam region. Barua (1995) published 8 species from Assam as rare and endangered plants. A list of 60 rare, endengred and threatened species from the state has been compiled (Table VIII) whose number will be much more if thorough explorations are made.

CONSERVATION MEASURES

The rich habitats are gradually depleting day by day due to various activities of human population for their survival and other developmental activities such as agriculture, urbanisation, mining, hydro-electric projects etc. G.A. Gammie (1895) commented while travelling to Lakhimpur district that "the country is well wooded around Gauhati" Now, not only the valleys but also the hills are denuded of their natural green covers giving rise to scrub jungles. The reason for this damage are not far to seek. Besides man made factors, the natural processes are causing more deletarius effects towards the depletion of the natural forest cover. As per the assessment made by the Forest Survey of India, Dehra Dun in 1993-1995, the entire North east has lost 783 sq. km in net forest cover. Of this, Assam has lost 447 sq km.

Table VIII
Rare and Endangered Taxa

Name of the species	Family	Status	Distribution
<i>Acanthephipium silhetense</i>	Orchidaceae	R	Garampani, Golaghat
<i>Acalypha australis</i>	Euphorbiaceae	R	Kachugaon R.F.
<i>Acranthera tomentosa</i>	Rubiaceae	V, En.	Assam, Meghalaya, Nagaland
<i>Adinandra griffithii</i>	Theaceae	E, R	Assam, Meghalaya
<i>Albertisia mesistophylla</i>	Menispermaceae	Ex	Assam and Meghalaya
<i>Anoectochilus sikkimensis</i>	Orchidaceae	R	Garampani, Golaghat
<i>Apostasia nuda</i>	Orchidaceae	R	Garampani, Golaghat
<i>Brassiopsis polycantha</i>	Araliaceae	R.	Upper Assam
<i>Begonia tessaricarpa</i>	Begoniaceae	Ex	Assam
<i>Beilschmiedia pseudomicropora</i>	Lauraceae	En	Digboi
<i>Bulbophyllum mishmeense</i>	Orchidaceae	R, En.	Assam, Arunachal Pradesh
<i>B. virens</i>	Orchidaceae	R, En.	Assam, Arunachal Pradesh
<i>Calanthe herbacea</i>	Orchidaceae	R.	Assam
<i>C. odora</i>	Orchidaceae	R.	Assam

Name of the species	Family	Status	Distribution
<i>Cassia wallichiana</i>	Leguminosae	R.	Manas
<i>Ceropegia lucida</i>	Asclepiadaceae	E, Probably Ex.	Cachar
<i>Chysoxylum assamicum</i>	Orchidaceae	R.	Assam
<i>Clematis fulvicoma</i>	Ranunculaceae	R	Assam
<i>Coelogyne rossiana</i>	Orchidaceae	V.	Assam
<i>Dendrobium aruanticum</i>	Orchidaceae	E	Assam
<i>Dioscorea deltoidea</i>	Dioscoreaceae	V.	Assam
<i>Dysoxylum reticulatum</i>	Meliaceae	R	Assam
<i>Eulophia manii</i>	Orchidaceae	R., En	Assam
<i>Fissistigma santapauli</i>	Annonaceae	En.	Assam
<i>Flacourtia helferi</i>	Flacourtiaceae	R	Assam
<i>Gulielmella ulissima</i>	Orchidaceae	R, Probably Ex.	Assam
<i>Goniothalamus simsonii</i>	Annonaceae	R	Assam
<i>Goodyera prainii</i>	Orchidaceae	En.	Assam and Nagaland
<i>Habenaria trifurcata</i>	Orchidaceae	R.	Assam
<i>Hedyotis brunonis</i>	Rubiaceae	R	Assam

Name of the species	Family	Status	Distribution
<i>H. scabra</i>	Rubiaceae	R	Assam
<i>Illigera appendiculata</i>	Hernandiaceae	R	Cachar
<i>Indofevillea khasiana</i>	Cucurbitaceae	R.	Assam
<i>Lagerstroemia minuticarpa</i>	Lythraceae	Ex.	Assam.
<i>Liparis delicatula</i>	Orchidaceae	R., En	NE India
<i>L. prainii</i>	Orchidaceae	En.	Assam, Nagaland
<i>L. vestita</i>	Orchidaceae	En.	Assam, Meghalaya
<i>Loropetalum chinense</i>	Hamamelidaceae	R.	Assam
<i>Livistona jenkinsiana</i>	Arecaceae	E.	NE. India.
<i>Maba cacharensis</i>	Ebenaceae	R.	Cachar
<i>Magnolia caveana</i>	Magnoliaceae	R.	Assam
<i>Milusa dolicantha</i>	Annonaceae	R.	Assam.
<i>M. gustavi</i>	Magnoliaceae	En.	Upper Assam
<i>M. insignis</i>	Magnoliaceae	R	Assam
<i>M. rabaniana</i>	Magnoliaceae	R	Assam
<i>Michelia baillonii</i>	Magnoliaceae	R	Assam

Name of the species	Family	Status	Distribution
<i>Michelia mannii</i>	Magnoliaceae	R, En.	Upper Assam
<i>Ophiorrhiza hispida</i>	Rubiaceae	E.	Assam.
<i>O. tingens</i>	Rubiaceae	V	Assam
<i>Orophea polycarpa</i>	Annonaceae	R	Cachar
<i>Paphiopedilum spicerianum</i>	Orchidaceae	R.	Cachar
<i>Phlogocanthus asperula</i>	Acanthaceae	R.	Upper Assam
<i>Polysolenia wallichii</i>	Rubiaceae	R	Cachar
<i>Smithia grandis</i>	Leguminogae	R.	Karrup.
<i>Sterculia khasiana</i>	Sterculiaceae	R.	Assam.
<i>Stylidium kunthii</i>	Stylidiaceae	R	Kamrup
<i>Symplocos glauca</i>	Symplocaceae	R.	Assam.
<i>Syzygium assamicum</i>	Myrtaceae	R.	Assam.
<i>Vanila pilifera</i>	Orchidaceae	R.	Assam

(R = Rare; E = Endangered; En = Endemic V = Vulnerable; T = Threatened, Ex = Extinct)

Natural causes mainly include the flood. Repeated flood havoc in every year has resulted in the habitat destruction by removing the top layers of humus rich soil, this has in turn affect on the vegetation of the state. Among the man-made causes, excessive use of fire wood, enchoachment in the Reserved forest areas for settlement and rehabilitation programmes, stone quarrying in the hilly regions, over collection of some economically important species etc. are some of the main causes that lead to deforestation. The resultant habitat destruction of species leads to degradation, depletion of the species diversity. Another important factor causing deforestation is raising of artificial forest by monoculture of some economically important species like Sal and Teak, etc.

As the forestry has played a very intimate role in social lives of the people living in Assam from ages, the importance of judicious management of this natural resource was not lost sight of even by the earliest rulers of the state. From the history of Assam it is evident that during the Ahom Dynasty, a specific administrative branch was there to look after the management of timbers exploitation and timber depots. This is evident from the fact that the surnames carried till today after the titles conferred by the Ahom kings to the persons engaged in their respective area of activites eg. Hati baruah, Kath-Baruah, Kath-Bharali etc. Provisions for treatment of animals during that period is also found in the Historical Saga of Assam. Planting of trees along roadside also used to be done during the Ahom Dynasty.

In real sense, the forest management in Assam was started in 1850. To regulate the scientific forest management and forest conservancy, the Assam Forest Regulation VII of 1891 was enacted and brought into force from 1st April 1891. Under this Act, the biological resources has been protected, till today, under the banner of protected forest and sanctuaries.

Presently there are 10 wild life sanctuaries, 1 National park and 1 Tiger reserve in the state covering an area of 2219 sq km (Table IX). Besides, Assam has 355 Reserved Forest covering an area of 18242.23 sq km. and 154 proposed Reserved Forest with total area of 3935.49 sq km. There are 8529.84 sq km. area covered by the unclassed state forests which may be treated as Nil as a result of heavy exploitation by the encroachers.

Table IX
Protected areas

Sl. No.	Name	Area in Sq km
1.	Kaziranga National Park	430.00
2.	Manas Tiger Reserve	500.00
3.	Rajiv Gandhi Wildlife Sanctuary (Orang)	72.00
4.	Laokhowa Wildlife Sanctuary	70.00
5.	Garampani Wildlife Sanctuary	6.00
6.	Barnadi Wildlife Sanctuary	26.00
7.	Kachugaon game Reserve	214.00
8.	Pava game Reserve	49.00
9.	Dibru-Saikhowa Wildlife Sanctuary	640.00
10.	Deepar-beel Wildlife Sanctuary	4.00
11.	Nameri Wildlife Sanctuary	137.00
12.	Pabitora Wildlife Sanctuary	16.00

Management planning, information collection and analysis, people's involvement and ecodevelopment are the key issues for conservation success. In consideration of these issues, a few points have been identified which certainly may effect biodiversity conservation in the Assam context. These are upgradation and extension of all the protected areas of Assam. Protection to the corridors and creation of new corridors. Protection of representative types of forest for conservation purpose viz Upper Assam Rain forest, grassland of Karbi and N.C. Hill, Bamboo and cane-brakes in Barak Valley. Regular monitoring of rare and endangered plants and their enumeration.

It should be only eco-friendly attitude of the people and their direct participation will pave the way for successful conservation. It is much difficult to impose the laws and orders for conservation among different ethnic groups of people of the state unless a peaceful political atmosphere is exists. So for the elimination of all the difficulties a clear understanding and interaction between the people and the government is necessary.

REFERENCES

- Arora, R.K. 1964. Phytogeographical notes on humid tropical flora of India world distribution and analysis of the woody dicotyledonous Flora of Western ghats and Assam. *J. Indian Bot. Soc.* **43** : 220-228.
- Barua, I.C. 1992. *Systematic studies of the Angiosperms of Kamrup Dt., Assam*. Ph. D. Thesis, Gauhati University.
- Barua, I.C. 1995. New report and rediscoveries of some rare and endangered plants in Assam. *J. Econ. Tax. Bot.* **19** : 273-276.
- Barua, I.C., S. Chowdhury and B. Neogi 1988. Primitive land plants (Angiosperms) and their distribution pattern in Assam. *J. Econ. Tax. Bot.* **12** : 81-92.
- Barua, I.C. and A.K. Gogoi, 1995. *Stylidium kunthii* (Stylidiaceae) A new record for Assam. *J. Econ. Tax. Bot.* **19** : 501-504.
- Barua, I.C., T.K. Goswami, and K.N. Barua, 1996. Distributional notes on some plants in Assam. *J. Econ. Tax. Bot.* **20** : 655-660.
- Baruah, B.N. 1978. *Studies on the systematics of orchids in the Brahmaputra Valley*. Ph. D. Thesis, Gauhati University.
- Burkill, I.H. 1960. *Chapters on the history of Botany in India*. New Delhi.
- Carter, H.G. *et al.* 1921. Useful plants of the district of Lakhimpur, Assam. *Rec. Bot. Surv. India* **6(9)** : 353-420.
- Champion, H.G. and S.K. Seth, 1968. *A revised survey of the forest types of India*. Govt. of India Press, Nasik.
- Chatterjee, D. 1940. Studies on the endemic flora of India and Myanmar. *J. Roy. Asiatic Soc. Bengal Sci.* **5** : 19-67.
- Clarke, C.B. 1898. Subareas of British India illustrated by the detailed distribution of the Cyperaceae in that empire. *J. Linn. Soc. London* **34** 1-146.

- Das, A. 1942. Floristics of Assam - A preliminary sketch. *150th Anniv. vol. Pt. I and II. Royh. Bot. Gard. Calcutta* 137-156.
- Das, B.N. and S. Rajkhova 1968. Woodlands of Assam. *Indian For. Rec.* **94** : 137-146.
- Gammie, G.A. 1895. Report on a botanical tour in Lakhimpur district, Assam. *Rec. Bot. Surv. India* **1**(5) : 61-88.
- Griffith, W. 1848. *Journals of Travels in Assam, Myanmar, Bhutan, Afghanistan and neighbouring countries.* Calcutta.
- Hajra, P.K. 1978. *Flora of Kaziranga National Park and Manas wild Life sanctuary of Assam.* Ph. D. Thesis, Gauhati University.
- Hazarika, D. and P. Gogoi 1985. Thermal Algae from Hot-springs of Nambar Forest, Assam. *Geio Bios, New Reports* **4**: 187-190
- Hooker, J.D. 1854. *Himalayan Journals*, 20 vols. Reeve and Col., London.
- Hooker, J.D. 1872 - 1897 *The Flora of British India*, 7 vols. Reeve and Co., London.
- Hooker, J.D. 1906 *A sketch of flora of British India.* London.
- Islam, M. 1990. *Flora of Majuli the greatest river island in the world.* Bishen Singh Mahendra Pal Singh, Dehra Dun.
- Jain, S.K. 1990. Botanical Regions and flora of India. *Everyman's Sci.* Dec.'89 - Jan.'90 issue : 213-223.
- Jain, S.K. and P.K. Hajra 1975 (78). On the botany of Manas wild life sanctuary. *Bull. Bot. Surv. India* **17** : 75-86.
- Jain, S.K. and R.R. Rao 1983. *An assessment of threatened plants of India.* Howrah.
- Jain, S.K. and A.R.K. Sastry (1983). *Threatened plants of India - A state-of-the-Art report.* Howrah.

- Jain, S.K. and A.R.K. Sastry 1983. *Materials for a catalogue of threatened plants of India*. Howrah.
- Kanjilal, U.N., et al. 1934-1940. *Flora of Assam*, 4 vols. Govt. of Assam, Shillong.
- Kar, S.K. and G. Panigrahi 1963 (1964). The Rubiaceae in Assam and NEFA. *Bull. Bot. Surv. India* 5 : 227-237.
- Kataki, S.K. and G. Panigrahi 1963 (1964). The Rubiaceae in Assam and NEFA. *Bull. Bot. Surv. India* 5 : 227-237.
- Kataki, S.K. and G. Panigrahi 1964. Ranunculaceae in Assam and NEFA. *Indian For.* 90 : 394-400.
- Lakhanpal, R.N. 1970. Tertiary floras of India and their bearing on the historical geology of the region. *Texon* 19 : 675-694.
- Nayar, M.P. 1980. Endemism and pattern of distribution of endemic genera (Angiosperms). *J. Econ. Tax. Bot.* 1 : 99-110.
- Panigrahi, G. and S.K. Kar 1966 (1967). The compositae in Assam and NEFA. *Bull. Bot. Surv. India* 8 : 228-235.
- Rao, A.S. 1974. Vegetation and phytogeography of Assam and Myanmar. In *Ecology and Biogeography in India* (ed) M.S. Mani, Junk Publishers, Hague, pp 204-246.
- Rao, A.S. and P.K. Hajra 1974 (1977). *Eulophia mannii* Hk. f. : a scarcely known ground orchid from Assam. *Bull. Bot. Surv. India* 16 : 156-157.
- Rao, A.S. and L.C. Rabha 1966 (1967). Contribution of the botany of Kamrup district (southern part), Assam. *Bull. Bot. Surv. India* 8 : 296-303.
- Rao, A.S. and D.M. Verma 1969 (1972). *Parakaempferia synantha* (Zingiberaceae) : a new genus and species from Assam. *Bull. Bot. Surv. India* 11 : 206-208.

- Rao, A.S. and D.M. Verma 1969 (1972). Contribution to the botany of North Lakimpur sub-division, Assam. *Bull. Bot. Surv. India* 11 : 403-413.
- Rao, R.R. and P.K. Hajra 1986. Floristic diversity of the eastern Himalaya - in a conservation perspective. *Proc. Indian Acad. Sci. Suppl.* 103-125.
- Rao, R.S. and G. Panigrahi 1961. Distribution of vegetational types and their dominant species in eastern India. *J. Indian Bot. Soc.* 40 : 274-285.
- Robinson, W. 1841. *A descriptive account of Assam*. London.
- Rowntree, J.B. 1953. An introduction to the vegetation of the Assam valley. *Indian For. Rec.* (n.s.) 9(1) : 1-87.
- Sahni, K.C. 1981. Botanical panorama of the eastern Himalaya. In *The Himalayan Aspects of Change* J.S. Mall (ed.). Oxford University Press, New Delhi. pp. 32-49.
- Santapau, H. and A.N. Henry 1973. *A dictionary of the flowering plants in India*. CSIR, New Delhi.
- Sarmah, J.N. 1989. *A detail study of the flora of Sibsagar district, Assam*. Ph. d. Thesis, Gauhati University.
- Sarkar, S. 1993. *Studies on the herbaceous plants of Karbi Anglong district of Assam with reference to their taxonomy and economic utilisation*. Ph. D. Thesis, Gauhati University.
- Sas Biswas, T.C. Bhuyan and G.C. Thakuria 1991. Studies on the forest flora of Lower Assam with particular reference to the Kachugaon Reserve Forest, District Kokrajhar, Assam. In *Higher Plants of Indian Subcontinents*. Bishen Singh Mahendra Pal Singh, Dehra Dun.
- Shukla, U. 1993. History of botanical works in the north eastern India. *J. Econ. Tax. Bot.* 17 : 537-554.
- Shukla, U. 1996. *Grasses of North-eastern India*. Scientific Publishers. Jodhpur.

Singh, K.P. and Sinha, G.P. 1995. *Lichen Flora of Nagaland*. Bishen Singh Mahendra Pal Singh, Dehra Dun.

Singh, Ranjit 1993. *Systematic studies on the dicotyledonous plants of Lakhimpur district (undivided), Assam*. Ph. d. Thesis, Gauhati University.

Takhtajan, A. 1969. *Flowering plants - origin and dispersal*. Oliver and Boyd Ltd., Edinburgh.

Ward, F. Kingdon 1960. *Pilgrimage for plants*. London.

Wallich, N. 1820-1832. *Plantae Asiaticae Rariores*, 3 vols. London.



Tropical evergreen forest : *Dipterocarpus retusus*
formation in Jeypore R.F.;



Subtropical broad leaved forest in N.C. Hills



A view of 'Sal forest' in south camp Kamrup dist.



Riparian forest along river Kopili in N.C. Hills



Semi evergreen forest with *Tetrameles nudiflora* : in Garampani sanctuary



Barringtonia acutangula : formation in pabitora Wildlife sanctuary
(Courtesy : P.J. Bora)



Agathis lanceolata in Jeypore R.F.



Bombax, Lagerstroemia formation in Nambor R.F.



Tacca laevis : an endangered plant in Assam



Dischidia benghalensis : a rare species from Rajpara R.F., Kamrup dist.



Vanilla pilifera : a rare and endangered climbing orchid in Garampani sanctuary



Flowers of *Vanilla pilifera*



Dendrobium aphyllum : one of the common orchid in Assam
(Courtesy : S.J. Phukan)



Dendrobium fimbriatum : one of the threatened species of orchid
(Courtesy : S.J. Phukan)



Aerides rosea : a rare orchid in Assam
(Courtesy : S.J. Phukan)

BIHAR

M. Das
R.P. Bhattacharya
V. Mudgal

Bihar, the 10th largest state of India lies between $21^{\circ}55'10''$ - $27^{\circ}31'15''$ N latitude and $83^{\circ}19'50''$ - $88^{\circ}17'40''$ E longitude, covering a geographical area of about 1,73, 877 sq km and is divided into 54 districts. It is bounded on the north by the international boundary of Nepal, on the South by the state of Orissa, on the east by the state of West Bengal and on the west by the states of Uttar Pradesh and Madhya Pradesh.

The mighty river Ganga broadly divides the state into two physiographic units, the Gangetic plain in the north and the Chotanagpur plateau in the south. The northern Gangetic Plain, created by the Ganga and its tributaries like Kosi, Sone, Gandak, etc., forms almost a flat alluvial plain except for the Himalayan foot-hills and Terai region in the extreme north-west. On the other hand, series of hills, valleys and plateaus cover the Chotanagpur plateau. Some of the important rivers that originate from this region are Damodar, Barakar, Koel, Subarnarekha, etc. The altitude ranging from 103 - 1365m also enhances the physiographic versatility of the state. The soil condition varies largely like new alluvium-chalky to non chalky, older alluvium composed of darkish clay or yellowish loam, sandy, laterite soil, etc.

Three distinct seasons prevailing in the state are the summer (March to mid-June), the monsoon (mid-June to October) and the winter (November to February). May is the hottest month with mean temperature exceeding 90°F (32°C) except in the extreme north and plateaus of Ranchi and Hazaribagh. The average annual rainfall varies between 100 cm in the west-central to more than 150 cm in the extreme north and in the south-west. The state is endowed with a rich vegetational wealth on account of its varied topographic and climatic factors. It has 29,226 sq km of total forest cover (16.81%), of which, 13,172 sq km is under dense forest while remaining 13, 415 sq km is under open forest. Legislatively this total area is classified as reserve forest (5,051.43 sq km) protected forest (24,167.51 sq km), and unclassed forest (7.09 sq km). Besides, a newly notified afforested area of road and land-side, etc., cover an area of *ca* 846 sq km. Some of the districts having dense forest cover are Palamau, Hazaribagh,

East and West Singhbhum, Giridih, Godda, Sahebganj, Rohtas, Ranchi, Munghyr, etc.

The rich vegetation and floristic diversity of the state have attracted the attention of a number of explorers and botanists in the past. Anderson (1863), Hooker (1872-1897), Clarke (1884), Wood (1902), Haines (1910, 1921-1925), Thomson (1917) surveyed and made collection from various parts of the state. Haines (1921-1925) did a pioneering work by publishing a monumental work, entitled 'The Botany of Bihar and Orissa'. Subsequently, a number of other botanists like Mukerjee (1947), Mooney (1950), Bressers (1951), Thothathri (1965), Kanodia (1966), Panigrahi (1966), Banerjee (1969), Paul (1973), Biswas (1980) and others surveyed extensively both Gangetic plain and Chotanagpur plateau and made additions to the flora of Bihar. Besides, Flora of districts viz. Ranchi Bhagalpur and Patna have been brought out by Bressers (1951), Verma (1981), Singh (1986), respectively.

VEGETATION

The vegetation of the state is mainly tropophilous. A few pockets however, exhibit vegetation of xerophilous nature. The southern plateaus and extreme north-western region are covered with natural vegetation. While the Gangetic plain hardly possess any remnants of natural flora but harbours scattered grasslands and some occasional plantations. Besides, a considerable extent of hydrophytic flora and swampy vegetations occur here and there. However, the vegetation of the state may be grouped into following categories.

I. FOREST

The major forest types found in Bihar are as follows

1. Dry Tropical Forest

(a) Tropical Dry Deciduous Forest

This is the most characteristic vegetation, comprising about 88% of total forest cover of the state. These forest occur scatteredly and often embrace a number of edaphic or pure formations of *Boswellia*, *Acacia*, *Butea*, Bamboos, etc., in different localities. Plateaus and hills with

shallow soils are the suitable habitats for these forest. Most of the forest are open type and remain leafless during dry seasons. Woody climbers and epiphytes are rare but bulbous and rhizomatous species are frequent. Subfruticose or herbaceous climbers are abundant during monsoon. Unlike the Moist Deciduous forest 'Sal' (*Shorea robusta*) is stunted here. It constitutes major percentage except in the pure formations.

The major elements forming the top canopy are *Shorea robusta*, *Anogeissus latifolia*, *Buchanania lanzan*, *Terminalia alata*, *T. belerica*, *Boswellia serrata*, *Mitragyna parvifolia*, *Lannea coromandelica*, *L. grandis*, *Sterculia urens*, *Lagerstroemia parviflora*, *Acacia catechu*, *A. leucophora*, *Butea monosperma*, *Catunaregum nutans*, *Soymida febrifuga*, *Ailanthus excelsa*, etc.

The second storey includes *Phyllanthus emblica*, *Desmodium oojenensis*, *Cochlospermum religiosum*, *Gmelina arborea*, *Gardenia gummifera*, *Aegle marmelos*, *Bauhinia purpurea*, *B. malabarica*, *B. racemosa*, *Euphorbia nivula*, *Phoenix sylvestris*, *Semecarpus anacardium*, *Diospyros melanoxylon* as principal constituents.

The shrubs forming third storey are *Flacourtia indica*, *Murraya paniculata*, *Helectres isora*, *Nyctanthes arbor-tristis*, *Petalidium barleriodes*, *Indigofera cassioides*, *Woodfordia fruticosa*, *Wendlandia tinctoria*, *Grewia helicterifolia*, *Zizyphus mauritiana*, *Flemingia chappar*, *F. nana*, *F. strobilifera*, *Clausena excavata*, *Desmodium benthamii*, *Crotalaria mysorensis*, *Glycosmis arborea*, *Flueggea obovata*, etc.

2. Moist Tropical Forest

(a) Tropical Moist Deciduous Forest

These forest account for less than one-seventh of the area occupied by Tropical dry deciduous forest and highly dominated by 'Sal'. Of this, a major part (85%) occurs in the damp valleys of southern Bihar a minor part (11%) found in the Himalayan foot-hills towards extreme north-western boundary, and only 4% of such forest in Gangetic plain exhibits greater admixture of species. However, the principal associates of 'Sal' are *Terminalia alata*, *T. arjuna*, *T. bellirica*, *Pterocarpus marsupium*, *Madhuca longifolia*, *Dillenia pentagyna*, *Haldinia cordifolia*, *Mitragyna parvifolia*, *Scleichera oleosa*, *Spondias pinnata*, *Garuga pinnata*, *Bursera serrata*

Gmelina arborea, *Toona ciliata*, *Callicarpa arborea*, etc., and these species form the top canopy.

The second storey formed by medium-sized evergreen trees are dominated by *Diospyros melanoxylon*, *Sizygium cumini*, *Alstonia scholaris*, *Kydia calycina*, *Saraca asoca*, *Artocarpus lacucha*, *Aphanamixis polystachya*, *Amora rohituka*, *Symplocos cochinchinensis*, *Ardisia solanacea*, *Pongamia pinnata*, *Polyalthia suberosa*, *Bridelia pubescens*, *Gelonium multiflorum*, *Antidesma acuminatum*, *A. acidum*, *Meliosma simplicifolia*, *Buchanania lanzan*, *Cipadessa baccifera*, etc.

Some important climbers of the forest are *Bauhinia vahlii*, *Combretum decandrum*, *Uvaria hamiltonii*, *Entada rheedii*, *Tiliacora acuminata*, *Acacia pennata*, *Millettia auriculata*, *Bridelia stipularis*, *Spatholobus parviflora*, *Naravelia zeylanica*, *Mucuna pruriens*, *M. imbricata*, *Cajanus crassa*, *Abrus precatorius*, *Ampelocissus latifolia*, *A. tomentosa*, etc.

Common shrubs forming the lowest storey are *Flemingia chappar*, *F. semialata*, *Desmodium pulchellum*, *D. gyroides*, *D. motorium*, *Clerodendrum viscosum*, *Linociera intermedia*, *Leea compactiflora*, *Jasminum pubescens*, *Croton roxburghii*, *Indigofera cassioides*, *Sideroxylon tomentosum*, *Urena lobata*, *Uraria rufescens*, *Colebrookia oppositifolia*, *Petalidium barlereoides*, etc.

The dominant herbs on the floor include *Alpinia nigra*, *Barleria strigosa*, *Zingiber capitatum*, *Ruellia beddomei*, *Phyllanthus debilis*, *Imperata cylindrica*, *Eranthemum pulchellum*, *Biophytum sensitivum*, *Costus speciosus*, *Themeda triandra*, etc.

(b) Tropical Semi-Evergreen Forest

These forest are rare and occasionally found in small patches the along rivers and streams in deep valleys and on both sides of the most steeply graded streams. Here moist conditions prevail throughout the year which helps in growth of a number of epiphytic Orchids, Ferns, climbers and luxuriant undergrowths. The important species making top canopy are *Garcinia xanthochymus*, *Aglaia spectabilis*, *Schleichera oleosa*, *Michelia champaca*, *Dillenia pentagyna*, *Shorea robusta*, *Sabia paniculata*, *Spondias pinnata*, *Haldinia cordifolia*, *Mangifera indica*, *Mitragyna*

parvifolia, *Meliosma simplicifolia*, *Artocarpus lacucha*, *Syzygium cumini*, etc.

The medium sized evergreen trees form the second storey. Some common of them are *Symplocos racemosa*, *Semicarpus anacardium*, *Bridelia verrucosa*, *Antidesma acuminatum*, *Gardenia turgida*, *Buchanania lanzan*, *Sideroxylon tomentosum*, *Aphanamixis polystachya*, *Micromelum minutum*, *Alstonia scholaris*, *Polyalthea suberosa*, *Saraca asoca*, *Pongamia pinnata*, *Mallotus philippensis*, *Caesalpinia cucullatum*, *Trema orientalis*, *Xylosma longifolia*, etc.

Some extensive climbers are *Bridelia scandens*, *Uvaria hamiltonii*, *Spatholobus parviflora*, *Tiliacora acuminata*, *Ventilago denticulata*, *Cayratia auriculata*, *Combretum roxburghii*, *Millettia extensa*, *Anamirta cocculus*, *Smilax ovalifolia*, *Dioscorea oppositifolia*, *Holmskioldia sanguinea*, etc.

Epiphytes like *Pelatanthria insectifera*, *Vanda tessellata*, *V. testacea*, *Aerides multiflorum*, *Dendrobium crepidatum*, *Scindapsus officinalis* are common.

Some notable shrubby evergreens and perennial herbs making the undergrowth are *Leea compactiflora*, *L. indica*, *Flemingia chappar*, *F. stricta*, *Desmodium velutinum*, *D. motorium*, *Polygala chinensis*, *Colebrookia oppositifolia*, *Clerodendrum serratum*, *C. viscosum*, *Barleria strigosa*, *Ardisia solanacea*, *Psychotria denticulata*, *Ficus heterophylla*, *Costus speciosus*, *Scutellaria discolor*, *Callicarpa nudiflora*, *Premna latifolia*, *Justicia japonica*, *Lepidagathis incurva*, *Strobilanthus auriculatus*, *Hemidesmus indicus*, *Cryptolepis buchmanii*, *Lobelia alsinoides*, *Youngia japonica*, *Typhonium trilobatum*, *Uraria rufesens* etc.

II. GRASSLANDS

The grasslands are mainly induced Savanas with rare exceptions of natural climaxes. The grasses of the Gangetic plain occupy more area than that of plateaus on the south. Of this, a larger part constitutes low level grasslands and sometimes extend into swamps where grasses are tall perennials. Some dominant elements of low level type are *Saccharum procerum*, *S. spontanum*, *S. bengalense*, *Ophrus megaphyllus*, *O. exaltatus*.

Arundinella bengalensis, *Phragmites karka*, *Vetiveria zizanioides*, *Themeda arundinacea*, *Coix aquatica*, *C. gigantea*, etc.

The grasses on high level plains are relatively dwarf. The important constituents of this type are *Saccharum narenga*, *S. spontaneum*, *Eulalia fastigiata*, *Cymbopogon nardus*, *Chionachne koenigii*, *Chrysopogon aciculatus*, *C. montanus*, *Parpelidium flavidum*, *Themeda caudata*, *Puliculum articulatum*, *Amphilopsis glabra*, *Andropogon ascinodis*, etc. Some other plants scattered here and there are *Careya herbacea*, *Olax nana*, *Grewia sapida*, *Ochna obtusata* var. *pumila*, *Murdannia edulis*, etc.

Grasslands of southern plateaus are mainly induced. The predominant species are *Heteropogon contortus*, *Pennisetum pedicellatum*, *Chrysopogon lanceolaries*, *C. monticola*, *Iscilema laxum*, *Themeda quadrivalvis*, *T. laxa*, *Eulaleopsis pinata*, *Andropogon assimilis*, *Axonopus compressus*, *Arundinella setosa*, *Anthistiria gigantea*, *A. ciliata*, *Cymbopogon martinii*, and a few others.

III. AQUATIC AND SWAMP VEGETATION

A large number of rivers, rivulets, canals, ponds and ditches form an extensive network of wetlands of Bihar and support about 90 aquatic angiospermous species. Some widely distributed dominant species are mentioned here under their respective habitation category.

1. Non-Anchored Hydrophytes

(a) Free-floating Hydrophytes

Pistia stratiotes, *Lemna gibba*, *L. perpusilla*, *L. trisulca*, *Spirodela polyrhiza*, *S. punctata*, *Wolffia arrhiza*, *Trapa bispinosa*, *Nymphoides indica*, *N. hydrophyllum*, *Eichhornia crassipes*, etc.

(b) Submerged Hydrophytes

Ceratophyllum demersum, *Najas gramineae*, *N. marina*, *N. minor*, *Potamogeton pectinatus*, etc.

2. Anchored Hydrophytes

(a) Floating Hydrophytes

Nymphaea nouchali, *N. pubescens*, *Euryale ferox*, *Nelumbo nucifera*, *Aponogeton crispus*, *A. natans*, etc.

(b) Submerged Hydrophytes

Hydrilla verticillata, *Ottelia alismoides*, *Vallisneria spiralis*, *Potamogeton nodosus*, *Blyxa aubertii*, *B. echinosperma*, *B. octandra*, *Lagarosiphon alternifolia*, *Hydrocharis dubia*, *Utricularia aurea*, *U. exoleta*, *U. stellaris*, *Ruppia maritima*, (*Potamogeton nodosus*), *Zannichellia palustris*, etc

(c) Emergent Hydrophytes

Aeschynomene indica, *A. aspera*, *A. americana*, *Alisma plantago-aquatica*, *Caldesia oligococca*, *C. parnassifolia*, *C. reniformis*, *Lymnophyton obtusefolium*, *Sagittaria guayanensis* subsp. *lappula*, *S. trifolia*, *Butomopsis latifolia*, *Eriocaulon setacetum*, *Monocheria vaginqlis*, *M. hastata*, *Typha angustifolia*, *Neptunia triquetra*, *Limnophylla aquatica*, *L. heterophylla*, *L. indica*, *Coix aquatica*, *Paspalidium geminotum*, *Cyperus corymbosus*, *Oryza rufipogon*, etc.

(d) Marshy-Amphibious Hydrophytes

Ipomoea aquatica, *Polygonum barbatum*, *P. glabrum*, *P. hydropiper*, *Ludwigia adscendens*, *L. octavalvis*, *L. perennis*, *L. prostata*, *Bacopa monnieri*, *Lymnophila aromatica*, *L. chinensis*, *Hygrophila auriculata*, *Alternanthera philoxeroides*, *Enhydra fluctuans*, *Commelina benghalensis*, *Dopatrium junceum*, *Melochia corchorifolia*, *Corchorus aestuans*, etc.

FLORISTIC DIVERSITY

According to present estimate, the flora of Bihar comprises of about 2650 species of flowering plants distributed in 1108 genera and 189 families. Of the 2650 species, 1887 species belong to dicots and 736 species to monocots which constitute ca 15% and 17% of country's dicot and monocot species, respectively. Number of families, genera and species found in Bihar are given in (Table I).

Table I

	Division	India	Bihar	% in Bihar over India
Families	Dicot	210	151	71.9
	Monocot	44	38	86.36
	Total	264	189	71.59
Genera	Dicot	2281	852	37.35
	Monocot	705	256	36.31
	Total	2986	1,108	37.10
Species	Dicot	12543	1,887	15.04
	Monocot	4236	736	17.37
	Total	16779	2,623	15.63

Among dicots, largest number of species belong to family Leguminosae (297 species under 90 genera), followed by Asteraceae, Acanthaceae, Euphorbiaceae, Rubiaceae, Scrophulariaceae etc. On the other hand, Poaceae contributes largest number of species (320 species under 109 genera) among monocots, followed by Cyperaceae, Orchidaceae, Zingiberaceae etc. (Table II).

Table II

Name of the Family	Number of Species		% of species in Bihar
	Bihar	India	
Poaceae	320	1291	24.13
Leguminosae	297	1141	26.02
Asteraceae	129	803	16.06
Cyperaceae	108	545	19.81
Acanthaceae	91	500	18.20
Euphorbiaceae	87	523	16.63
Orchidaceae	83	1229	6.75
Rubiaceae	73	616	11.85

Name of the Family	Number of Species		% of species in Bihar
	Bihar	India	
Scrophulariaceae	61	368	16.57
Convolvulaceae (Including cuscutaceae)	54	199	27.13
Malvaceae	49	93	52.63
Verbenaceae	45	145	31.03

Twelve dominant families of Bihar on the basis of number of genera are given below (Table III).

Table III

Name of the family	Number of genera		% of genera in Bihar
	Bihar	India	
Poaceae	109	264	41.44
Leguminosae	90	167	52.02
Asteraceae	72	166	43.37
Acanthaceae	38	92	41.30
Rubiaceae	38	113	33.28
Euphorbiaceae	33	84	39.28
Orchidaceae	33	184	17.93
Scrophulariaceae	26	62	41.93
Asclepiadaceae	24	57	42.10
Apocynaceae	22	47	46.80
Verbenaceae	19	25	82.60
Cyperaceae	17	38	44.73

As generic level, the genus *Crotalaria* exhibits higher diversity with largest number of species (31 species) among dicots, followed by *Ficus*, *Euphorbia*, *Ipomoea* etc. On the otherhand, *Cyperus* includes a largest number of species (32 species) among monocot genera followed by *Fimbristylis*, *Eragrostis*, *Panicum*, etc. (Table IV).

Table IV

Name of the genus	Number of species		% of species in Bihar
	Bihar	India	
<i>Cyperus</i>	32	72	44.44
<i>Crotalaria</i>	31	104	29.30
<i>Ficus</i>	28	100	28.00
<i>Euphorbia</i>	26	130	20.00
<i>Ipomoea</i>	25	60	41.66
<i>Fimbristylis</i>	21	91	23.07
<i>Eragrostis</i>	20	36	55.55
<i>Cassia</i>	19	56	33.92
<i>Indigofera</i>	17	60	28.33
<i>Acacia</i>	17	94	18.08
<i>Desmodium</i>	15	47	31.91
<i>Lindernia</i>	15	27	55.55
<i>Vigna</i>	15	24	62.50
<i>Panicum</i>	15	35	42.85

A list of total number of angiospermic families along with their respective number of genera and species is given below (Table V).

Table V

Name of the family	No. of genera	No. of species
DICOTYLEDONS		
Ranunculaceae	5	14
Dilleniaceae	1	3
Magnoliaceae	2	2
Annonaceae	8	17
Menispermaceae	6	9
Berberidaceae	1	1
Nymphaeaceae	2	4
Nelumbonaceae	1	1

Name of the family	No. of genera	No. of species
Papaveraceae	2	2
Fumariaceae	1	1
Brassicaceae	14	25
Capparaceae	3	9
Violaceae	2	3
Bixaceae	1	1
Cochlospermaceae	1	1
Flacourtiaceae	4	6
Pittosporaceae	1	3
Polygalaceae	2	11
Caryophyllaceae	9	11
Portulacaceae	1	5
Tamaricaceae	1	3
Elatinaceae	1	2
Hypericaceae	1	3
Clusiaceae	4	5
Theaceae	1	1
Dipterocarpaceae	1	1
Malvaceae	15	49
Bombacaceae	3	3
Sterculiaceae	15	29
Tiliaceae	4	25
Elaeocarpaceae	1	4
Linaceae	2	2
Erythroxylaceae	1	1
Malpighiaceae	4	6
Zygophyllaceae	3	3
Tropaeolaceae	1	1
Oxalidaceae	2	7
Averrhoaceae	1	2
Balsaminaceae	1	1
Rutaceae	14	23
Simaroubaceae	1	1

Name of the family	No. of genera	No. of species
Balanitaceae	1	1
Ochnaceae	1	1
Burseraceae	5	6
Meliaceae	14	16
Olacaceae	1	1
Ophiliaceae	2	2
Icacinaceae	1	1
Aquifoliaceae	1	1
Celastraceae	3	4
Siphonodontaceae	1	1
Rhamnaceae	5	10
Vitaceae	5	16
Leeaceae	1	5
Sapindaceae	8	10
Staphyleaceae	1	1
Sabiaceae	2	2
Anacardiaceae	7	7
Moringaceae	1	1
Leguminosae	90	297
(a) Papilionoideae	63	211
(b) Caesalpinioideae	14	47
(c) Mimosoideae	13	39
Rosaceae	8	19
Vahliaceae	1	2
Crassulaceae	1	3
Droseraceae	1	3
Haloragaceae	1	2
Callitrichaceae	1	1
Rhizophoraceae	5	6
Combretaceae	6	17
Myrtaceae	7	24
Barringtoniaceae	1	2
Lecythidaceae	2	3

Name of the family	No. of genera	No. of species
Memecylaceae	1	1
Melastomataceae	3	8
Lythraceae	5	18
Sonneratiaceae	1	2
Punicaceae	1	1
Onagraceae	1	5
Trapaceae	1	1
Turneraceae	1	1
Passifloraceae	1	3
Caricaceae	1	1
Cucurbitaceae	14	29
Begoniaceae	1	2
Cactaceae	4	7
Aizoaceae	1	1
Molluginaceae	2	3
Apiaceae	15	22
Araliaceae	3	3
Cornaceae	1	1
Alangiaceae	1	2
Sambucaceae	1	1
Rubiaceae	38	73
Asteraceae	72	129
Stylidiaceae	1	2
Campanulaceae	2	5
Sphenocleaceae	2	5
Vacciniaceae	1	1
Plumbaginaceae	2	4
Primulaceae	3	5
Myrsinaceae	4	6
Theophrastaceae	1	1
Sapotaceae	5	5
Ebenaceae	5	12
Styraceae	1	1

Name of the family	No. of genera	No. of species
Symplocaceae	1	2
Oleaceae	3	14
Salvadoraceae	2	2
Apocynaceae	22	34
Asclepiadaceae	24	39
Loganiaceae	3	5
Buddlejaceae	1	2
Gentianaceae	5	10
Menyanthaceae	1	2
Polemoniaceae	2	2
Hydrophyllaceae	1	1
Boraginaceae	8	21
Convolvulaceae	13	54
Cuscutaceae	1	2
Solanaceae	10	33
Scrophulariaceae	26	61
Orobanchaceae	2	4
Lentibulariaceae	1	10
Gesneriaceae	6	6
Bignoniaceae	16	28
Pedaliaceae	3	4
Acanthaceae	38	91
Verbenaceae	19	45
Avicenniaceae	10	21
Lamiaceae	14	34
Plantaginaceae	1	3
Nyctaginaceae	4	5
Amaranthaceae	12	29
Chenopodiaceae	4	7
Basellaceae	1	1
Phytolaccaceae	1	1
Polygonaceae	7	16
Aristolochiaceae	1	4

Name of the family	No. of genera	No. of species
Piperaceae	2	7
Lauraceae	5	8
Proteaceae	1	1
Elaeagnaceae	1	1
Loranthaceae	3	3
Santalaceae	1	1
Euphorbiaceae	33	87
Urticaceae	8	12
Ulmaceae	3	6
Cannabinaceae	1	1
Moraceae	5	37
Casuarinaceae	1	1
Salicaceae	1	1
Ceratophyllaceae	1	1
MONOCOTYLEDONS		
Hydrocharitaceae	6	8
Burmonniaceae	1	2
Orchidaceae	33	83
Zingiberaceae	9	38
Costaceae	1	1
Marantaceae	3	4
Musaceae	1	2
Strelitziaceae	1	1
Cannaceae	1	1
Iridaceae	1	1
Amaryllidaceae	3	6
Hypoxidaceae	2	2
Agavaceae	4	10
Taccaceae	1	1
Dioscoreaceae	1	13
Stemonaceae	1	1
Alliaceae	1	6

Name of the family	No. of genera	No. of species
Liliaceae	8	12
Smilacaceae	1	4
Pontederiaceae	2	3
Xyridaceae	1	3
Commelinaceae	5	16
Flagellariaceae	1	1
Juncaceae	1	2
Arecaceae	10	17
Pandanaceae	1	2
Typhaceae	1	2
Araceae	15	24
Lemnaceae	3	6
Allismataceae	4	7
Limnocharitaceae	1	1
Najadaceae	2	7
Aponogetonaceae	1	2
Potamogetonaceae	1	6
Zannichelliaceae	1	1
Eriocaulaceae	1	12
Cyperaceae	17	108
Poaceae	109	320

PHYTOGEOGRAPHICAL AFFINITIES

The state is partly situated between the Sivalik range of Himalaya on the north-west, Eastern Ghats and the Deccan plateau on the south-west and with transverse terminals of Vindhyan series on the extreme west. The northern major half and southern half of the state fall into Gangetic plain and Deccan plateau phytogeographical regions of India, respectively. While the northern districts of the state exhibit greater admixture of temperate species, the southern plateaus possess many elements of Eastern Ghats and Deccan plateau. The occurrence of some Himalayan elements on high hills of Chotanagpur and some Deccan elements in northern districts made Haines (1922) to consider high hills of Chotanagpur as the 'stepping stones' for the migration of species from

Himalaya to Peninsular India and vice-versa. A number of xeric and semi-xeric species of drier parts of the state are also found common in isoclimatic western semi-arid region of India. Besides, the flora of the state as a whole shows some affinities with other phytogeographic regions of the country as given below.

Some species common with Eastern India

Alphansea ventricosa, Clematis gouriana, Thalictrum foliolosum, Desmos longiflorus, D. chinensis, Fissistigma polyanthum, Thlaspi arvense, Crateva magna, Xylosma longifolia, Pittosporum napaulense, Hypericum japonicum, Aspidopterys indica, Trichilia connaroides, Eriosema himalaicum, Garcinia xanthochymus, Elaeocarpus sphaericus, Acronychia pedunculata, Clausena excavata, Spondias pinnata, Desmodium triquetrum, Homalium napaulense, etc.

Some species common with Western Himalaya

Clematis roylei, Thalictrum foliolosum, Cissampelos pereira, Barberis asiatica, Euryle ferox, Pittosporum napaulense, Hypericum japonicum, Flemingia strosilifera, Erythrina suberosa, Rosa brunonii, Osbeckia nepalensis, Woodfordia fruticosa, Gnaphalium affine, Inula cappa, Jasminum multiflorum, Buddleja asiatica, Veronica-anagallis aquatica, Rhynchoglossum obliquum, Ficus palmata, Eulophia dubia, Sagittaria trifolia, etc.

Some species common with Eastern Himalaya

Salix tetrasperma, Celtis tetrandra, Ficus squamosa, Artocarpus chama, Morus australis, Olax nana, Rumex nepalensis, Stellaria media, Amaranthus viridis, Miliusa longiflora, Litsea glutinosa, Berberis asiatica, Piper pepuloides, Woodfordia fruticosa, Milleitia extensa, Smithia ciliata, Euphorbia thymifolia, Globba multiflora, Bulbostylis barbata, Cyperus niveus, etc.

Some species common with Western Ghats

Anamirta cocclus, Tinospora sinensis, Hybanthus enneaspermus, Polygala elongata, Abutilon persicum, Hibiscus aculeatus, Crotalaria mysorensis, C. hirsuta, Bauhinia malabarica, Thunbergia alata, Strychnos nux-vomica, Canscora diffusa, Ficus auriculata, F. nervosa, Eriocaulon

quinquangulare, *Fimbristylis aestivalis*, *Panicum paludosum*, *Phrynium placentarium*, *Alpinia malaccensis*, *Smilax perfoliata*, *Acampe praemorsa*, *Goodyera procera*, etc.

Some species common with Western Dry region

Miltusa tomentosa, *Cocculus hirsutus*, *Argemone mexicana*, *Cleome chelidonii*, *Capparis spinosa*, *C. zeyanica*, *Tamarix ericoides*, *Aegle marmelos*, *Naringi crenulata*, *Balanites aegyptiaca*, *Ziziphus mauritiana*, *Alysicarpus hamosus*, *Crotalaria hirsuta*, *Indigofera cordifolia*, *Tephrosia purpurea*, *Caesalpinia decapetala*, *Cassia auriculata*, *Acacia catechu*, *A. modesta*, *A. torta*, *Mimosa himalayana*, *Kalanchoe pinnata*, *Blumea eriantha*, *Blepharis repens*, *Cyperus compressus*, *Acrachne racemosa*, *Apluda mutica*, *Aristida setacea*, etc.

Some species common with Andaman and Nicobar Islands

Dillenia aurea, *Capparis zeylanica*, *Cleome rutidospermum*, *Rinorea heteroclita*, *Polygala longifolia*, *Garcinia cowa*, *Mesua ferrea*, *Byttneria grandifolia*, *Firmina colorata*, *Pterigota alata*, *Sterculia villosa*, *Brownlowia tersa*, *Grewia serrulata*, *Elaeocarpus tectorius*

Some species common with Eastern Ghats

Ziziphus xylopyrus, *Vitex negundo*, *Hibiscus micranthus*, *Cardiospermum helicacabum*, *Bauhinia racemosa*, *Abrus precatorius*, *Indigofera cordifolia*, *Crotalaria medicaginea*, *Euphorbia antiquorum*, *Grewia rotundifolia*, *Waltheria indica*, *Olax nana*, *Albizia thomsonii*, *Protulaca oleracea*, *Alocasia montana*.

Besides these the state possess of a number of species which show affinities with phytogeographic region outside India. Some of them are as follows

Some species common with Malaysian region

Dillenia pentagyna, *Viola betonicifolia*, *Cochlospermum religiosum*, *Polygala linarifolia*, *Oxalis corniculata*, *Biophytum reinwardtii*, *Hybanthus enneaspermus*, *Bergia ammannioides*, *Hypericum japonicum*, *Hibiscus radiatus*, *Pavonia repanda*, *Brownlowia tersa*, *Grewia abutilifolia*, *Leea*

indica, Tacca lenotopetaloides, Hypolytrum nemorum, Porana paniculata, Celosia argentea, Eleocharis congesta, Fimbristylis sericea

Some species common with tropical Africa

Cocculus hirsutus, cleome rutidospermum, Hybanthus enneaspermus, Flacourtia indica, Polygala crioptera, P. persicariifolia, Polycarpon prostratum, Bergia ammannioides, Abelmoschus ficulneus, Hibiscus aculeatus, Pavonia odorata, Urena lobata, Sterculia foetida, Grewia damine, G. rothii, G. serrulata, Plumbago zeylanica, Tamarindus indica, Indigofera linnaei, Chloris barbata

Some species common with tropical America

Argemone mexicana, Thlaspi arvense, Coronopus didymus, Bixa orellana, Corchorus aestuans, Cassia tora, C. occidentalis, Leucaena leucocephala, Hybanthus enneaspermus, Guazuma ulmifolia, Protulaca pilosa, Malachra capitata, Heliotropium indicum, Volulopsis nummularia, Datura metel, Nicotiana plumbaginifolia, Martynia annua, Ruellia tuberosa, Alternanthera pungens, Gomphrena celosioides.

Some species common with Europe

Fumaria indica, Protulaca oleracea, Lepidium sativum, Eruca sativa, Spergula arvensis, Stellaria media, Coronopus didymus, Vaccaria pyramidata, Oxalis corniculata, Medicago lupulina, M. polymorpha, Melilotus alba, Vicia hirsuta, V. sativa, Sonchus oleraceus, Anagallis arvensis, Convolvulus arvensis, Polypogon monspeliensis, Sorghum halepense, etc.

MEDICINAL PLANTS

About 200 well-known medicinal plant species are found in Bihar. The medicinal properties and parts used of a plant vary from species to species. In some cases the entire plant is used whereas in other cases different parts of the plant such as leaves, flowers, fruits, roots, bark, etc., are only used. In addition to these well known medicinal plants, a number of other species are used as medicine by different ethnic groups of Bihar in their traditional system of medicine. A list of such species along with their non-conventional use are given in the following table.

Name of the species	Part used	Diseases
<i>Andrachne cordifolia</i> (Euphorbiaceae)	Root	Rheumatism
<i>Aloe barbadensis</i> (Liliaceae)	Leaf pulp	Contraceptive
<i>Alangium salviifolium</i> (Alangiaceae)	Stem-bark	Abortion and menstrual disorders
<i>Argemone mexicana</i> (Papaveraceae)	Leaf	Boiles, blisters and ulcers
<i>Buchanania canzan</i> (Anacardiaceae)	Stem-bark	Cuts, wounds and burns
<i>Bauhinia acuminata</i> (Caesaplinoideae)	Stem-bark	Antidote to snake bite and scorpion sting
<i>Bridelia crenlata</i> (Euphorbiaceae)	Root	Bone fracture
<i>Buddleja asiatica</i> (Buddlejaceae)	Leaf	Gastric disorder
<i>Caesulia axillaris</i> (Asteraceae)	Leaf	Goitre
<i>Cajanus scarabaeoides</i> (Papilionoideae)	Root	Rheumatism
<i>Canscora diffusa</i> (Gentianaceae)	Plants	Headaches
<i>Cassine glaucas</i> (Celastraceae)	Stem-bark	Gastric - disorders, epilepsy and hysteria
<i>Celastrus paniculatus</i> (Celastraceae)	Seed	Tuberculosis
<i>Clausena excavata</i> (Rutaceae)	Root	Dysentery
<i>Croton roxburghii</i> (Euphorbiaceae)	Root	Malaria
<i>Dendrophoe falcata</i> (Loranthaceae)	Leaf and stem	Antifertility

Name of the species	Part used	Diseases
<i>Desmodium motorium</i> (Papilionoideae)	Root	Vomiting, dysentery and cholera
<i>Diplocyclos palmatus</i> (Cucurbitaceae)	Leaf	Ophthalmic infections
<i>Eclipta prostrata</i> (Asteraceae)	Whole Plant	Insanity, malaria
<i>Elytrophorus spicatus</i> (Poaceae)	Whole plant	Gastric disorders
<i>Euphorbia tirucalli</i> (Euphorbiaceae)	Whole plant	Bone - fractures
<i>Flemingia strobilifera</i> (Papilionoideae)	Root	Obesity, sexually transmitted diseases
<i>Gardenia turgida</i> (Rubiaceae)	Root	Jaundice, giddiness abortifacient
<i>Gnephalium polycanlon</i> (Asteraceae)	Whole plant	Gastric disorders
<i>Gmelina arborea</i> (Verbenaceae)	Root	Malaria fever
<i>Hoppea dichotoma</i> (Gentianaceae)	Whole plant	Bone fractures
<i>Indigofera linnaei</i> (Papilionoideae)	Root	Antifertility
<i>Leonotis nepetaefolia</i> (Lamiaceae)	Flower and seed	Cut, wound and burn
<i>Ludwigia hyssopifolia</i> (Onagraceae)	Root	Abortion and menstrual disorders
<i>Mallotus philippensis</i> (Euphorbiaceae)	Seed	Boils, blisters and ulcers
<i>Micromeria capitellata</i> (Lamiaceae)	Whole plant	Rheumatic pains
<i>Millettia extensa</i> (Papilionoideae)	Root	Vermicide

Name of the species	Part used	Diseases
<i>Ochna obtusata</i> var. <i>pumila</i> (Ochnaceae)	Root	Miscarriage and threatened abortion
<i>Oroxylum indicum</i> (Bignoniaceae)	Bark	Morning sickness.
<i>Plectranthus mollis</i> (Lamiaceae)	Leaf	Snake - bite
<i>Plumbago zeylanica</i> (Plumbaginaceae)	Root	Antifertility
<i>Pygmaeopremna herbacea</i> (Verbenaceae)	Whole plant	Leucorrhoea
<i>Rotala densiflora</i> (Lythraceae)	Twig	Deafness
<i>Senecio nudicaulis</i> (Asteraceae)	Root	Antiinflammatory agents.
<i>Soymida febrifuga</i> (Meliaceae)	Stem-bark	Gonorrhoea
<i>Sphaeranthus senegalensis</i> (Asteraceae)	Flower	Eye-pains, night- blindness and asthma
<i>Stephania glabra</i> (Menispermaceae)	Root	Elephantiasis
<i>Taxillus tomentosus</i> (Loranthaceae)	Leaf	Malaria and fevers
<i>Trichosanthes tricuspidata</i> (Cucurbitaceae)	Root	Oedema
<i>Pentanema indicum</i> (Asteraceae)	Root	Antifertility

ENDEMISM

There are only 11 endemic species known from Bihar (Table VI). Besides these, some species are found to be endemic to Bihar and its adjoining states / country (Table VII).

Table VI
Endemic Plants of Bihar

Name of the species	Family
<i>Carum villosum</i>	Apiaceae
<i>Ligusticum albo - alatum</i>	Poaceae
<i>Clematis roylei</i> var. <i>patens</i>	Ranunculaceae
<i>Sophora bakeri</i>	Papilionoideae
<i>Agrostis brachiata</i>	Poaceae
<i>Chrysopogon hamiltonii</i>	Poaceae
<i>Dendrocalamus sericeus</i>	Poaceae
<i>Dimeria ornithopoda</i>	Poaceae
var. <i>gracillima</i>	
<i>Indochloa clarkei</i>	Poaceae
<i>Iseilema holei</i>	Poaceae
<i>Lophopogon kingii</i>	Poaceae

Table VII
Endemic Plants of Bihar and adjoining areas

Name of the species	Distribution
<i>Crotalaria pusilla</i> (Papilionoideae)	Endemic to Western Peninsula, Bihar
<i>C. quinquefolia</i> (Papilionoideae)	Endemic to Western Peninsula, Bihar
<i>C. globosa</i> (Papilionoideae)	Bihar, Karnataka, Tamilnadu
<i>C. topouensis</i> (Papilionoideae)	South India, Bihar
<i>C. filipes</i> var. <i>trichophora</i>	Bihar, Maharashtra, W.B.
<i>Desmodium benthamii</i> (Papilionoideae)	Andhra Pradesh, Bihar, M.P., W.B., Maharashtra, Tamilnadu.
<i>Acacia pennata</i> ssp. <i>pennata</i> var. <i>carlescens</i> (Mimosoideae)	Bihar, Sikkim

Name of the species	Distribution
<i>Derris hainensiana</i> (Papilionoideae)	Bihar, Nepal
<i>Acacia pseudo-eburenea</i> (Mimosoideae)	Bihar, NW India, U.P.
<i>Erythrina resupinata</i> (Papilionoideae)	Bihar, Orissa, U.P.
<i>Alysicarpus roxburghianum</i> (Papilionoideae)	Peninsula, Bihar, Orissa, U.P., Rajasthan
<i>Albizia thompsonii</i> var. <i>galbana</i> (Mimosoideae)	Bihar, Orissa
<i>Crotalaria prostrata</i> var. <i>levis</i> (Papilionoideae)	Bihar, Myanmar
<i>Hardwickia binata</i> . (Caesalpinioideae)	Bihar, Peninsula, C. India, Delhi, Rajasthan, U.P.
<i>Pterocarpus marsupium</i> var. <i>acuminata</i> (Papilionoideae)	Bihar, Gujrat, Karnataka, Maharashtra, Rajasthan
<i>Apocopsis vaginata</i> (Poaceae)	A.P., Bihar, M.P., U.P.
<i>Chrysopogon lancearius</i> (Poaceae)	Bihar, Sikkim
<i>Cymbopogon giberba</i> (Poaceae)	Peninsular India, Bihar, W.B. to E. Himalayas.
<i>Dimeria connibens</i> (Poaceae)	Bihar, Orissa
<i>Eragrostiella brachyphylla</i> (Poaceae)	Peninsular India to Bengal, Bihar
<i>E. nardoides</i> (Poaceae)	Bihar to Himalayas
<i>Ischaemum duthiei</i> (Poaceae)	Bengal, Bihar, M.P.
<i>I. hirtum</i> (Poaceae)	Bihar, Bengal to Meghalaya
<i>Manisuris clarkii</i> (Poaceae)	Peninsular India up to Bihar, Gujrat, M.P.
<i>Pseudoraphis minuta</i> (Poaceae)	Assam, Bihar, W.B.

Name of the species	Distribution
<i>Themeda strigosa</i> (Poaceae)	Assam, Bihar, Maharashtra, W.B.
<i>Tripogon capillatus</i> (Poaceae)	Western ghats in Kerala and Karnataka to Bihar.

RARE PLANTS

There are about 250 species which are rare in the area and need to be conserved. A list of some species is given below

<i>Abrus pulchellus</i>	Papilionoideae
<i>Agrostis brachiata</i>	Poaceae
<i>Aglaia elaeagnoidea</i>	Meliaceae
<i>Alysicarpus pubescens</i>	Papilionoideae
<i>A. hamosus</i>	Papilionoideae
<i>Aristida funiculata</i>	Poaceae
<i>Atalantia monophylla</i>	Rutaceae
<i>Barberis asiatica</i>	Barberidaceae
<i>Beilschmiedia dalzelli</i>	Lauraceae
<i>Brachiaria kurzii</i>	Poaceae
<i>Canavalia gladiata</i>	Papilionoideae
<i>Caryopteris wallichiana</i>	Verbenaceae
<i>Chloris montana</i>	Poaceae
<i>Chrysopogon lancearius</i>	Poaceae
<i>Coelachne simpliciuscula</i>	Poaceae
<i>Coix aquatica</i>	Poaceae
<i>Cotula hemispherica</i>	Asteraceae
<i>Crotalaria acicularias</i>	Papilionoideae
<i>C. angulata</i>	Papilionoideae
<i>Clematis gouriana</i>	Ranunculaceae
<i>Commelina appendiculata</i>	Commelinaceae
<i>Cynodon arcuatus</i>	Poaceae
<i>C. barberi</i>	Poaceae

<i>Dendrobium crepidatum</i>	Orchidaceae
<i>D. formosum</i>	Orchidaceae
<i>Derris cuneifolia</i>	Papilionoideae
<i>Dichanthium foveolatum</i>	Poaceae
<i>Dimeria ornithopoda</i>	Poaceae
<i>Dinebra retroflexa</i>	Poaceae
<i>Diploknema butyracea</i>	Sapotaceae
<i>Drosera indica</i>	Droseraceae
<i>Epilobium angustifolium</i>	Onagraceae
<i>Eriocaulon pumilio</i>	Eriocaulaceae
<i>Eriolaena stocksii</i>	Eriocaulaceae
<i>Erythrina fusca</i>	Papilionoideae
<i>Galactia tenuiflora</i>	Papilionoideae
<i>Garnotia tenella</i>	Poaceae
<i>Glossogyne bidens</i>	Asteraceae
<i>Hedychium thyriforme</i>	Zingiberaceae
<i>Hymenachne pseudo-interrupta</i>	Poaceae
<i>Hyptianthera stricta</i>	Rubiaceae
<i>Indochloa clarkei</i>	Poaceae
<i>Ischaemum indicum</i> var. <i>indicum</i> sub. var. <i>malacophyllum</i> .	Poaceae
<i>Iseilema laxum</i>	Poaceae
<i>Kingidium decumbens</i>	Orchidaceae
<i>Linociera ramiflora</i>	Oleaceae
<i>Leea alata</i>	Leaceae
<i>Mallotus roxburghianus</i>	Euphorbiaceae
<i>Maytenus senegalensis</i>	Celastraceae
<i>Meizotropis buteformis</i>	Papilionoideae
<i>Melanocenchris jacquemontii</i>	Poaceae
<i>Microstegium ciliatum</i>	Poaceae
<i>Mnesithea leavis</i>	Poaceae
<i>Murdannia blumei</i>	Commelinaceae
<i>Narenga porphyrocoma</i>	Poaceae
<i>Orobanche cernua</i>	Orobanchaceae
<i>Oropetium thomaeum</i>	Poaceae

<i>Panicum antidotale</i>	Poaceae
<i>Paracalyx scariosus</i>	Papilionoideae
<i>Pseudopogonatherum contortum</i>	Poaceae
<i>Pseudoraphis brunoniana</i>	Poaceae
<i>Pterocarpus indicus</i>	Papilionoideae
<i>Pycnocycla glauca</i>	Apiaceae
<i>Ranunculus pensylvanicus</i>	Ranunculaceae
<i>Rhynchosia canna</i>	Papilionoideae
<i>R. bracteata</i>	Papilionoideae
<i>Rubus mollucana</i>	Rosaceae
<i>Salix tetrasperma</i>	Salicaceae
<i>Schoenefeldia gracilis</i>	Poaceae
<i>Sehima nervosum</i>	Poaceae
<i>Symphorema involucratum</i>	Symphoremataceae
<i>Tacca leontopetaloides</i>	Taccaceae
<i>Tragus roxburghii</i>	Poaceae
<i>Thallictrum foliolosum</i>	Ranunculaceae
<i>Turnera ulmifolia</i>	Turneraceae
<i>Tripogon capillatus</i>	Poaceae
<i>Viola patrinii</i>	Violaceae

CONSERVATION STRATEGIES

Bihar is rich in species diversity and this diversity is continuously declining on account of various developmental activities, like mining operations for her rich coal and mineral deposits, industrialization, urbanisation, etc. Expansion of agricultural land, biotic interferences and other socio-economic factors also lead to the depletion of natural habitats.

Recently, encouraging steps have been taken to protect further depletion of vegetation in the state by declaring an area of 4450 sq km under two National Parks and 19 Wild life Sanctuaries. Besides, a few following measures have been suggested.

Declaration of a number of more protected areas in diversity-rich zones like Champaran, Ranchi, West Singhbhum, Godda, Chaibasa, etc.

Establishment of Botanic gardens for *ex situ* conservation of plant diversity of the state.

Encouragement of cultivation of well-known and less-known economically (including medicinal plants) potential plants to check their destruction from natural habitat.

Effective land management programmes aimed for regeneration and reclamation of areas effected by mining operations, power projects, etc.

Establishment of field gene banks, seed banks, and *in-vitro* storage system in different diversity-rich reserve-forest.

Appropriate legislative mechanism for sustenance of rare, threatened and endangered species.

Substitution of traditional tourism by eco-tourism to stop irreversible damage to the natural environment.

Involvement of local population in forest management and imparting of environmental awareness for integrated development of the Flora *vis-a-vis* local populace.

Encouragement for study and survey by different research- institutions and universities for documentation of flora and to collect data on different ecological aspects.

REFERENCES

- Ahmedullah, M. and M.P. Nayar 1986. *Endemic plants of the Indian region*. Vol. 1. Botanical survey of India. Calcutta.
- Anderson, T. 1863. On the flora of Bihar and the mountains of Parasnath with a list of species collected by Messrs Hooker, Edgeworth, Thomson and Anderson. *J. Asiat. Soc. Bengal* **32**: 187-218.
- Banerjee, S.P. and R.N. Banerjee 1969. A sketch of the vegetation of Champaran district of North Bihar. *Bull. Bot. Soc. Bengal* **23**: 167-170.
- Biswas, D.K. and J.K. Maheshwari 1980. A contribution to the vegetation of Chaibasa, Singhbhum District in South Bihar. *Bull. Bot. Soc. Bengal* **25** (1 and 2): 43 - 51.
- Bressers, J. 1951. *Botany of Ranchi district*. Ranchi.
- Clarke, C.B. 1884. Notes on the Flora of Parasnath, N.W. Bengal. *J. Linn. Soc.* **35**: 245-247.
- Haines, H.H. 1910. *A forest flora of Chotanagpur including Gangpur and Santalparganahs*. Calcutta.
- Haines, H.H. 1921. *The Botany of Bihar and Orissa*. London.
- Hooker, J.D. 1872. *Flora of British India*. Vols. 1-7. London.
- Kanodia, K.C. and K.C. Malick 1966. New Plant records and critical notes on some plants from south Bihar. *Indain For.* **92**: 707-708.
- Mukerjee, S.K. 1947. A Botanical tour in Chotanagpur. *Bull. Bot. Soc. Bengal* **1**: 27-28.
- Mooney, H.F. 1950. *Supplement to the Botany of Bihar and Orissa*. Ranchi.
- Panigrahi, G. 1966. A botanical tour in the Rajmahal hills of Bihar. *Bull. Bot. Surv. India.* **8**(1): 1-15.

- Paul, S.R. 1973. On the Aquatic and Marsh Flora of Monghy, Bihar. *Botanique*. 4: 143-152.
- Singh, M.P. 1986. *Flora of Patna (Dicotyledones)*. New Delhi.
- Subramanyam, K. 1962. *Aquatic Angiosperms*. C.S.I.R. New Delhi.
- Thomson, T. 1917. The Botany of Parasnath hills. *Hazaribagh district Gazetteer*. Calcutta.
- Thothathri, K. A 1965. Contribution on some plants from Champaran district, North Bihar. *Ind. For.* 91: 743-746.
- Verma, S.K. 1981. *Flora of Bhagalpur*. Today and Tomorrow Printers and Publishers, New Delhi.
- Wood, J.J. 1902. Plants of Chutia Nagpur, including Jaspur and Sirguja. *Rec. Bot. Surv. India* 2 (1): 1-170.



Butea monosperma in bloom
(Courtesy : P.K. Hajra)



Acacia farnesiana
Inset : Pods and Flowers



Allium cepa under cultivation
(Courtesy : P.K. Hajra)



Desmodium velutinum



Caesalpinia digyna



Gregarious growth of *Ranunculus sceleratus* in marshy places
(Courtesy : P.K. Hajra)



Pandanus odoratissimus
(Courtesy : P.K. Hajra)



Mining operation by the side of Saranda forest



Erianthus munja cultivated for thatching.
(Courtesy : P.K. Hajra)



A pond near cultivated field covered with *Eichhornia crassipes*
(Courtesy : P.K. Hajra)



Agave americana : planted as hedge
(Courtesy : P.K. Hajra)



Chirita hamosa : a curious little plant of Netarhat plateau

CHANDIGARH

Bipin Balodi
J.R. Sharma
B.P. Uniyal

Le Corbusier's "City Beautiful" Chandigarh is probably the only city in the world that was first planned and then built. The city has derived its name from the ancient temple of the Hindu diety "Chandi" the Goddess of power. The suffix GARH means a fort. Chandigarh is situated about 10 km from the temple and because of its beauty, sorroundings, parks and buildings it has earned for itself the acronym of the "City beautiful". The construction of the city began in 1952 as a capital of the then Punjab state. After carving out the states of Haryana and Himachal Pradesh under the reorganisation of Punjab state in 1966, this city was given the status of a union territory.

This modern city with an area of *ca* 114 sq km lying at 30°44' N latitude and 76° 53' E longitude, falls at the foot of Siwalik range near Kasauli hills of N.W. Himalaya. The average altitude of the city is 230 m in its North and 347 m in the South, thus, showing a gradual slope from North to South. Chandigarh is surrounded by catchment area of "Sukhna lake-choe" in the east and is delimited by "Patiali Rao" on the north-western side.

The major area is dry flat land. The surface soil is predominantly sandy-loam. The underlying strata consist of interbedded clay and sand up to the depth of 2.3 m. At some places, boulders and gravel have been intercalated between these beds. The area surrounding Chandigarh is an essentially fertile agricultural tract. The topography of the area has undergone a sea change during the past 40 years or so. Earlier, entire area was dotted with ponds of various sizes. These used to serve as the water source for villagers. After the building of capital complex all ponds, wells, watersheds etc. were filled up resulting in complete wiping of these natural water sources and their dependent flora and fauna.

Chandigarh enjoys the general climatic pattern of most of the tropical N.W. Himalayan cities. The winters (November to February) are very cold with sporadic rains and temperature dropping to 1°C. January is the coldest month. The spring and autumn are pleasant. The summer are dry

(March to June) with temperature rising as high as 43°C. The hot and dry summer is followed by rainy season (July to mid September) with hot and humid weather ranging from 85-110 cm. Maximum rainfall (75%) occurs in July-August. September has the maximum daily relative humidity while April has the minimum relative humidity. Scattered rains may also occur from March to May.

The area belongs to the Pinjore stage of Upper Siwalik. It consists of an alternating series of sandrock and clay. The sandrock contains scattered pebbles at places, but towards the top of the stage it becomes definitely conglomerate and includes thin bands of cobble and boulder beds. The uppermost bed of the upper Siwaliks of the area consists almost entirely of thick boulder beds, the boulders being mostly of Tertiary sandstone. Brownish loamy-clay is often interbedded with the boulders bed.

As regards the botanical explorations of Chandigarh, no specific information is available, though most of the plants of the area have been recorded and described in various Floras and botanical reports dealing with the plants of Punjab state and adjoining areas by Aitchison (1869); Powell (1868-1872); Stewart (1869); Coventry (1901); Collett (1902); Duthie (1903-1929); Sabnis (1940); Bamber (1916); Parker (1924); Kashyap and Joshi (1936); Ahmed (1954); Raizada, Bharadwaja and Jain (1957) and Maheshwari (1963). About 1200 species of the angiosperms distributed under 500 genera including exotics, have been reported so far from Chandigarh. Punjab university took to the task of exploring Chandigarh and brought out information on the plant wealth of Chandigarh through several publications like Sharma and Sharma (1966, 67, 68) Khullar and Sharma (1991b); Nair (1966); Sharma (1988); Sharma and Khosla (1989); Mangal and Sharma (1993); Mangal, Khullar and Sharma (1995) and Mangal, Sharma and Kullar 1996 (in press).

VEGETATION

Since the city was constructed according to a plan, it obviously had scope for avenues, parks, gardens, traffic squares, etc. Introduced plants therefore constitute major share of vegetation within the city. Avenues of pure as well as mixed tree species are a common sight in Chandigarh. These tree species include *Barringtonia acutangula*, *Bischofia javanica*, *Haplophragma adenophyllum*, *Millingtonia hortensis*, *Alstonia scholaris*,

Cassia spp., *Jacaranda mimosifolia*, *Koelreuteria apiculata*, *Sweitenia macrophylla*, *Azadirachta indica*, *Kigelia pinnata*, *Acacia auriculiformis*, *Schleichera oleosa*, *Ficus infectoria*, *Polyalthia longifolia*, *Chorisia speciosa*, *Chuckrasia tabularis*, *Hibiscus tiliaceus*, etc. Other plants usually employed for beautification are *Holmskioldia sanguinea*, *Tecoma stans*, *Lantana indica*, *Caesalpinia pulcherrima*, *Nerium odorum*, *Thevetia neriifolia*, *Monstera deliciosa*, *Philodendron giganteum*, *Adenocalymma alliaceum*, *Tecomella undulata*, etc.

The wild flora is mostly represented by scrubs and weeds. The few tree species present belong to *Acacia catechu*, *A. modesta*, *Wendlandia heynei*, *Pithecellobium dulce*, *Dalbergia sissoo*, *Melia azedarach*, *Flacourtia indica*, *Syzygium cumini*, *Morus* spp., *Albizia lebbek*, *Cassia fistula*, etc. with shrubby species like *Ziziphus mauritiana*, *Capparis sepiaria*, *Carissa spinarum*, *Dodonaea viscosa*, *Murraya koenigii*, *Ricinus communis*, *Grewia tenex*, *Adhatoda vasica*, *Tamarix* sp. and herbaceous elements like *Alysicarpus vaginalis*, *Indigofera linifolia*, *I. linnaei*, *Malvastrum coromandelianum*, *Pupalia lappacea*, *Ageratum conyzoides*, *Rivina humilis*, *Euphorbia hirta*, *Alternanthera pungens*, *Cleome gynandra*, *Tridax procumbens*, *Vernonia cinerea*, *Boerhavia diffusa*, *Heliotropium strigosum*, *Sida* spp. etc. *Cynodon dactylon*, *Bothriochloa pertusa*, *Dichanthium annulatum*, *Apluda mutica*, *Cenchrus pennisetiformis*, *Saccharum bengalense*, *Phragmites karka*, *Heteropogon contortus*, etc. are some of the common grasses in and around Chandigarh.

The climbers and trailers are mainly represented by *Diplocyclos palmatus*, *Cardiospermum halicacabum*, *Cissampelos pareira*, *Atylosia platycarpa*, *Pergularia daemia*, *Rhynchosia capitata*, *Coccinia grandis*, *Oxystelma esculentum*, *Ipomoea eriocarpa*, *I. nil*, etc. The commonly occurring parasites like *Cuscuta reflexa* and *Dendrophthoe falcata* are common here also. The marshy and aquatic vegetation too is well represented by *Hydrilla verticillata*, *Ceratophyllum demersum*, *Bacopa monnieri*, *Typha angustata*, *Eichhornia crassipes*, *Potamogeton* spp. etc. *Ranunculus trichophyllus*, a temperate aquatic, has also been reported from Chandigarh. (Table I)

DIVERSITY

The wild flora of Chandigarh comprises 574 species of flowering plants distributed in 286 genera and 70 families (Table I).

Table I
No. of Families/Genera/Species of Dicots and Monocots

	Families	Genera	Species
Dicots	61	218	451
Monocots	9	68	123
Total	70	286	574

As many as 31 families are represented only by one genus while *ca* 18 families are represented by single genus and single species. Hydrocharitaceae, Pontederiaceae, Lemnaceae, Potamogetonaceae (Monocots) and Ceratophyllaceae (Dicots) are represented by aquatic plants only.

Poaceae is the largest family with 52 genera and *ca* 82 species. The Tables II and III below provide the details of the dominant families and genera respectively.

Table II
Dominant Families (species-wise)

Family	Chandigarh	India
Poaceae	(52) 82	(264) 1291
Asteraceae	(41) 57	(166) 803
Leguminosae	(20) 49	(167) 1141
Cyperaceae	(6) 39	(38) 545
Scrophulariaceae	(12) 22	(62) 368
Euphorbiaceae	(5) 19	(84) 523
Acanthaceae	(9) 15	(92) 500
Lamiaceae	(10) 13	(72) 435
Amaranthaceae	(8) 11	(20) 60
Convolvulaceae	(4) 11	(28) 184
Solanaceae	(4) 11	(17) 75
Polygonaceae	(2) 11	(17) 163

The figures in the parenthesis represent the number of genera.

Table III
Dominant Genera

Genera	No of Species
<i>Cyperus</i>	16
<i>Euphorbia</i>	11
<i>Polygonum</i>	9
<i>Indigofera</i>	8
<i>Digitaria</i>	8
<i>Fimbristylis</i>	7
<i>Crotolaria</i>	6
<i>Commelina</i>	6
<i>Alysicarpus</i>	5
<i>Eragrostis</i>	5

USEFUL PLANTS

It is clear from the vegetational account that the major part of the flora of Chandigarh constitute introduced plants. The wild vegetation does not include many interesting plants from distributional point of view but some have economic or medicinal value such as

<i>Urena lobata</i>	Malvaceae
<i>Helicteres isora</i>	Sterculiaceae
<i>Aspidopterys wallichii</i>	Malpighiaceae
<i>Celastrus paniculatus</i>	Celastraceae
<i>Elaeodendron roxburghii</i>	Celasteraceae
<i>Mollugo pentaphylla</i>	Molluginaceae
<i>Azadirachta indica</i>	Meliaceae
<i>Cassia fistula</i>	Caesalpiniaceae
<i>Dalbergia sissoo</i>	Fabaceae
<i>Bombax ceiba</i>	Bombacaceae
<i>Bauhinia variegata</i>	Caesalpiniaceae
<i>Aegle marmelos</i>	Rutaceae
<i>Toona ciliata</i>	Meliaceae
<i>Butea monosperma</i>	Fabaceae

<i>Acacia catechu</i>	Mimosaceae
<i>Moringa oleifera</i>	Moringaceae
<i>Justicia adhatoda</i>	Acanthaceae
<i>Tinospora cordifolia</i>	Menispermaceae
<i>Eclipta prostrata</i>	Asteraceae
<i>Holarrhena pubescens</i>	Apocynaceae
<i>Solanum surattense</i>	Solanaceae
<i>Withania somnifera</i>	Solanaceae
<i>Bacopa monnieri</i>	Scrophulariaceae
<i>Kigelia pinnata</i>	Bignoniaceae
<i>Plantago ovata</i>	Plantaginaceae
<i>Achyranthes aspera</i>	Amaranthaceae

CONSERVATION

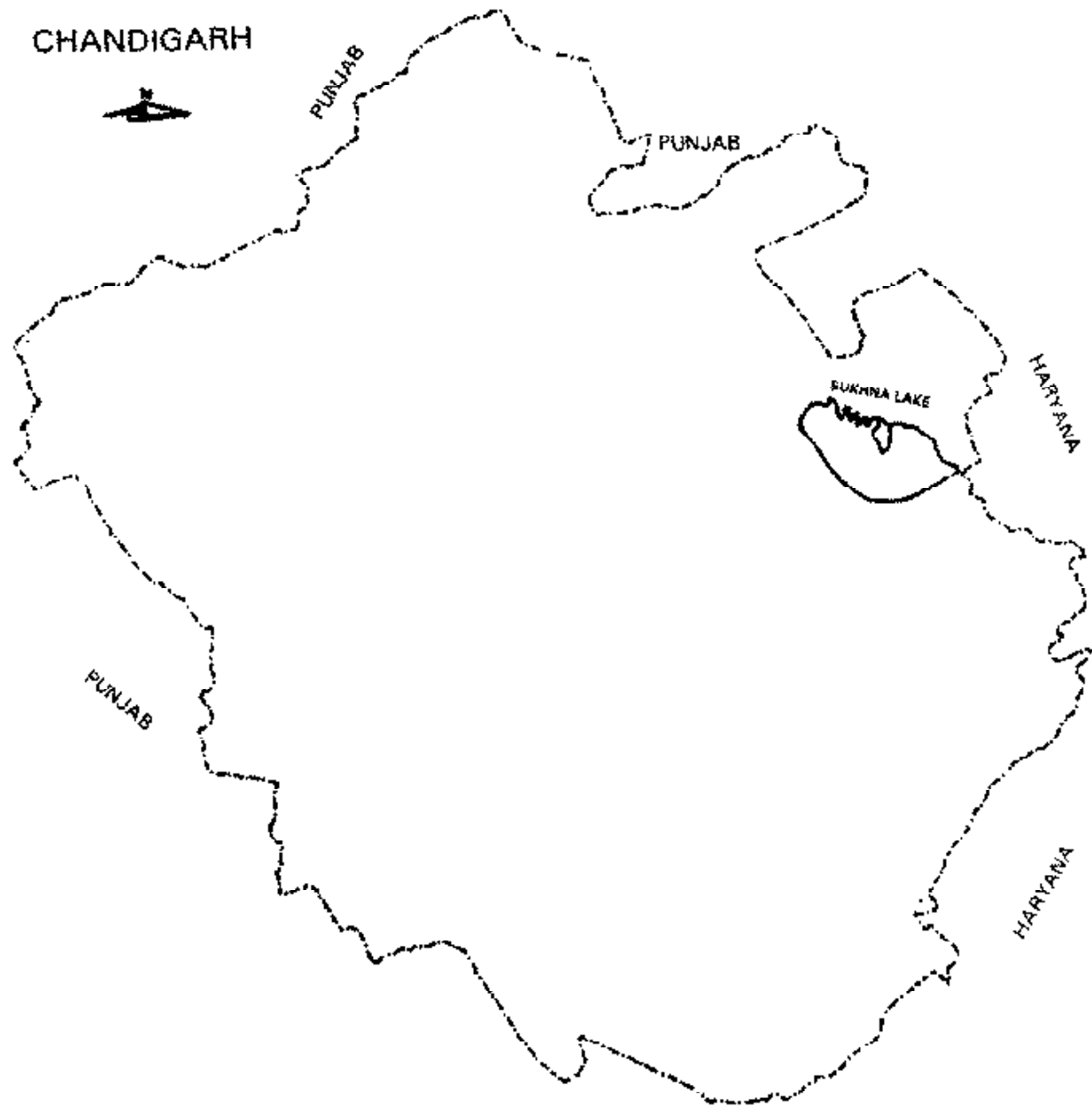
As mentioned above, the number of introduced plant species is more than the natural wild flora of Chandigarh. The habitat loss due to urbanisation and tourist influx are among the major threats to the wild flora. It is necessary that apart from creating a general public awareness through NGOs, Radio, Television, Newspapers, etc., earnest efforts should be made for *ex situ* conservation of both introduced and rare wild species of flora in university/public gardens.

As such, the city does not encompass any protected area for *in situ* conservation. Sukhna Lake situated in the lap of Shivaliks is the only man-made wetland area created in 1958 for the city of Chandigarh. The National Committee on Wetlands, Mangroves and Coral reefs under Ministry of Environment and Forests, has recognised it as one of the 21 wetlands in the country for intensive conservation. Due to the large catchment area (42 sq km), tonnes of silt is carried annually into the lake, thus decreasing the original capacity of the lake and also effecting the aquatic population. It is suggested that the enhanced desilting efforts by the local administration/ communities should be accompanied by voluntary plantations of fruitbearing trees and other ecologically-important trees in the catchment area. This excessive afforestation in the catchment area should also be followed by building of check dams to halt the silt flow into the lake and removal of aquatic weeds. Annual census of waterfowls may also be used as a bioindicator for regular monitoring of the status of the Sukhna Lake.

REFERENCES

- Aitchison, J.E.T. 1869. *A catalogue of the plants of the Punjab and Sindh*. London.
- Ahmad, Sultan 1954. *Grasses and Sedges of Lahore District*. Lahore.
- Bamber, C.J. 1916. *Plants of the Punjab*. Lahore.
- Collett, H. 1902. *Flora Simlensis*. Calcutta and Simla.
- Coventry, E.M. 1901. *A catalogue of the trees and shrubs of the Punjab*. Lahore.
- Duthie, J.F. 1903-1929. *Flora of the Upper Gangetic plain and of the Adjacent Siwalik and Subhimalayan Tracts*. 3 vols. Calcutta. Reprinted 1960 in 2 volumes, Calcutta.
- Kashyap, S.R. and A.C. Joshi 1936. *Lahore District Flora*. Lahore.
- Khullar, S.P. and M.P. Sharma 1991b. Weeds of the city beautiful (Indore session). *Proc. Indian Sci. Congr. Assoc.* Part- II.
- Maheshwari, J.K. 1963. *The Flora of Delhi*, New Delhi.
- Mangal, A.K. and M.P. Sharma 1993. The armed weeds of Chandigarh. *Proc. 80th Indian Sci. Congr. Assoc.* Part-III (Goa Session) pp. 107-108 (Abstract)
- Mangal, A.K., S.P. Khullar and M.P. Sharma 1995. Garden and Lawn weeds of city beautiful. *Bull. Bot. Soc. Sagar Univ. Silver Jubilee Vol.* (Press).
- Mangal, A.K., M.P. Sharma and S.P. Khullar 1996. An analysis of the weeds of the Le Corbusier,s City beautiful. *J. World Weeds*, Deh Dun (Press).
- Nair, M.N. 1966. *Checklist of Plants of the Shivalik Hills and Pinjore Gardens*. (Pvt. Publication, Jan. 8, 1966, pp 10. Bot. Deptt. P. Univ.).

- Parker, R.N. 1924. *A Forest Flora of the Punjab with Hazara and Delhi*. Ed-II, Lahore.
- Powell, B.H. (1868-1872). *Handbook of the Economic products of the Punjab with a combined Index and Glossary of Technical vernacular words* vol. I, 1868, Roorkee; Vol. 2, 1872, Lahore.
- Raizada, M.B., R.C. Bharadwaja and S.K. Jain 1957. Grasses of the Upper Gangetic Plain. Panicoidae, Part-I (Maydeae and Andropogoneae). *Indian Forest Rec. (n.s.) Botany* 4: 171.
- Sabnis, T.S. 1940. A contribution to the Flora of the Punjab Plains and the associated hill regions. *J. Bombay Nat. Hist. Soc.* 42: 124.
- Sharma, M.L. 1988. An artificial key to the grasses of Chandigarh and its neighbourhood. *Res. Bull. (Sci.) Pb. Univ.* 39: 1-19.
- Sharma, M.L. and P.K. Khosla 1989. *The grasses of Punjab and Chandigarh*. Punjab. Univ. Chandigarh pp. 296.
- Sharma, O.P. and M. Sharma 1966. Observation on the flora of Chandigarh and its neighbourhood. *Res. Bull. (n.s.) Pb. Univ.* 17: 371-405.
- Sharma, O.P. and M. Sharma 1967. Observation on the flora of Chandigarh and its neighbourhood-II. *Res. Bull. (n.s.) Pb. Univ.* 18: 443-474.
- Sharma, O.P. and M. Sharma 1968. Observation on the flora of Chandigarh and its neighbourhood-III. *Res. Bull. (n.s.) Pb. Univ.* 19: 307-325.
- Stewart, J.L. 1869. *Punjab Plants*. Lahore.



MAP OF CHANDIGARH



An avenue



***Cassia* sp. in the university campus**



An avenue of *Haplophragma adenophyllum*



Tecoma stans



An ornamental climber



Hibiscus tiliaceus



Holmskioldia sanguinea in the university garden



Cassia sp. along the roadside



Koelreuteria apiculata



Sukhna lake : General view of the vegetation



Clumps of *Saccharum munja*



Wasteland vegetation

DADRA AND NAGAR HAVELI

**N.P. Singh
P.P. Sharma**

The union territory of Dadra and Nagar Haveli is situated on the west coast of India, between latitudes of 20° 0' - 20° 25' North and longitudes of 72° 50' - 73° 15' East. Total area is 491 sq km (Pandey and Ladwa, 1989), which comprises of two enclaves, viz. Dadra and Nagar Haveli. The territory is surrounded on the west, north and east by Valsad district of Gujarat state and on the south and south-east by 'Thane' district of Maharashtra state.

The whole area is undulating and hilly with a hilly terrain specially towards the north-east and east, surrounded by the ranges of 'Sahyadri mountains' (Western Ghats). Total forest area of the territory is 198.77 sq km (19876.41 ha) with high altitudes ranging from 250 to 432 m. 'Gambhirgad' the highest region with 684 m altitude is just outside the border of Nagar Haveli. The terrain is intersected by the river Damanganga and its three tributaries. The river arises in the ghat 64 km away from the coast and discharges itself in the Arabian sea at the port of Daman.

Climate in Dadra and Nagar Haveli is moderate and generally healthy in the central zone. Temperature ranging from 20.8°C to 33.5°C and average humidity ranging from 30 % in May to 85 % in August, it shows hot and humid summers.

The rainy season is normally from June to September and receives heavy rainfall during these months with an annual rainfall ranging between 2000 to 2500 mm (Pandey and Ladwa, 1989).

Soil in Dadra and Nagar Haveli is mostly formed by disintegration of the deccan trap rocks, occurring as thin finely broken well serrated mantle mixed up with decayed organic matter varying in texture and depth according to the degree of disintegration and extent of erosion. The colour of soil varies from brick red to black.

VEGETATION

The vegetation of Dadra and Nagar Haveli in general is that of moist deciduous type dominated by *Teak-Terminalia* community. There is no much scope to discuss about the floristic diversity of Dadra, because most part of the area is under cultivation, though there are few open grasslands and wastelands. While in Nagar Haveli there is considerable area under forest cover. Food crop cultivation is limited to plains and valleys only.

Small patches of grassy fields are found within the forest areas, probably formed by the shifting cultivation practices of the nomadic 'Girijans'. The vegetation of Nagar Haveli is closely related to the hilly flora of Gujarat state having common tree species viz. *Tectona grandis*, *Terminalia crenulata*, *Garuga pinnata*, *Butea monosperma* and *Phyllanthus emblica*, etc. The dominant species in shrubby layer are represented by *Carissa congesta*, *Woodfordia fruticosa*, *Wrightia tinctoria* and *Holarrhena pubescens*, etc. The vegetation is frequented by vast variety of climbers; commonly *Calycopteris floribunda* and *Combretum ovalifolium* thus dominate the climber species.

Rao (1985), while working for the flora of Goa, Diu, Daman, Dadra and Nagar Haveli has recorded 407 angiosperm species belonging to 278 genera and 84 families from the Dadra and Nagar Haveli alone. Of these, 196 genera and 295 species belongs to 71 dicot families and 82 genera and 112 species come under 13 monocot families. 3 pteridophytic species belonging to 3 genera and arranged under 3 families have also been recorded.

Table I
Number of families, genera and species

	Families	Genera	Species
ANGIOSPERMS	84	278	407
DICOTS	71	196	295
MONOCOTS	13	82	112
PTERIDOPHYTES	3	3	3
TOTAL	87	281	410

Three small books on the plants of Nagar Haveli and Daman were published in Portuguese by Caetano Gracias (1899) and C.F. Xavier Gracias (1902 and 1927).

At the beginning of 19th century some workers made notable contributions to the floristic studies of Western India viz. Cooke (1901-1908), Talbot (1909-1911), Saxton and Sedgwick (1918), Indrajithakar (1910) and several others. Though there were such authentic works on the flora of the whole of western India, data on plants of Dadra and Nagar Haveli based on authentic herbarium material were lacking.

Rao (1985) had worked out the flora of Goa, Diu, Daman, Dadra and Nagar Haveli by extensive exploration of these areas.

At present ethnobotanical studies on Dadra and Nagar Haveli under All India Co-ordinated Research Project on Ethnobiology is in progress.

FLORISTIC DIVERSITY

Out of the overall forest area of 198.77 sq km of Dadra and Nagar Haveli, the area covered by wildlife sanctuaries alone is 92.17 sq km which are represented in the north-east and eastern regions surrounded by 'Sahyadri Mountains' (Western Ghats). Forest in Dadra and Nagar Haveli are dominated by *Tectona grandis* and *Terminalia crenulata*. However, the percentage of dominance of these species is comparatively low in the sanctuaries. These areas with comparatively dense vegetation and shady moist valleys are usually dominated by the community formed by *Mallotus philippensis*, *Syzygium cumini*, *Mangifera indica*, *Mitragyna parvifolia*, *Lanea coromandelica*, *Terminalia bellirica* and *Bridelia retusa*, etc. *Sterculia urens* is more conspicuous in the forest of northern zone. While *Madhuca longifolia* is more common in Nagar Haveli as compared to Dadra.

Forest in sanctuaries, usually away from habitation are having a more or less mixed composition of different types and appear to be rich in floristic diversity.

Table II
Percentage occurrence of some common species in total
Dadra and Nagar Haveli forest compared
to the sanctuaries area

Name of the species	Percentage Occurrence in Dadra and Nagar Haveli forest	Percentage Occurrence in Sanctuaries Area
<i>Tectona grandis</i>	21.25	8.68
<i>Terminalia crenulata</i>	11.93	9.52
<i>Holarrhena pubescens</i>	8.52	6.59
<i>Garuga pinnata</i>	8.45	1.89
<i>Haldina cordifolia</i>	6.67	4.68
<i>Butea monosperma</i>	4.13	0.72
<i>Lagerstroemia parviflora</i>	3.63	2.49
<i>Bridelia retusa</i>	2.64	4.52
<i>Acacia catechu</i>	2.38	1.03
<i>Lannea coromandelica</i>	2.19	4.17
<i>Terminalia bellirica</i>	2.07	2.20
<i>Ficus asperrima</i>	2.02	0.67
<i>Mitragyna parvifolia</i>	1.89	4.68
<i>Madhuca longifolia</i> var. <i>latifolia</i>	1.64	0.84
<i>Casearia tomentosa</i>	1.60	2.67
<i>Ficus glomerata</i>	1.56	0.61
<i>Dalbergia latifolia</i>	1.53	3.24
<i>Schleichera oleosa</i>	1.23	0.64
<i>Gmelina arborea</i>	1.19	0.46
<i>Desmodium oojeinensis</i>	0.88	0.35
<i>Milusa tomentosa</i>	0.77	1.92
<i>Albizia lebbeck</i>	0.62	1.20
<i>Ziziphus xylopyrus</i>	0.49	1.12
<i>Bombax ceiba</i>	0.44	0.91
Other species	10.28	34.20
Total	100 %	100 %

From the Table II, it is clear that the forest areas demarcated as sanctuaries show a high floristic diversity as compared to the other forest areas which show more uniform type of vegetation. This higher diversity attributed to sanctuaries is mainly due to lower biotic pressure exerted on the sanctuary areas in comparison to the interferences caused in other forest areas of the territory of Dadra and Nagar Haveli.

From the present studies also, it is agreed that the widely distributed moist deciduous forest of Nagar Haveli are dominated by *Tectona grandis* and *Terminalia crenulata*. Palms like *Phoenix sylvestris* and *Borassus flabellifer* occur more in the plains, while grassy meadows are found at few places on the plateaus and hill tops.

Besides *Tectona grandis* and *Terminalia crenulata* other common species found are *Anogeissus latifolia*, *Haldina cordifolia*, *Mitragyna parvifolia*, *Lagerstroemia parviflora*, *Sterculia urens*, *Acacia chundra* and *Dalbergia latifolia*, etc. These species commonly form the top canopy or Upper storey. While *Wrightia tinctoria*, *Holarrhena pubescens*, *Butea monosperma*, *Cassia fistula* and *Bombax ceiba* are some of the dominant species forming the second storey.

Besides above mentioned plant species some other plants which constitute first and second storey in various combinations are *Diospyros melanoxylon*, *Oroxylum indicum*, *Cassine glauca*, *Heterophragma quadriloculare*, *Morinda tinctoria*, *Careya arborea*, *Bridelia squamosa*, *Trewia polycarpa* and *Madhuca longifolia*, etc.

The shrubby undergrowth or ground flora which forms the third storey in the forest clearings and exposed field situations is poorly represented at some places in the forest due to illicit cutting, grazing and rab burning practices by local inhabitants. However, in the protected areas like sanctuaries there is luxuriant shrubby undergrowth. Some of the climbers, shrubs and herbs representing the forest undergrowth are *Calycopteris floribunda*, *Carissa congesta*, *Woodfordia fruticosa*, *Grewia tiliaefloia* var. *leptopetala*, *Helicteres isora*, *Leea indica*, *Thespesia lampas*, *Pimpinella* sp., *Dioscorea bulbifera*, species of *Abelmoschus*, *Rungia elegans*, *Urena lobata* and *Sida acuta*, etc.

Important grass species found in the ground flora are species of *Oplismenus*, *Ischaemum*, *Spodiopogon rhizophorus*, *Eulalia fimbriata*,

Arundinella pumila and *Coix lacryma-jobi*, etc. A few epiphytic orchids commonly found are species of *Aerides*, *Oberonia* and *Dendrobium*, etc. *Viscum articulatum* is the common stem parasite. *Adiantum philippense*, *Ceratopteris thalictroides*, *Lygodium flexuosum* are commonly found pteridophytes.

The vegetation along the bank, of river Damanganga and its tributaries is dominated by *Homonoia riparia*, *Tamarix ericoides*, *Polygonum glabrum*, *Rotula aquatica*, *Rotula serpyllifolia*, *Hygrophila serpyllum*, *Bacopa monnieri*, *Cyathocline purpurea*, *Ammannia baccifera* and *Conscora diffusa* mixed with sedges and grasses as species of *Cyperus*, *Fimbristylis*, *Eleocharis* and *Arundinellia*, etc.

In the following Tables III and IV attempt has been made to show the dominance of various families in the Dadra and Nagar Haveli flora based on the number of genera and species and compared with the total number of genera and species present in India.

Table III
The number of genera for 10 large families in the
area in comparision with India

Sl. No.	Family	In Dadra and Nagar Haveli	In India
1.	Poaceae	38	264
2.	Fabaceae	25	167
3.	Asteraceae	17	166
4.	Acanthaceae	11	92
5.	Scrophulariaceae	11	62
6.	Rubiaceae	10	113
7.	Euphorbiaceae	7	84
8.	Cyperaceae	6	38
9.	Convolvulaceae	4	28
10.	Commelinaceae	3	14

Table IV
The number of species for 10 large families in
the area in comparison with India

Sl. No.	Family	In Dadra and Nagar Haveli	In India
1.	Poaceae	52	1291
2.	Fabaceae	40	1141
3.	Cyperaceae	24	545
4.	Asteraceae	18	803
5.	Acanthaceae	15	500
6.	Euphorbeaceae	14	523
7.	Rubiaceae	13	616
8.	Scrophulariaceae	12	368
9.	Convolvulaceae	10	184
10.	Commelinaceae	10	90

The relative dominance of family Poaceae in this area in respect of number of genera and species is same for the whole country. Family Commelinaceae takes 10th position in all Dadra and Nagar Haveli and India.

PHYTOGEOGRAPHY

The vegetation of Dadra and Nagar Haveli which is situated in west coast of India is allied to the hilly flora of south, south-west Gujarat and other moist deciduous forest of Western India.

The moist deciduous forest of Dadra and Nagar Haveli are represented by 407 species of angiosperms, most of them are found in south Gujarat and Thane and other districts of Western Maharashtra also.

Shah (1981), listed 168 species endemic to south Gujarat, however 39 of them are recorded in Dadra and Nagar Haveli by Rao (1985).

According to Jain and Sastry (1982), certain elements are common to the flora of Western India and the ghats of the peninsular region and

eastern parts of south Africa and Sri Lanka. The flora of Dadra and Nagar Haveli situated on the west coast of India also shows phytogeographical affinities with eastern parts of south Africa and Sri Lankan flora. A few example of such affinities are given below.

The plant species *Desmodium gangeticum*, *Emilia sonchifolia*, *Gloriosa superba* and *Grewia tiliaefolia* are common elements occurring in eastern parts of south Africa as well as in this area. Similarly, the Sri Lankan element occurring in this region is *Soymida febrifuga*. Species such as *Commelina hasskarlii* restricted to India and Bangladesh are met with in Dadra and Nagar Haveli also.

ENDEMISM

There is no endemic or threatened taxa reported so far from Dadra and Nagar Haveli, but some of the endemic plants of India are distributed in this area.

Studies on South Gujarat by Shah (1981), shows 168 plants endemic to South Gujarat. However, 39 of these are also found in Nagar Haveli. The plant *Exacum bicolor* (Gentianaceae) reported to be rare and endemic from sacred groves of Western Maharashtra, by Vartak (1981) is found in this area.

List of the endemic plants of India distributed in Dadra and Nagar Haveli, with distribution in other areas of the country. (Ahmedullah and Nayar, 1986).

Name of the species	Distribution in India
<i>Anisomeles heyneana</i>	Western Ghats, Konkan, (Mahabaleshwar), Nilgiris, Deccan.
<i>Argyria sericea</i>	Western Ghats, Konkan, Malabar, Nilgiris to Tirunelveli Hills.
<i>Arisaema murrayii</i> .	Gujarat, Western Ghats, Konkan to Nilgiris.

Name of the species	Distribution in India
<i>Asystasia dalzelliana</i> .	Western Ghats from South Kanara southwards at low altitudes.
<i>Barleria prattensis</i> .	Maharashtra
<i>Blepharis asperrima</i> .	Western Ghats, Hills of Karnataka, South Kanara and Coorg.
<i>Crotalaria filipes</i>	Western Ghats or coast, Konkan; Kanara.
<i>Curcuma decipiens</i>	Western Ghats, Shimoga.
<i>Dendrobium ovatum</i>	Western Ghats, Konkan North Kanara, Belgaum and Hassan.
<i>Dimeria stapfiana</i>	Northern Western Ghats, Poona, Khandala and North Kanara.
<i>Ensete superbum</i>	Western Ghats, 900-1500m extending upto Gujarat.
<i>Erythrina variegata</i> var. <i>orientalis</i>	Deccan, Chickanahalli, Karnataka.
<i>Hemigraphis latebrosa</i> var. <i>heyana</i>	Peninsular India.
<i>Jasminium malabaricum</i>	Western Ghats, Konkan, Southwards, Karnataka to Nilgiris.
<i>Neanotis rheedii</i>	West Coast, Western Ghats, Konkan, Karnataka, and Southwards to Cochin and Anamalais.
<i>Neuracanthus sphaerostachyus</i>	Western Ghats of Tamilnadu.
<i>Oberonia brunoniana</i>	Western Ghats, most districts of Karnataka, Nilgiris.

Name of the species	Distribution in India
<i>Rhamphicarpa longiflora</i>	South Western Ghats, Nilgiris and Anamalais.
<i>Torenia indica</i>	Maharashtra, Karnataka (Shimoga).
<i>Trewia polycarpa</i>	Western Ghats, Konkan Malabar and Tranvancore.
<i>Trilobachne cookei</i>	Northern Western Ghats, Konkan, North Kanara.

ECONOMIC USES

Cereals: *Eleusine coracana*, *Oryza sativa*, *Setaria italica*, *Sorghum vulgare*, *Triticum aestivum* and *Zea mays*.

Pulses: *Cajanus cajan*, *Cicer arietinum* and *Dolichos lablab*.

Vegetables: *Abelmoschus esculentus*, *Cucurbita maxima*, *Cucumis sativus*, *Daucus carota*, *Dioscorea bulbifera*, *Lagenaria siceraria*, *Moringa oleifera* and *Solanum tuberosum*, etc.

Fruits: *Annona squamosa*, *Borassus flabellifer*, *Carica papaya*, *Citrus medica*, *Cucumis melo*, *Diospyros melanoxylon*, *Phyllanthus emblica*, *Mangifera indica*, *Manilkara zapota*, *Pithecellobium dulce*, *Phoenix sylvestris*, *Psidium guajava*, *Tamarindus indica*, *Ziziphus mauritiana* and *Ziziphus rugosa*.

Fibre yielding plants: *Bombax ceiba*, *Calotropis gigantea*, *Corchorus capsularis*, *Crotalaria juncea*, *Gossypium herbaceum*, *Helicteres isora*, *Hibiscus cannabinus* and *Urena lobata*.

Beverages: The fresh sap from *Borassus flabellifer*, *Phoenix sylvestris* and the Liquor prepared from flowers of *Madhuca longifolia*.

Tooth brushes: Tender branches of *Acacia nilotica*, *Azadirachta indica*, *Ficus benghalensis*, *Sida acuta* and *Urena lobata*.

Bidi wrappers: The leaves of *Bauhinia racemosa* and *Diospyros melanoxylon* are used.

Timber trees : Timber is obtained from *Acacia chundra*, *Anogeissus latifolia*, *Dalbergia latifolia*, *Gmelina arborea*, *Haldina cordifolia*, *Lagerstroemia parviflora*, *Desmodium oojeinensis*, *Pterocarpus marsupium*, *Tectona grandis*, *Terminalia bellirica* and *T. crenulata*.

Minor forest products

Dye yielding plants: Bark of *Acacia chundra*, *Cassia fistula*, and flowers of *Butea monosperma*.

Gum yielding species : *Acacia nilotica*, *Azadirachta indica*, *Garuga pinnata*, *Pterocarpus marsupium*, *Sterculia urens* and *Terminalia crenulata*.

Medicinally important plants

There are many wild plants which are used medicinally either by the local people or commercially by the pharmaceutical companies. *Asparagus racemosus*, *Capparis zeylanica*, *Gloriosa superba*, *Helicteres isora*, *Hemidesmus indicus*, *Heterophragma quadriloculare*, *Holarrhena pubescens*, *Ocimum americanum*, *Plumbago zeylanica*, *Solanum surattense*, *Vitex negundo*, and *Woodfordia fruticosa*, etc. are some useful medicinal plants from the forest of Dadra and Nagar Haveli.

VULNERABILITY AND THREATS

The main causes of degradation and depletion of biodiversity in this area are

Biotic interferences: The Dadra and Nagar Haveli forest have been subjected to severe biotic interferences since ages. The fast growing industrial estates in this area resulted in great influx of people to the territory which in turn affected the forest ecosystem. From 1971 to 1981 the population of the area has increased by 40 %. This increase in human population has considerably widened the gap between the demand and supply of the forest produce, rendering the forest more vulnerable to injuries caused by man.

The trees, shrubs and even their roots are indiscriminately removed by the local people for fuel, medicines, construction, thorn fencing and for other purposes. This affects the vegetation in many ways. The requirement of woody biomass for fuel purposes alone had increased from 37,000 Metric Tonnes to 48,400 Metric Tonnes in 1995. Consumption of fuel wood in rural areas of the territory is estimated to be about 400 Kg/year/head.

Some primitive agricultural practices such as 'Tahal' cultivation, which is a form of shifting cultivation, lopping and removal of brushwood for rab making and diminishing productivity of the agricultural lands due to faulty practices are the main causes resulting in the ecological degradation.

Grazing : The entire territory is deficient in fodder. The herbivores indiscriminately graze on the seedlings of trees, shrub species and on the herbaceous vegetation. This over grazing affects the regeneration of the natural vegetation.

Developmental Activities: The upcoming of Damanganga irrigation project on river Damanganga resulted in degradation of the forest in the catchment areas. Developing industrial estates and other activities, especially construction of roads and tourist spots in the territory has also destroyed a lot of vegetation. At present occupation for tourism and tourist activities in the forest are responsible for the degradation of the forest habitat to an extent.

CONSERVATION

Intense human activity and biotic pressure like grazing affect the ecological conditions of the area resulting in soil erosion. Exposed areas are highly susceptible to high velocity of wind. The shifting cultivation practiced by nomadic 'Girijans' is one of the most serious problems resulting in highly disturbed ecological conditions. Disappearance of natural forest, uncontrolled growth of weed flora, and soil erosion, etc. are the result of this practice.

To save the forest from the diverse biotic and abiotic effects, administration of Dadra and Nagar Haveli has taken a number of steps. Certain areas in the territory are declared as wildlife sanctuaries to protect plants and animals. The catchment area of Damanganga irrigation

project and buffer zone around it have been proposed for permanent conservation. Soil conservation measures had been carried out wherever necessary.

Conservation of more areas, which is more vulnerable due to fast depletion can be achieved by

Protecting the boundary areas of the adjoining forest of Gujarat and Maharashtra states.

By planting some economically and medicinally important plants in wastelands.

Eco-friendly and sustainable development in areas of nearby villages may be undertaken with the help of village Panchayats.

Developing nurseries to preserve and propagate some important plant species.

Controlling open grazing and forest floor clearing including collection of humus.

Stopping all sorts of legal and illegal clear felling.

Developing awareness in local people through various agencies like forest department, agricultural department as well as NGO's.

REFERENCES

- Ahmedullah, M and M.P. Nayer 1986. *Endemic plants of Indian region*. Calcutta.
- Jain, S.K. and A.R.K. Sastry 1982. Threatened plants and habitats, a review of work in India, *Plant Conservation Bulletin, No. 2*.
- Pandey, C.N. and V.R. Ladwa 1989. *Working plan for the forest of Dadra and Nagar Haveli (1986-87 to 1995-96)*. Vol. I and II.
- Rao, R.S. 1985. *The Flora of Goa, Diu, Daman, Dadra and Nagar-Haveli*. Vol. I and II, Botanical Survey of India.
- Shah, G.L. 1981. Rare species with restricted distribution in south Gujarat. *An Assessment of Threatened Plants of India* Jain, S.K. and R.R. Rao (Eds.) pp. 50-54.
- Vartak, V.D. 1981. Observations on rare, imperfectly known and endemic plants in sacred groves of Western Maharashtra. *An Assessment of Threatened Plants of India*. Jain, S.K. and R.R. Rao (Eds.) pp. 169-178.



Moist deciduous forest at sanctuary area in Nagar Haveli, dominated by *Tectona grandis* and *Terminalia crenulata*



Calycopteris floribunda : climber on *Bambusa* sp., common in Nagar Haveli



Sterculia urens : most conspicuous in forest of northern zones, Nagar Haveli



Madhuca longifolia. var *latifolia* in flowers

DAMAN AND DIU

N.P. Singh
P.P. Sharma
P.G. Diwakar

The Union Territory of Daman and Diu, one of the former Portuguese colonies is situated on the edge of southern borders of Gujarat State. It came into separate existence on 30th May 1987, after delinking from Goa which attained statehood on the same date.

Daman, a small enclave on the west coast lies in between 20° 12' 20°28' N and 72°50' 72°54' E. It covers a total area of 72 sq km, of which 63% is under cultivation (Anonymous, 1991). On the west, Daman is bounded by Arabian sea and Valsad district of Gujarat state on other sides. The main river Damanganga comes from 'Sahyadri ranges' and divides the territory into two parts 'Mothi Daman' in the south and 'Nani Daman' in the north. While the river 'Kalai' in the south sets up a natural boundary of about 4 km, to the north, river 'Kolak' affords a boundary for about 6 km.

Diu is a beautiful and quiet secluded, tiny island, situated between the 20°41'- 20°44'N and 70°52'-71°0' E. Total area covered by the island is about 40 sq km (3850 ha), of which 363 ha is covered by food crops and about 430 ha is utilised for cash crops like coconut, vegetables, etc. This island is bounded by 'Chasi' river on the north and on the remaining three sides it is hugged by Arabian Sea. On the north Chasi river separates Ghoghla from the mainland of Junagadh district of Gujarat State. Ghoghla together with another tiny Simbor island (situated few kilometers away, east of Diu along the coast) forms a part of Diu district.

Soil in Daman, derived from Deccan Trap rock are alluvium mixed with sand and medium black soils. While in Diu very thin cover of light brown sandy loam soil is present. In both the areas soils are neutral to slightly alkaline.

Climate in Daman is generally mild and warm, the area receives an average annual rainfall of about 1600 mm. Temperature varies between 22°C and 31°C.

According to Rao and Agarwal (1964), climate in Diu is typical of humid subtropical with concentration of precipitation in warm season, the high humidity in conjunction with the high temperature results in sultry, oppressive conditions in contrast to dry summer heat. Average annual rainfall is about 540 mm and temperature varies from 20°C to 30°C.

Relative humidity in both the areas is high during rainy season and low during summer, the percentage varying from 55 to 87 through out the year.

VEGETATION

The land of Daman and Diu island is devoid of natural forest as such. Different kinds of habitats found in these areas are sand stone pits, soil filled rocky creeks, salt pans, sandy belt along sea shore, swampy backwater area and road sides. Based on the habitat preference of different plant communities, vegetation can be classified as

1. Rock strand vegetation,
2. Sandy sea shore vegetation and
3. Inland sandy plain vegetation.

1. Rock strand vegetation

Plants growing in rocky habitat along sea shore are stunted or of creeping life form, may be due to constant high velocity wind and effect of sun rays.

Rocky area exposed to Arabian sea is comparatively very less in Daman, with scanty vegetation along the rocky creeks and crevices. While in Diu considerable rocky area is exposed to Arabian Sea, even sandy beaches of Diu are intercepted in some areas by rocky shoreline. The exposed rocks with holes and crannies are often filled up with sandy soil. Plants forming large populations in such habitat are *Statice stocksii*, *Lepidagathis trinervis* and *Serricostoma pauciflorum*, etc. *Atriplex stocksii*, *Euphorbia indica*, *Glinus oppositifolius*, *Goniogyna hirta*, *Indoneesiella echioides*, *Lindenbergia indica*, *Phyllanthus debilis*, *Polycarpaea spicata*, *Portulaca quadrifida*, *Tephrosia uniflora ssp. petrosa* are the common prostrate or stunted species found in this habitat.

Root parasite *Striga gesnerioides* var. *minor* is rather frequent in Diu on *Indoneesiella echioides* and *Lepidagathis trinervis*.

In Diu slightly interior of the sea shore, where soil is more sandy than rocky, species like *Aerva lanata*, *Bombax micranthus*, *Celosia argentea*, *Clerodendrum multiflorum*, *Crotalaria retusa*, *Dipteracanthus patulus*, *Leucas aspera* and *Trianthema decandra*, etc. are common.

2. Sandy sea shore vegetation

The sandy or strand vegetation is found all along the narrow sandy beaches. While in narrow stripes of muddy flats mangrove vegetation is found both in Daman and Diu. Common components growing in such a habitat are *Acacia nilotica* ssp. *indica*, *Aloe barbadensis*, *Ipomoea pes-caprae*, *Jatropha gossypifolia*, *Lantana* sp., *Sericostoma pauciflorum* and *Solanum surattense*, etc. *Ipomoea pes-caprae* forms extensive patches all over the foreshore, alongwith *Halopyrum mucronatum* and other common sand binders like *Aeluropus lagopoides*, *Cyperus arenarius* and *Launaea sarmentosa*.

The grass *Halopyrum mucronatum* forms gregarious patches along sea shore, mixed with *Goniogyna hirta* and *Convolvulus microphyllus*, occupying a borderline between pure strand flora and the inland flora.

Muddy flats towards northern end of Diu, at the bank of Chasi river and at the estuarine region of Damanganga river in Daman, harbour mangrove species *Avicennia marina* var. *acutissima*. Other species found in association are *Acanthus ilicifolius*, *Aegiceras corniculatus*, *Sonneratia apetala*, *Salicornia* sp. and a few members of Cyperaceae and Poaceae like *Apluda mutica*, *Arthraxon lancifolius*, *Digitaria ciliaris*, *Eragrostis ciliaris* and *Fimbristylis polytrichoides*, etc.

3. Inland Sandy Plain Vegetation

The undulating terrain and hillock of Daman is dominated by scrub jungle. A few shrubs and many grasses dominate such a habitat. The plant species which dominate wastelands, open grassy fields and the hillock slopes in Daman are *Themeda-Pseudanthistiria* community with common associates like *Chloris barbata*, species of *Digitaria*, *Eragrostis*

viscosa, *Heteropogon contortus*, *Ischaemum indicum*, *I. semisagittatum* and *Iseilema laxum* with few species of Legumes, viz. *Alysicarpus bupleurifolius*, *Celosia argentea*, *Evolvulus alsinoides*, *Geissaspis cristata*, *Sopubia delphinifolia* and *Smithia* sp. Plants like *Bombax ceiba*, *Erythrina stricta*, *Euphorbia neriifolia*, *E. tirucalli*, *Grewia tiliaefolia*, *Justicia adhatoda*, *Lantana* sp., *Vitex negundo*, *Woodfordia fruticosa* and *Zizyphus mauritiana*, etc. are also found to be common in Daman.

The gravelly soil in Diu, deposited by thin mantle of sand, harbour plants like *Acacia nilotica*, *Cassia italica*, *Enicostema verticillatum*, *Euphorbia hirta*, *Heliotropium zeylanicum*, *Jatropha gossypifolia*, *Leucas aspera*, *Lotus garcini* and *Pedaliium murex*, etc. The plants like *Calotropis procera*, *Capparis decidua*, *Clerodendrum multiflorum* and *Euphorbia neriifolia* are also common.

The branched palm *Hyphaene dichotoma* and other palms and trees like *Borassus flabellifer*, *Phoenix sylvestris*, *Pithecellobium dulce*, *Pongamia pinnata*, *Tamarindus indica* and *Thespesia populnea*, etc. are common in Daman and Diu. The palm species *Hyphaene dichotoma* and *Phoenix sylvestris* are abundant in Diu and Daman respectively. The Union territory is ideal for coconut cultivation. Northern part of Daman and most of the cultivated area of Diu is densely covered by *Cocos nucifera* plantations.

Common hedge plants in the island are *Cadaba fruticosa*, *Capparis sepiaria*, *Cordia dichotoma*, *C. gharaf*, *Lantana* sp., *Maerua oblongifolia* and *Pongamia pinnata*.

Common climbers found in Daman and Diu are *Cayratia trifolia*, *Clitoria ternatea*, *Cocculus hirsutus*, *Ipomoea sepiaria* and *Mukia maderaspatana*.

Near the salt pans, halophytes, like *Suaeda* sp. and *Arthrocnemum* sp. are found together with grasses and sedges like *Aeluropus lagopoides*, *Fimbristylis polytrichoides*, *Cymbopogon parkeri*, *Chloris montana* and *Urochondra setulosa*, etc.

Caetano Gracias (1899) and C.F. Xavier Gracias (1902 and 1927) have published three small books in Portuguese on the plants of Daman and Nagar Haweli.

Previously the plant accounts of Daman and Diu were not worked out thoroughly ever though some workers like Cooke (1901-1908), Talbot (1909-1911), Saxton and Sedgwick (1918), Indrajithakar (1910) and several others made notable contributions to the floristic studies of Western India. In spite of such a good work on the plants of Western India data on the plants of Daman and Diu based on authentic herbarium material were lacking, except for few from Daman by Bhide (Rao, 1985).

Rao (1964) while working on the ecology of Saurashtra coast and neighbouring islands, has studied the ecology of Diu island.

Flora of Goa, Diu, Daman, Dadra and Nagar Haveli have been worked out by Rao (1985), with extensive exploration of these areas. At present ethnobotanical studies on Daman and Diu under All India Co-ordinated Research Project on Ethnobiology is in progress at Pune.

FLORISTIC DIVERSITY

Rao (1985) while working for the flora of Goa, Diu, Daman, Dadra and Nagar Haveli has recorded 404 angiospermic species belonging to 267 genera and 76 families from Daman and Diu alone as follows (Table I).

Table I
Number of families, genera and species

	Families	Genera	Species
Dicots	64	204	285
Monocots	12	63	119
Total	76	267	404

The largest ten families in the area of Daman and Diu are Poaceae (44 genera and 70 species), Fabaceae (25 genera and 42 species), Asteraceae (19 genera and 22 species), Cyperaceae (6 genera and 29 species), Euphorbiaceae (6 genera and 21 species), Acanthaceae (10 genera and 14 species), Scrophulariaceae (8 genera and 13 species),

Malvaceae (with 8 genera and 13 species), Convolvulaceae (6 genera and 13 species), Rubiaceae (6 genera and 9 species).

The following Tables II and III show the ten largest families in Diu and Daman and are compared with the total number of genera and species present in India.

Table II
Comparison of number of genera with that of India

Sl. No.	Family	Genera in Daman and Diu	Genera in India	Percentage occurrence in Daman and Diu
1.	Poaceae	44	264	16.66
2.	Fabaceae	25	167	14.9
3.	Asteraceae	19	166	11.44
4.	Acanthaceae	10	92	10.86
5.	Scrophulariaceae	8	62	12.90
6.	Malvaceae	8	22	36.36
7.	Rubiaceae	6	113	5.30
8.	Euphorbiaceae	6	84	7.14
9.	Cyperaceae	6	38	15.78
10.	Convolvulaceae	6	28	21.42

Table III
Comparison of number of species with that of India

Sl. No.	Family	Species in Daman and Diu	Species in India	Percentage occurrence in Daman and Diu
1.	Poaceae	70	1291	5.42
2.	Fabaceae	42	1141	3.68
3.	Cyperaceae	29	545	5.32
4.	Asteraceae	22	803	2.73
5.	Euphorbiaceae	21	523	4.01

Sl. No.	Family	Species in Daman and Diu	Species in India	Percentage occurrence in Daman and Diu
6.	Acanthaceae	14	500	2.8
7.	Scrophulariaceae	13	368	3.53
8.	Convolvulaceae	13	184	7.06
9.	Malvaceae	13	93	13.97
10.	Rubiaceae	9	616	1.46

The relative dominance of family Poaceae in this area in respect of number of genera and species is same for the whole country. Family Fabaceae takes second position in this area, and so also in the flora of India.

PHYTOGEOGRAPHY

Vegetation of Daman and Diu is allied to the general flora of the coastal regions of Gujarat, Maharashtra and Goa states.

The flora of Daman and Diu is represented by 404 species of angiosperms, comprising of 76 families and 267 genera. Most of them are found to be common along the coastal areas of Gujarat and Maharashtra states. However, some plants which are common in Daman and Diu are reported as restricted to the arid tracts of Gujarat State and Sind province of Pakistan, (Raghavan and Singh, 1983 and Sabnis and Rao, 1981). A few examples of such plant species are : *Atriplex stocksii*, *Commiphora wightii*, *Sericostoma pauciflorum* and *Statice stocksii*, etc.

Generally palms are seen in Diu with extensive growth of *Hyphaene* and *Borassus* are somewhat comparable with the palms of Sudan and North Arabia (Rao, 1985). But phytogeographically the flora of these areas show affinities with tropical and sub-tropical Africa and Indomalesia. The examples of such affinities are the common elements of tropical and sub-tropical Africa like: *Abutilon indicum*, *Desmodium gangeticum*, *Emilia sonchifolia*, *Gloriosa superba* and *Sesbania bispinosa*, etc. Some plants, like *Bombax ceiba* and *Cleome viscosa* found in Indomalesia are common in Daman and Diu (Rao and Ellis, 1995).

ENDEMISM

The endemic plant *Hyphaene dichotoma*, restricted to Western India, seen in several hundreds along the sandy bed of the airfield area of Diu and also in the adjoining regions outside Diu boundary, is really remarkable and has no parallel anywhere in India, either along coastal or desert areas (Rao,1985). While it is comparatively less in number in Daman.

Some of the endemic plant species of India are also distributed in this area: (Ahmedullah and Nayar,1986).

Sl.No.	Name of the species	Family
1.	<i>Atriplex stocksii</i>	Chenopodiaceae
2.	<i>Crotalaria filipes</i>	Fabaceae
3.	<i>Eriocaulon diana</i> var. <i>diana</i>	Eriocaulaceae
4.	<i>Erythrina variegata</i> var. <i>orientalis</i>	Fabaceae
5.	<i>Hibiscus talhotii</i>	Malvaceae
6.	<i>Hyphaene dichotoma</i>	Arecaceae
7.	<i>Ixora brachiata</i>	Rubiaceae
8.	<i>Neanotis rheedii</i>	Rubiaceae
9.	<i>Sericostoma pauciflorum</i>	Boraginaceae

ECONOMIC USES

A variety of plants are being used in the territory for different purposes, such as fruits, vegetables, cereals, pulses, fibres, condiments, spices, timber, bedi wrapping, liquor making, etc. They are categorised as follows.

Cereals and Millets : *Eleusine coracana*, *Oryza sativa* and *Zea mays*, etc. are the main cereals and millets cultivated in Daman.

Pulses : *Cajanus cajan*, *Cicer arietinum* and *Lablab purpureus* are the main pulses.

Condiments and Spices : *Allium sativum*, *Capsicum annum* and *Coriandrum sativum*.

Fibres : The fibre crops grown in the territory are *Crotalaria juncea*, *Gossypium arboreum*, *G. herbaceum* and *Hibiscus cannabinus*, etc.

Fruits : Plants cultivated for fruits are, *Annona squamosa*, *Carica papaya*, *Mangifera indica*, *Musa paradisiaca* and *Psidium guajava*; epicarp of ripe fruit of *Hyphaene dichotoma* is also edible.

Vegetables : Main vegetables grown in Daman and Diu are *Abelmoschus esculentus*, *Allium cepa*, *Brassica oleracea*, *Cucumis sativus*, *Ipomoea batatas*, *Luffa acutangula*, *Lycopersicon lycopersicum*, *Raphanus sativus* and *Solanum tuberosum*, etc.

Beverages : The fresh sap from *Borassus flabellifer* and *Phoenix sylvestris* is used as beverage.

Coconut : *Cocos nucifera* is one of the most important cash crop of the area.

Minor forest products : Some plants play an important role in the economy of the local people. Mature hard endosperm of *Hyphaene dichotoma* is utilised in making attractive small scent and snuff containers, thus serving as a good source for cottage industry.

Bauhinia racemosa and *Diospyros melanoxylon* leaves are used for Bedi wrapping. *Anacardium occidentale* is one of the cash crops cultivated in Daman.

Fodder Plants : *Apluda mutica*, *Crotalaria juncea*, *Cynodon dactylon*, *Digitaria* sp. and *Setaria pumila*; in addition many legumes are found growing wild in the grasslands, the common ones being *Geissaspis cristata*, *Goniogyna hirta* and species of *Desmodium*, *Alysicarpus* and *Indigofera*.

Medicinally Important plants

Some plants medicinally used in Daman and Diu are *Asparagus racemosus*, *Boerhavia diffusa*, *Capparis zeylanica*, *Gloriosa superba*, *Holarrhena pubescens*, *Justicia adhatoda*, *Solanum surattense*, *Vitex negundo* and *Woodfordia fruticosa*, etc.

MAJOR THREATS

There is no natural forest in Daman and Diu. Vegetation in the form of scrub jungle is also in the state of ecological degradation due to steadily dwindling areas of natural vegetation and due to biotic and abiotic interferences.

The natural vegetation in both the areas is not only damaged but also gradually being reduced in quality, for example, the palm *Phoenix sylvestris* is being overtapped for toddy, which otherwise with straight and tall trunks, often look crooked. Collection of coconut leaves and leaves of other palms for thatching purposes causes injuries particularly to young plants. It may result in decrease in number of these species.

Fishing and other related activities by fishermen at sea shore proves to be fatal for the herbaceous plant life along the sea shore.

Increase in industrial estates in Daman and its adjoining areas resulted in the great influx of people from outside the territory, and as a result of this the natural resources are depleting at a rate much faster than they are regenerating. The industrial effluents, which are being added in Damanganga river also directly or indirectly affects the vegetation along the river bank.

Slow but gradual increase in areas of salt production by salt producing agencies along the sea shore are also destroying the vegetation cover.

Illicit cutting of trees and shrubs by locals for fuel, fencing and construction of their thatched huts ultimately reduces the vegetation.

Grazing pressure

The seedling of trees, shrubs and herbaceous species are excessively grazed by herbivores, which reduces the scrub formation and thus destroys the natural vegetation by over exploitation.

The activities of Tourism department, especially in construction of roads and tourist spots, etc. like (in both areas) leads to the vegetation at some places along the sea shore being cleared off for developing tourist spots by building cottages and tented accomodation, etc.

CONSERVATION MEASURES

Man has yet to realise that the plants, vital for his survival are continuously being destroyed by him for different purposes. Now it is time, that plants or forest should be conserved. If not, the degradation will soon reach a point where reclamation would be extremely difficult. Thus, he must make every effort to protect the plants.

For conserving the vegetation, it is essential to give suitable and effective protection to the area, otherwise destruction of vegetation will very soon result in destruction of habitat of the plants.

As far as Daman and Diu are concerned, most of the land part is being used for non forestry purposes, except the areas under plantation of *Casuarina equisetifolia* declared as reserve forest, which forms thick patches along the sea shore.

For protection and conservation of the plants, administration of Daman and Diu have taken several steps. Plants like *Casuarina equisetifolia*, *Mangifera indica*, *Tamarindus indica*, etc. has been provided to local tribal families to plant on their field bunds and available land at their house and farm sites. Under the scheme, rupees ten per plant per month and proper fencing materials are also provided for proper care and protection. At present, there is complete ban on the sale of land by the native tribal to non-tribal, ultimately, this avoids increase in number of industries in the territory and also limits the use of farm land for other purposes. The scheme for subsidy grant to locals for coconut plantation is also approved by administration.

Apart from these above mentioned measures taken by the authorities of Daman and Diu, more conservation could be achieved by adopting very strict legislation to save the floristic diversity.

The following measures may help to maintain the floristic diversity of this region.

(1) *In situ* conservation of some economically and medicinally important species; (2) Selection of plots for coconut cultivation only in heavily disturbed and waste land areas; (3) Control over open grazing; and (4) Develop awareness among local people towards conservation of floristic diversity through various programmes.

REFERENCES

- Ahmedullah, M and M.P. Nayar 1986. *Endemic Plants of the Indian Region*. Botanical Survey of India, Calcutta.
- Anonymous 1991. *Eighth Five Year Plan 1992-97 and Annual Plan 1992-93 of Tribal sub-plan, Daman*. Prepared by Collectorate, Daman, Tribal Sub-Plan Cell, Daman and Diu.
- Raghavan, R.S. and N.P. Singh 1983. Endemic and Thrtatened plants of Western India. *Plant Conservation Bulletin*. No. 3.
- Rao, R.S. 1985. *The Flora of Goa, Diu, Daman, Dadra and Nagar Haveli*. Vol. I and II, Botanical Survey of India.
- Rao, T.A. and K.R. Agarwal 1964. Ecological studies of Saurashtra Coast and Neighbouring Islands. I. Diu Island. *Bull. Bot. Surv. India* 6(2-4): 173-183.
- Rao, T.A. and J.L.Ellis 1995. Flora of Lakshadweep Islands off the Malabar Coast, Peninsular India with emphasis on phytogeographical distribution of plants. *J. Econ. Tax. Bot.* 19(1). 235-250.
- Sabnis, S.D. and K.S.S Rao 1983. Observations on some Rare or Endangered Endemics of South-eastern Kutch. In: S.K. Jain and R.R. Rao (eds.) *An assessment of threatened plants of India* pp. 71-77.



Hyphaene dichotoma : Indian doum palm and its regeneratin, Diu



Phoenix sylvestris : patch along sandy seashore, Daman



Erythrina sp. : commonly grown in Daman



Swampy area at Chasi river, Diu harbouring mangrove species, *Avicennia marina* var. *acutissima*

DELHI

B.D. Naithani

B.P. Uniyal

Delhi, being seat of power for many rulers in the past, has played a crucial role in the Indian History. Its lofty towers, magnificent palaces, grand mosques and temples, splendid mausolea and majestic forts bear ample testimony to its glorious past. The earliest mention of a settlement at Delhi is found in the famous epic "Mahabharata" which describes a city called Indraprastha along the bank of Yamuna between the more modern Kotla of Feroze Shah and Humayun's tomb. While the origin of the name "Delhi" is shrouded in antiquity, the first reference to it appears to date back to first and second centuries A.D. Ptolemy, the noted Alexanderine geographer had marked "Daidala" in his map of India between Mathura and Thaneshwar close to Indraprastha. Its origin is also believed to have been derived from Raja Dhilu who ruled the region in ancient times. However, according to more reliable belief, Delhi was founded in 736 A.D. by Tomars, a Rajput clan who ruled over the territory of Haryana with Dhillika as its capital. Thus the name of the city seems to have finally evolved from "Daidala" through "Dhillika" and "Dilli". The ruins of atleast eight capitals, scattered over an area of about 181.3 sq km provide enough inkling to the prominence of this territory in the political geography of India. Barring Rome and Istanbul, perhaps no capital city in the world had such a long and sustained significance. The territory assumed the status of National Capital in 1912 when the Britishers shifted the metropolis from Calcutta to New Delhi.

The National Capital Territory Region (NCTR) or the Union Territory of Delhi lies between the coordinates 28°12' - 28°53' N Latitudes and 76°50' - 77°23' E Longitudes. Situated on the watershed dividing two mighty river systems, viz. the Indus and the Ganges, the region occupies a nodal position in the Indian subcontinent. It is bounded on the North, South and West by Karnal, Gurgaon and Rohtak districts of Haryana respectively, and on the East by river Yamuna that forms the boundary with Meerut and Ghaziabad district of Uttar Pradesh. The territory, with an average elevation of 213-219 m above mean sea level, extends to a maximum length of 53 km and breadth of 48 km covering a total geographical area of about 1483 sq km. The Delhi ridge, which is the culminating spur of Mewat Branch of Aravali Hills, constitutes the most

significant geomorphological feature of the region. Famous as Delhi Ridges it spreads across the territory of Delhi in the Southwest - Northeast direction. It enters the Union Territory from South and runs straight up to Yamuna in North-east direction, appearing like rampart of a huge fort. An outcrop of the Ridge near Bhati extends in a north-easterly direction upto Arangpur and then turns to North-West till it meets the main ridge again in a sweeping curve. The Ridge is fairly dissected, and apart from its main branch there are a number of flanking spurs adding to the complexity of the landscape.

Delhi has four well defined natural physiographic divisions which have considerably influenced the associations and distribution of plants. These are Khadar or the riverine zone adjoining river Yamuna, Bangar or the area irrigated by wells and canals, the Dabar or the low-lying rain fed areas, and Kohi or the hillsides. The climate of the territory is characterised by great extremes of temperature, low rainfall, mild wind and frequent thunder and dust storms and squalls. The summer is marked by scorching heat, with the mercury rising as high as 46°C, whereas the average minimum temperature during the extreme winter month is about 6°C. The average annual precipitation is about 67 cm, with the highest annual rainfall recorded in the territory being 153 cm in 1933 and lowest 20.68 cm in 1868.

Wedged between the thar desert of Rajasthan, the Indo-Gangetic plain and the Aravalis, the Union Territory shows an assemblage of floristic elements of arid regions of Rajasthan, drier regions of Upper Gangetic Plains and semi-arid parts of Haryana. Most of the vegetation found on the Ridge, in the marshes, ponds and along the bank of Yamuna are naturally occurring, while others, though not indigenous, have long become naturalised. The tree species are usually sparse, medium sized and thorny with an open canopy that facilitates dense herbaceous ground vegetation.

VEGETATION

As mentioned by Maheswari (1963) the natural flora of Delhi is represented by the ridge and is characteristic of arid or semi arid zones. The tree species here include *Acacia nilotica* ssp. *indica*, *A. catechu*, *A. modesta*, *Butea monosperma*, *Balanites roxburghii*, *Anogeissus pendula*, *Cordia dichotoma*, *Diospyros cordifolia*, *Ehretia laevis*, *Holarrhena pubescens*, *Flacourtia indica*, *Wrightia tomentosa* etc. The shrubs and

undershrubs are dominated by *Capparis sepiaria*, *Carissa spinarum*, *Adhatoda zeylanica*, *Maytenus senegalensis*, *Indigofera tinctoria*, *Clerodendrum phlomidis*, *Grewia tenax*, *Ziziphus nummularia*, *Securinega leucopyrus*, *Tephrosia* spp., *Salvadora* spp., etc.

The herbaceous vegetation includes *Cleome viscosa*, *Bidens biternata*, *Ageratum conyzoides*, *Achyranthes aspera*, *Martynia annua*, *Peristrophe bicalyculata*, *Pupalia lappacea*, *Euphorbia hirta*, *Dichanthium annulatum*, *Corchorus aestuans*, *Triumfetta rhomboidea*, *Xanthium strumarium* and many other seasonal species.

Among the twiners *Cissampelos pareira*, *Cayratia carnosia*, *Coccinia indica*, *Melothria heterophylla*, *Abrus precatorius*, *Cucumis sativus*, *Cryptolepis grandiflora*, *Telosma pallida*, *Cardiospermum halicacabum*, *Rhynchosia minima*, *Rivea hypocrateriformis*, *Ipomoea* spp., etc.

In the low lying areas especially adjoining the river Yamuna, the vegetation is represented by pure formations of *Tamarix troupii* and *T. dioica* with *Alhagi pseudalhagi* mixed up at some places. *Citrullus colocynthis*, *Fimbristylis dichotoma*, *Desmostachya bipinnata*, *Scirpus affinis*, *Salvadora persica* and species of *Suaeda*, *Eragrostis* and *Sporobolus* may also be seen in the sandy locations.

The aquatic and marshy vegetation includes *Ceratophyllum demersum*, *Eichhornia crassipes*, *Lemna paucicostata*, *Nymphaea nouchali*, *Oenanthe javanica*, *Ranunculus sceleratus*, *Ammannia baccifera*, *Phragmites karka*, *Hydrilla verticillata*, *Vallisneria spiralis*, *Nymphoides cristata*, *Panicum paludosum*, *Eleocharis palustris*, *Jussiaea repens*, *Typha angustata*, *Polygonum glabrum*, *P. barbatum* etc. A few of the bladderworts e.g. *Utricularia flexuosa* and *U. stellaris* have also been recorded from the marshy habitats.

A large number of plants both indigenous and exotic have been introduced in Delhi as ornamentals, Avenue trees, Garden plants and hedges. Some of such species are *Azadirachta indica*, *Ailanthus excelsa*, *Cassia fistula*, *Delonix regia*, *Albizia lebeck*, *Haplophragma adenophyllum*, *Jacaranda mimosifolia*, *Kigelia pinnata*, *Parkinsonia aculeata*, *Dalbergia sissoo*, *Pongamia pinnata*, *Acacia auriculiformis*, *Millingtonia hortensis*, *Alstonia scholaris*, *Mimusops elengi*, *Michelia champaca*, *Magnolia grandiflora*, *Anthocephalus chinensis*, *Polyalthia*

longifolia, *Bombax ceiba*, *Chorisia speciosa*, *Pterospermum acerifolium*, *Pterygota alata*, *Mitragyna parviflora*, *Moringa oleifera*, *Ficus* spp., *Lagerstroemia* spp., *Terminalia* spp., *Syzygium cumini*, *Melia azedarach*, *Adenocalymma nitidum*, *Dombeya mastersii*, *Tabernaemontana divaricata*, *Pyrostegia venusta*, *Clerodendrum splendens*, *Campsis radicans*, *Roystonea regia*, *Caryota urens*, *Casuarina equisetifolia*, *Cupressus sempervirens*, *Holmskioldia sanguinea*, *Citrus microcarpa*, *Guazuma ulmifolia* and many others.

FLORISTIC DIVERSITY

Following Mukherjee, (1953), Paker (1918), Maheshwari (1963), Viswanathan *et al.* (1982, 1991) the flowering plants of Delhi comprises approximately 962 species (including exotics) of flowering plants belonging to 123 families and about 579 genera. The number of families of Dicotyledonous, Monocotyledonous and Gymnosperms are tabulated below (Table I).

Table I
Conspectus of Families, genera and species

Plant group	No. of Families	No. of Genera (apprx.)	No. of Species (apprx.)
DICOTS	99	472	771
MONOCOTS	23	104	184
GYMNOSPERMS	1	2	2

The dominant families in the Flora of Delhi (species wise) are as follows in Table II.

Table II
Dominant Families

Family	Delhi	India
Leguminosae	(59) 123	(167) 1141
Poaceae	(59) 99	(264) 1291
Asteraceae	(38) 54	(167) 950

Family	Delhi	India
Cyperaceae	(7) 37	(38) 545
Euphorbiaceae	(13) 32	(84) 528
Malvaceae	(12) 31	(22) 93
Acanthaceae	(18) 30	(92) 510
Convolvulaceae	(9) 28	(28) 184
Verbenaceae	(16) 26	(25) 145
Amaranthaceae	(9) 17	(20) 60
Lamiaceae	(8) 15	(72) 454
Bignoniaceae	(13) 14	(20) 34

The Figures in parenthesis represent the number of genera.

Cyperus with 20 species is the largest genus in the flora of Delhi followed by *Ipomoea* (18), *Euphorbia* (13) and *Cassia* (12). Rest of the genera have less than 10 species.

Table III
Dominant Genera

Name of genera	No. of Species
<i>Cyperus</i>	20
<i>Ipomoea</i>	18
<i>Euphorbia</i>	13
<i>Cassia</i>	12
<i>Acacia</i>	8
<i>Eragrostis</i>	8
<i>Indigofera</i>	8
<i>Solanum</i>	8
<i>Corchorus</i>	6
<i>Crotalaria</i>	6
<i>Eucalyptus</i>	6
<i>Jasminum</i>	6
<i>Polygonum</i>	6

The interesting, rare and threatened taxa include *Decaschistia crotonifolia*, *Hibiscus surattensis*, *Lotus corniculatus*, *Melthania futteyporensis*, *Petunia parviflora*, *Crotalaria hirta*, *Tribulus rajasthanensis*, *Mazus delavayi*, *Vahlia digyna*, *Lactuca dissecta*, *Desmodium tortuosum*, *Waltheria indica*, *Euphorbia heyneana*, *E. helioscopia*, *Cuscuta chinensis* etc.

PHYTOGEOGRAPHICAL AFFINITIES

Detailed studies of earlier workers Mukherjee (1953) and Maheswari (1963) reveal that the characteristic elements of natural flora of Delhi state show a great affinity with the flora of adjoining states like Rajasthan, Punjab plains and the Northern drier parts of Uttar Pradesh. The presence of *Acacia*, *Anogeissus*, *Balanites*, *Capparis* and *Grewia* species reveals African affinity. There is good representation of elements coming from Malayan region in the east, from North Africa through Asia Minor and the widespread elements of tropics and of purely Indian species. Blatter and Hallberg also report the occurrence of same three type of elements in the Flora of Rajputana Desert. The North African elements are much more prevalent than the Indo-Malayan elements in the flora of Delhi state.

ECONOMIC PLANTS

The following species of plants are of economic importance and being used locally for various purposes.

Name of the species	Uses
<i>Abrus precatorius</i>	Seeds used as Jeweller's weight
<i>Adhatoda zeylanica</i>	Medicinal
<i>Aeschynomene indica</i>	Fodder
<i>Alhagi pseudalhagi</i>	Camel fodder
<i>Azadirachta indica</i>	Medicinal
<i>Bacopa monnieri</i>	Medicinal
<i>Balanites roxburghii</i>	Medicinal and other uses
<i>Corchorus capsularis</i>	Fibre
<i>C. depressa</i>	Medicinal
<i>Crotalaria burhia</i>	Fodder
<i>C. juncea</i>	Flowers eaten as vegetable

Name of the species	Uses
<i>C. medicaginea</i> var. <i>luxurians</i>	Fodder
<i>Fagonia cretica</i>	Medicinal
<i>Grewia asiatica</i>	Fruits are used on cooling
<i>G. tenax</i>	Fruits edible
<i>Hibiscus micranthus</i>	Fruits edible
<i>Indigofera hochstetteri</i>	Fodder
<i>Justicia procumbens</i>	Medicinal
<i>Lathyrus aphaca</i>	Fodder
<i>L. sativus</i>	Fodder
<i>Medicago polymorpha</i>	Used as vegetable
<i>Melilotus alba</i>	Fodder
<i>Pedaliium murex</i>	Medicinal
<i>Polygala chinensis</i>	Roots used as substitute for Senega
<i>Scoparia dulcis</i>	Medicinal
<i>Sida cordifolia</i>	Medicinal
<i>Solanum nigrum</i>	Medicinal
<i>S. surratense</i>	Medicinal
<i>Sporobolus diander</i>	Horse fodder
<i>Tephrosia purpurea</i>	Medicinal
<i>Tribulus terrestris</i>	Medicinal
<i>Withania somnifera</i>	Medicinal

CONSERVATION STRATAGIES

Considerable damage has been done to the natural flora on the Ridge and its neighbouring hilly tracts of Delhi state. The practices of encroachments in the past as well as in the present such as the Polo club on the Presidents estate in the Central Ridge, about 100 marble traders shops occupying an area of 25,000 sq m on the Central Ridge, well equipped farm houses with swimming pools and stables, occupying about 150 hectares in the southern ridge, presence of Para Military camps occupying 300 acres and temporary establishments of CRPF occupying 20.5 acres in the Central Ridge, have undoubtedly resulted in a heavy damage to the prime forest of the Ridge. Many of the species like *Acacia catechu*, *A. eburnea*, *Boswellia serrata*, *Euphorbia nivulia*, *Grewia*

flavescens, *Melhanian futteyporensis*, *Decaschistia crotonifolia* etc., have become rare (Maheshwari 1963) or have even disappeared. Some of the species like *Flacourtia indica*, *Mimosa hamata*, *Rhus mysurensis*, *Fimbristylis junciformis* etc., are to be found in patches and that too in restricted areas.

The Ridges have now been thoroughly surveyed and four ridges instead of the two have been identified.

1. Northern Ridge	:	87 hectares
2. Central Ridge	:	864 hectares
3. South-Central Ridge	:	626 hectares
4. Southern Ridge	:	<u>6200 hectares</u>
Total	:	7777 hectares

For the scientific management and better development of the ridge area, a committee was set up. On the recommendation of this committee, three ridges have been handed over to Delhi Development Authority while the Southern ridge remains under the Control of Forest Department.

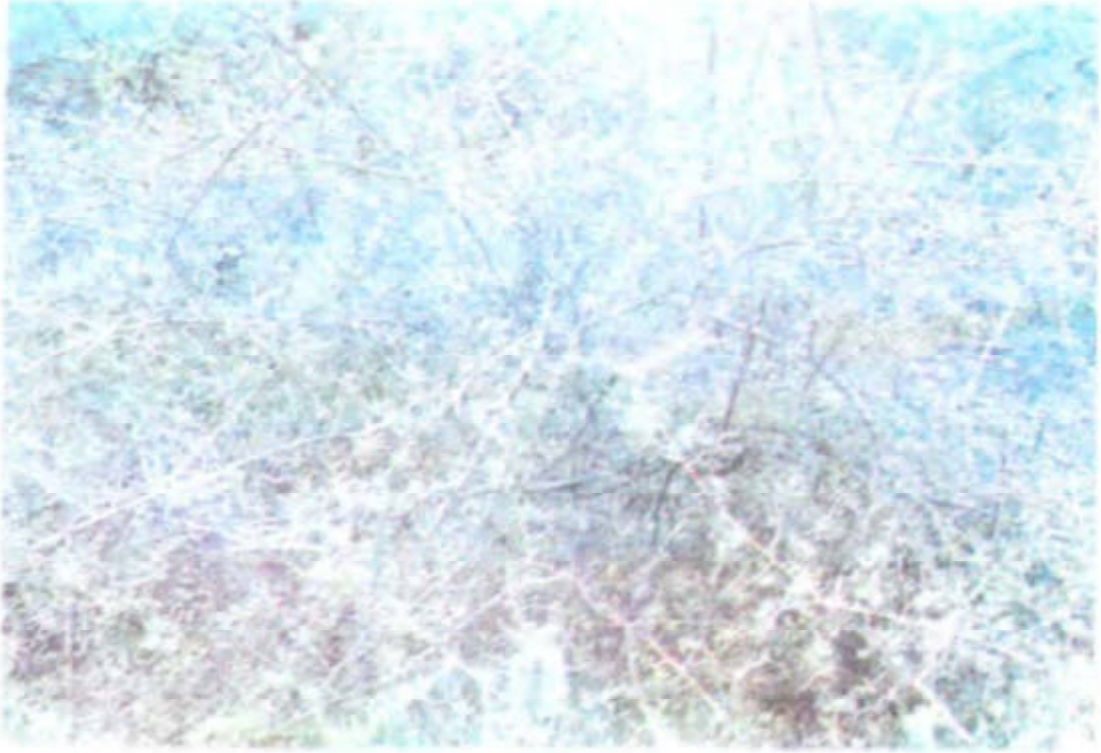
The following steps have been taken for the conservation of the floristic diversity of the Ridge area and the areas proposed under afforestation programme.

All the four ridges have been declared as Reserve Forest in 1994 under the Forest Act 1927. Strict vigilance, however, has to be maintained to prevent any encroachments. Secondly, while the conversion of the ridge area into parks should be stopped all the afforestation programmes in the region should utilise indigenous species only.

The apex court has also come forward by ordering eviction of the ridge by unauthorised residents and dismantling the encroachments. This certainly will help in conserving the natural flora. The lost species can be gathered from the neighbouring states and planted on the ridge.

REFERENCES

- Maheshwari, J.K. 1963. *The Flora of Delhi*. New Delhi.
- Maheshwari, J.K. 1966. *Illustrations to the Flora of Delhi*. New Delhi.
- Mukherje, S.K. 1953. Vegetation of the Delhi 'Ridge'. *J. Bomb. Nat. Hist. Soc.* 51: 439-465.
- M.V. Viswanathan *et al.* 1982. Additions to the Flora of Delhi. *J. Econ. Tax. Bot.* 3: 579-580.
- M.V. Viswanathan 1991. Additions to the Flora of Delhi. *J. Econ. Tax. Bot.* 15(2): 446-447.
- Parker, R.N. 1918. *A Forest Flora for the Punjab with Hazara and Delhi* (ed. 3. 1924), Lahore.



Rhus mysurensis in JNU area, sparsely growing in some places



Albizia lebbek along the road within the campus of JNU



Prosopis juliflora Forest



Vegetation in and around JNU with common species of *Acacia nilotica* ssp. *indica*, *Prosopis juliflora*, *Cassia fistula*, *Tamarindus indica*, *Azadirachta indica* and *Pongamia pinnata*, gradually becoming scarce in the area

GOA

N.P. Singh
M.J. Kothari

Goa, Gomantak, Gomanchal or Govapuri, the land of scenic beauty is situated between 14° 53' 15° 47' N latitude and 73° 40' 74° 20' E longitude covering an area of about 4000 sq km with Ratnagiri district on the north, Uttar Kannada on the south, the Western ghats on the east and the Arabian sea on the west. Goa has 131 km long coast line with 105 km length and 60 km width and 11 administrative talukas. There are 7 estuarine areas of which rivers Mandovi (c 61.6 km long) and Zuari (62.4km long) form wide alluvial deltas. A water fall 'Dudhasagar' is located in Sangeum taluka. There are 4 Sanctuaries, viz. Bhagwan Mahavir (Molem) wild life sanctuary (240 sq km), Bonda wild life sanctuary (8 sq km), Choraro island Dr. Salim Ali wild life sanctuary (2.78 sq km) and Kotigao wild life sanctuary (105 sq km). There is also a National Park viz., Bhagwan Mahavir N.P. (Molem 107 sq km) in Goa.

Soils of Goa are of three types

1. 'Laterites' of high and low level types formed by natural metamorphosis and degeneration of underlying rocks along ghats.
2. Red gravelly soils derived from micaceous granite gneiss covering undulating plateau, mixed with black soils in adjoining river banks.
3. Alluvial soils including coastal alluvium along coastal belt.

Climate of Goa is humid, relaxing and healthy with usual four seasons. The annual average rainfall is about 2,500 mm. The maximum temperature is 35° 37°C in April-May, while the lowest is in January ranging from 15°- 16°C.

VEGETATION

'Garcia da Orta' was the first person who studied drug plants of Goa. Based on his contacts with local Ayurvedic Vaidyas and personal experience for about three decades, in 1563, he published a detailed account of *ca* 57 medicinal plants. This was followed only by the work

by D'Silva (1862) with a small publication on *Natural History of Goa* with a floristic list of c 163 species. Dalgado (1898) published a list of ca 731 wild and 279 cultivated species with local names. This includes plants of Sawantwadi also. Vartak (1966) published a list of c 1512 species from *Gomantak* based on literature and plant exploration. This list includes c 200 species from Goa and rest from N. Kanara, Ratnagiri etc. (Rao, 1985). Thereafter the region was explored by Botanical Survey of India, Western Circle, Pune with the help of Raghavan, Singh, Kanodia and Cherian and Nagar Haveli by Ansari in different seasons beginning with November 1962. Based on these explorations and collections, Rao (1985) published a detailed *Flora of Goa, Diu, Daman, Dadra and Nagar Haveli* in two volumes. Kothari and Rao (1990, 91, 95) explored coastal belt of Goa. The vegetation of Goa can be broadly classified into following four categories.

1. Estuarine vegetation consisting of mangroves along swampy river banks

Mangroves are located along the swampy banks of Chapora, Mandovi, Tiracol and Zuari rivers. They are abundant at Camburjua canal linking Mandovi and Zuari and Chorao Island located in Panaji (Kothari and Rao, 1990).

The Mangroves are distributed uniformly in the swampy habitat. Dominant species found among them are *Avicennia alba*, *A. marina*, *A. officinalis*, *Excoecaria agallocha*, *Kandelia candel*, *Rhizophora apiculata*, *R. mucronata* and *Sonneratia caseolaris*, etc., while *Aegiceras corniculatum* and *Bruguiera gymnorrhiza* are scattered and infrequent.

Some mangrove associates and a few others occur as undergrowth. They are *Acanthus ilicifolius*, *Acrostichum aureum* (littoral fern), *Caesalpinia crista*, *Cayratia trifolia*, *Cyperus arenarius*, *C. compactus*, *C. malaccansis*, *Derris trifoliata*, *D. scandens*, *Fimbristylis dichotoma*, *Sesuvium portulacastrum*, etc. On the stem-branches of *Rhizophora* spp., epiphytic ferns like *Drynaria quercifolia* and orchids like *Vanda tessellata* were collected.

2. Strand vegetation

In sandy and rocky coastal areas tree species observed are *Calophyllum inophyllum*, *Hyphaene dichotoma*, *Pandanus tectorius*,

Pongamia pinnata, *Thespesia populnea*, etc. and cultivated ones like *Anacardium occidentale*, *Casuarina equisetifolia* and *Cocos nucifera*, etc., Other associated herbaceous species found as undergrowth or as soil binders are *Boerhavia diffusa*, *Cyanotis cristata*, *Ipomoea pes-caprae*, *Phyla nodiflora*, *Spinifex littoreus*, etc.

3. Plateau vegetation along undulating terrain and foothills

This category includes a major portion of Goa with the following two sub-types.

(a) Open scrub jungle

This type of vegetation occurs on undulating rocky plateau from 50-200 m alt. Due to various biotic effects, this type has become scanty along Panaji to Colvale, Cortalim to Margao and Bicholim to Sanquelim. Here *Anacardium occidentale* is cultivated on a large scale. On waste lands, some dry deciduous elements occur like *Carissa congesta*, *Calicopteris floribunda*, *Holarrhena pubescens*, *Lantana camara* var. *aculeata*, *Microcos paniculata*, *Vitex negundo* and species of *Acacia*, *Albizia*, *Breynia*, *Terminalia*, *Ziziphus*, etc. While herbaceous species found are *Borreria stricta*, *Euphorbia fusiformis*, *Girardinia zeylanica* and *Scoparia dulcis* and many climbers eg. species of *Asparagus*, *Ampelocissus*, *Cissus*, *Cissampelos*, *Cocculus*, *Dioscorea*, *Gloriosa*, *Gymnema*, *Pergularia*, *Wattakaka*, etc. A few species of grasses and Cyperaceae like *Cyperus arenarius*, *Heteropogon* sp., *Perotis* sp. etc., were present.

(b) Moist deciduous forest

These types of forest are found around Tudal, Ordfond, Butpal, Molem, Kodal, Ambiche gol near Valpoi and Anmode ghat at altitudes between 200-500 m. Important floristic components found in the areas are species of *Anogeissus*, *Careya*, *Dalbergia*, *Dillenia*, *Grewia*, *Hymenodictyon*, *Lannea*, *Phyllanthus*, *Terminalia*, *Wrightia*, *Xeromphis*, *Xylia*, etc. These are mixed with *Bambusa* sp. and *Dendrocalamus strictus*. Similarly, some members predominant in these forest are species of *Haldina*, *Ixora*, *Mitragyna*, *Morinda*, etc., of family Rubiaceae; species of *Heterophragma*, *Oroxylum* and *Radermachera* of Bignoniaceae; species of *Bridelia*, *Glochidion*, *Mallotus*, etc., of Euphorbiaceae and species of *Acacia*, *Albizia*, *Dalbergia*, *Pterocarpus*, etc. of Leguminosae.

The first tier is composed of a number of tall, arboreal trees e.g. *Kydia calycina*, *Lagerstroemia lanceolata*, *Schleichera oleosa* and *Terminalia crenulata* while second tier includes medium sized trees like *Alstonia scholaris*, *Garuga pinnata*, *Macaranga peltata*, *Xerophis spinosa*, etc. The third tier includes small trees like *Callicarpa tomentosa*, *Ziziphus xylopyrus*, etc. The ground flora includes some herbaceous plants species like *Alysicarpus*, *Crotalaria*, *Indigofera*, *Justicia*, *Lepidagathis*, *Rungia*, *Scoparia*, *Torenia*, etc. A number of climbers in the families Convolvulaceae, Cucurbitaceae, Fabaceae, Ranunculaceae, Smilacaceae, etc., are also met with. In moist places, some Pteridophytic elements like *Ophioglossum fibrosum*, *Pteris vittata*, *Selaginella prouneri*, *S. tenera* etc. also occur.

4. Semi-evergreen and evergreen vegetation along upper ghats

(a) Semi-evergreen forest

Such forest are seen at Ambichegol, Butpal, Molem and Nadquem at elevations above 500 m. The vegetation here also can be differentiated into three tiers.

The first tier includes some tall trees like *Actinodaphne angustifolia*, *Canthium dicoccum*, *Cryptocarya wightiana*, *Ficus talbotii*, *Lagerstroemia lanceolata*, *Michelia champaca*, *Pterospermum diversifolium*, *Zanthoxylum rhetsa* etc.

The second tier includes trees like *Alseodaphne semicarpifolia*, *Bischofia javanica*, *Clausena dentata*, *Glochidion hohenackeri*, *Hopea wightiana*, *Ixora nigricans*, *Linociera malabarica*, *Macaranga peltata*, *Olea dioica* etc. Some other trees are also observed along the forest outskirts e.g. *Blachia denudata*, *Celtis cinnamomea*, *Ficus asperrima*, *Glochidion velutinum*, *Leea edgeworthii*, *Meyna laxiflora* etc.

The third tier consists of some shrubs like *Chassalia ophioclyoides*, *Glycosmis mauritiana*, *Gymnosporia rothiana*, *Leea indica*, *Maesa indica* etc. These species are associated with some climbing shrubs e.g. *Ancistrocladus heyneanus*, *Connarus wightii*, *Lavanga sarmentosa*, *Rourea santaloides*, *Salacia oblonga* etc. In disturbed forest areas *Careya arborea*, *Dillenia pentagyna* etc. are frequently associated with climbers like *Anodendron paniculatum*, *Argyreia* spp., *Smilax zeylanica* etc.

(b) Evergreen forest

The density of evergreen forest is much less due to biotic interference. The tall and lofty tree components observed here are *Artocarpus gomezianus*, *Calophyllum elatum*, *C. apetalum*, *Canarium strictum*, *Diospyros ebenum*, *Garcinia gummi-gutta*, *Knema attenuata*, *Lophopetalum wightianum* etc. whereas middle sized trees include *Aporosa lindeleyana*, *Carallia brachiata*, *Euodia lunu-akenda*, *Ficus asperrima*, *Litsea wightiana* etc. Near water streams, plants like *Ficus tsjakela*, *F. talbotii*, *Hydnocarpus laurifolia*, *Mammea suriga*, etc. are frequent. Alongwith them, some woody climbers or lianas like *Butea parviflora*, *Chonemorpha fragrans*, *Derris bakerii*, *Entada rheedeii*, *Gnetum ula*, etc. and as undergrowth shrubby species like *Dracaena terniflora*, *Ixora coccinea*, *Mackenzia sp.*, *Rauvolfia serpentina* etc. are met with. The ground vegetation is scattered, poor and limited to the members of Araceae, Asteraceae, Cyperaceae, Jrticaceae and Zingiberaceae due to frequent cutting and grazing (Rao, 1985).

Epiphytes as compared to those of N. Kanara are poor and limited to the members of Orchidaceae species of *Aerides*, *Bulbophyllum*, *Cymbidium*, *Eria*, *Vanda* etc. and *Asclepiadaceae*, *Hoya pendula* and Araceae, *Remusatia vivipara*. A few species like *Agrostemma courtallense*, *Begonia crenata*, *Utricularia striatula*, etc., are found in the crevices of tree bark in moist places. Some epiphytic ferns like *Drynaria quercifolia*, *Microsorium membranaceum*, *Pyrrosia adnascens*, etc., occur there frequently. "Parasitic elements" like *Aeginetia indica*, species of *Rhamphicarpa*, *Santalum*, *Sopubia*, *Striga*, etc., are found as root-parasites, while members of Loranthaceae, viz. species of *Dendrophthoe*, *Helicanthes*, *Helixanthera*, *Viscum*, etc., and *Cuscutaceae*, *Cuscuta reflexa* are frequent. Some terrestrial orchids like species of *Habenaria*, *Malaxis*, *Nervilia*, *Peristylis*, *Plantanthera*, etc., also occur.

Herbaceous flora found here are *Adenostemma lavenia*, *Ageratum conyzoides*, *Blumea, sp.*, *Costus speciosus*, *Curcuma decipiens*, *Emilia sonchifolia*, *Spilanthes paniculata*, etc. alongwith members of Cyperaceae, Eriocaulaceae, Fabaceae and Poaceae.

Hydrophytes

These include submerged, free floating as well as some marshy plants. The rooting marsh plants include *Monochoria vaginalis*, *Nelumbo*

nucifera, *Nymphaea pubescens*, *N. nouchali*, species of *Cryptocoryne*, *Eriocaulon*, *Polygonum*, etc. besides many sedges and grasses. A littoral fern, *Acrostichum aureum* also grows along back waters of Mandovi, Zuari and Tirem, some submerged aquatic species like *Blyxa echinosperma*, *Ceratophyllum demersum*, *Hydrilla verticillata*, *Ottelia alismoides*, *Vallisneria spiralis*, etc., occur frequently. Some other free floating aquatics found over surface of water are *Hygrorhiza aristata* (a floating grass with swollen petiole), *Neptunia oleratia*, *Pistia stratiotes*, *Utricularia flexuosa*, etc. A rare marshy plant, *Eriocaulon rivulare* also occurs here. Some members of Podostemaceae like *Griffithella hookeriana* and *Terniola zeylanica* in association with *Homonoia riparia* also occur in flowing streams. In moist or drying mud near ponds some insectivorous plant species of *Drosera* and *Utricularia* are found associated with *Bacopa*, *Cyperus*, *Limnophila*, *Phyla*, *Xyris*, etc. On the banks of streams, some rheophytic species like *Pandanus tectorius* with thickets of *Lygodium flexuosum* and tree species like *Barringtonia racemosa*, *Hydnocarpus laurifolia*, etc., are observed.

Grasses

In swampy regions of Goa, a number of grasses observed and collected are *Hygrorhiza aristata*, *Isachne miliacea*, *Jansenella griffithiana*, *Paspalidium geminatum*, *Saccharum spontaneum* etc. In moist shady places, species found are *Garnotia stricta*, *Oplismenus burmanni*, *O.compositus*, *Sporobolus diander*, etc. Along stony sea-shore and rocky slopes, species of *Eragrostis*, *Digitaria*, *Heteropogon*, *Manisuris*, *Perotis*, *Themeda*, etc., occur. Grasses like *Manisuris talbotii* are endemic to Goa and adjoining region and a new species *Manisuris goensis* has been also described (Rolla Rao, 1985). Similarly, *Porteresia coarctata* is found as a new record for Goa and Gujarat states (Kothari and Rao, 1991) and some sedges in the family Cyperaceae have also been found in association with grasses e.g. species of *Cyperus*, *Cyanotis*, *Fimbristylis* etc.

Plants of Botanical interest

The flora of Goa is interesting and important from two view points, taxonomically as well as academically. A new species, *Manisuris goensis* (Rao and Hemadri, 1968) and new records *Bruguiera cylindrica*, *Dolichandrone spathacea* and *Porteresia coarctata* (Kothari and Rao, 1991, 1994, 1995) are known from Goa besides a rare plant, *Ceropegia*

fantastica, collected from Goa after a lapse of over 50 years (Rao, 1985). Some insectivorous plants like *Drosera indica* and *Utricularia* spp., members of Podostemaceae like *Griffithella hookeriana*, *Hydrobryopsis sessile*, *Polypleurum stylosum*, *Terniola zeylanica*, and parasites like *Aeginetia indica*, species of *Dendrophthoe*, *Helicanthes*, *Helixanthera*, *Lotanthus*, *Macrosolen* and *Viscum* are known from Goa. Epiphytic and terrestrial orchids found in the area are species of *Cymbidium*, *Dendrobium*, *Eulophia*, *Habenaria*, *Liparis*, *Plantanthera*, *Pholidota*, *Vanda*, etc. Some pteridophytic elements occurring in the area are *Acrostichum aureum* (a littoral fern), *Angiopteris evecta*, *Ophioglossum fibrosum*, *Schizoloma heterophyllum*, *Selaginella*, sp., etc.

FLORISTIC DIVERSITY

The floristic diversity of Goa includes 1143 species belonging to 683 genera among 158 families of Angiosperms, Gymnosperms and Pteridophytes of the 1115 species of Angiosperms, 891 species belong to dicots in 538 genera of 124 families while 224 species belong to 119 genera of 22 families of Monocotyledons. Pteridophytes include 27 species belonging to 25 genera and 11 families. There is only one gymnospermic species, *Gnetum ula* occurring in Goa region (Table I).

Table I
Floristic Diversity

Group	Number of			
	Families	Genera	Species	Endemics
ANGIOSPERMS	146	657	1115	5
DICOTS	124	538	891	2
MONOCOTS	22	119	224	3
GYMNOSPERMS	1	1	1	
PTERIDOPHYTES	11	25	27	
Total	158	683	1143	5

Family Leguminosae (*S.l.*) with 121 species stands first and family Orchidaceae with 21 species stands last in Goa flora (Table II). The

position of Leguminosae (with Papilionoideae, Caesalpinoideae and Mimosoideae) is third in Flora of India (1141 spp.) but it is third in world Flora. Similarly, position of Orchidaceae which is last in Goa is second in Flora of India and second in the world. According to number of species, Poaceae stands first in position in respect of Flora of India. Whereas family Asteraceae (21,000 species) ranks first, Orchidaceae second and Leguminosae third in the world.

Table II
Dominant families

Sl.No.	Family	No. of species	
		Goa	India
1.	Leguminosae	121	1141
2.	Poaceae	68	1291
3.	Euphorbiaceae	51	523
4.	Cyperaceae	48	545
5.	Rubiaceae	46	616
6.	Acanthaceae	42	500
7.	Asteraceae	41	803
8.	Convolvulaceae	33	184
9.	Malvaceae	26	93
10.	Lamiaceae	22	435
11.	Orchidaceae	21	1229

According to number of genera also, Leguminosae (57 genera) stands first and Cyperaceae (9 genera) stands last in Goa Flora. In Flora of India, family Poaceae (264 genera) stands first and Malvaceae (22 genera) stands last. The position of Leguminosae and Cyperaceae in Flora of India is third and eighth respectively, but it is fifth and eighth in the world (Table III).

Table III
Dominant Genera

Sl.No.	Family	No. of genera	
		Goa	India
1.	Leguminosae	57	167
2.	Poaceae	44	264
3.	Asteraceae	31	166
4.	Rubiaceae	28	113
5.	Euphorbiaceae	28	84
6.	Orchidaceae	16	184
7.	Lamiaceae	14	72
8.	Convolvulaceae	12	28
9.	Malvaceae	11	22
10.	Cyperaceae	9	38

PHYTOGEOGRAPHY

According to Rao (1985) floristic composition in respect of dominant families of Goa flora looks closer with that of North Kanara than that of Khandala. After comparing Gamble's work on Peninsular India and Hooker's work on Flora of India, he concluded that Goa flora shows more affinity with the evergreen forest of the Mysore ghats in India. Floristic patterns of Western ghats especially Maharashtra, Goa and Mysore also suggest that there is a gradual change from semi-evergreen type of vegetation to the evergreen beginning from Phonda-Ambolighat area along with Goa ghats forming transitional zone and showing phytogeographical significance (Rao, 1978). Because of sudden change in geology, climate including heavy rainfall, humidity etc., Ambolighat-Goa ghat region marks a turning point from semi-evergreen to evergreen species like those of *Calophyllum*, *Canarium*, *Garcinia*, *Hopea* and *Mesua* inter-mixed with species of *Diospyros*, *Hydnocarpus*, *Syzygium* etc.

Goa has ca 131 km long coast line with estuarine areas formed by brackish water and having rich mangrove vegetation. A detailed survey

of Mangroves of Gujarat, Goa and part of Maharashtra by Banerjee *et al.* (1989) and Kothari and Rao (1990, 1991, 1995) suggest that species of *Avicennia* are common and dominant throughout the western coast while species of *Rhizophora* and *Bruguiera* are infrequent in Gujarat and common in Goa. A littoral fern *Acrostichum aureum* and a mangrove associate *Dolichandrone spathacea* found in Goa, do not occur in Gujarat coast.

Indian flora is not only rich in indigenous elements but also have ca 7,200 (c 40%) exotic elements e.g. Flora of N.E. India has some floristic elements of Malesia, Myanmar, Tibet, Japan etc. Similarly, flora of Western Ghats and peninsular India including part of Goa has affinities with Sri Lanka and South African Flora (Singh and Kothari, 1996, in press) e.g. *Ludvigia hyssopifolia* (Onagraceae) a native of Africa is distributed in various states of India including coastal region of Goa as frequent (Kothari and Rao, 1990).

ENDEMISM

Out of the five endemics, two species *Glyphochloa goensis* and *Glyphochloa talbotii* are known from Goa only, whereas other three species endemic to India, also occur in the state of Goa. There are a number of species known from western ghats described as endemics but due to wide distribution, have turned out to be false endemics e.g. *Cyanotis concanensis*, *Indochloa clarkei* and *Senecio hewrensis*, etc. (Rao, 1985).

There are five endemic and rare species of plants in Goa flora. Among these two species belong to dicots and three to monocots (Table IV).

Table IV
Endemic and Rare species

Name of the species	Family	Distribution/frequency of the species in the area
<i>Canarium strictum</i>	Burseraceae	Western Ghats. Occasional on the Goa ghats.

<i>Ceropegia fantastica</i>	Asclepiadaceae	Western Ghats. Rare and endangered, known from solitary locality (Ordofond forest in Canacona Taluka) in 1963.
<i>Ilyphaene dichotoma</i>	Arecaceae	Endemic to W. Coast, known from one locality i.e. Miramar Beach in Goa.
<i>Glyphochloa goaensis</i>	Poaceae	Rare known from three localities in Goa.
<i>G. talbotii</i>	Poaceae	Rare known from type locality in Marmagoa and two localities in Ilhas.

Threatened and Rare Taxa

Raghavan and Singh (1983) have given an account of endemic and threatened plants of western India including Gujarat, Goa, Maharashtra and Karnataka. According to them out of several rare and threatened taxa of western India only *Glyphochloa talbotii* is restricted to Goa. This species is endemic, rare and threatened as it is known only from type and two other localities in Goa. Similarly, these other four species are occasional with scattered or restricted distribution in Goa.

ECONOMIC USES

Goa flora is not only rich in plant diversity but is also a hidden treasure of plants of economic and medicinal value. There are a number of plants used for food, fodder, fuel, timber, cottage industries, minor forest products like gum, resin, dyes, tannin as well as for medicinal purposes. Some of these are mentioned as under.

Plants used for food

Roots, tubers or rhizomes of many wild species are utilized by local people for food e.g. *Asparagus racemosus*, *Colocasia esculenta*,

Dioscorea bulbifera, etc., Similarly, leaves or young shoots of species like *Abrus precatorius*, *Acrostichum aureum* (a littoral fern), *Clerodendrum serratum*, *Ipomoea aquatica*, *Portulaca oleracea*, etc., are cooked as vegetable and eaten. Fruits of *Hyphaene dichotoma* (epicarp), *Sonneratia caseolaris*, *Phyllanthus officinalis*, etc., are eaten raw or cooked.

Plants used for beverages

Fresh sap of *Borassus flabellifer*, *Phoenix sylvestris* etc., are tapped and used for delicious beverages like Goa's famous 'Toddy' or liquor.

Fodder Plants

There are a number of species of grasses like *Jansenella*, *Perotis*, *Saccharum*, *Sporobolus*, etc., which are used as fodder. During scarcity, leaves and young fruits of *Avicennia* spp., are also utilised as cattle fodder.

Fuel plants

Wood of plants e.g. species of *Acacia*, *Albizia*, *Anogeissus*, *Carissa*, *Euphorbia*, etc., found in open scrub and deciduous forest, and coastal species like *Avicennia* provide wood for fuel purpose.

Timber plants

Plants like *Dalbergia latifolia*, *D.sissoo*, *Haldina cordifolia*, *Tectona grandis*, *Terminalia* spp., *Avicennia* spp., etc., are used for furniture, boat building, etc.

Minor forest products

'Gum' (karaya) obtained from *Sterculia urens* used as food preservative. Plants like *Aegiceras corniculatum* is a good source of 'resin'. Species like *Avicennia officinalis* and *Azadirachta indica* etc., have on their large branches 'Beehives' which provide 'Honey'. Leaves of species like *Bauhinia racemosa* and *Diospyros melanoxylon* are used as 'Bidi wrappers'.

Dyes and tannin

Plants like *Butea monosperma*, *Indigofera tinctoria*, *Mallotus philippensis*, etc., are a good source of natural dyes, whereas wood of a

number of mangroves e.g. species of *Avicennia*, *Bruguiera*, *Kandelia*, *Rhizophora*, etc., provide good tannin used in leather industries.

Cottage Industry

Coastal plants like *Cocos nucifera*, *Phoenix sylvestris*, *Borassus flabellifer*, *Caryota urens*, *Hyphaene dichotoma*, etc., are used for making brooms, carpets, and leaves used as thatching material for huts etc.

Medicinal plants

There are a number of species in Goa region used for medicine e.g. *Acanthus ilicifolius*, *Asparagus racemosus*, *Boerhavia diffusa*, *Butea monospema*, *Calophyllum inophyllum*, *Clitoria ternatea*, *Garcinia indica*, *Gloriosa superba*, *Hemidesmus indicus*, *Holarrhena pubescens* and *Tinospora cordifolia*, etc.

VULNERABILITY AND MAJOR THREATS

Floristic wealth of Goa, especially in ghat region and estuarine areas is very rich. During the period of Portuguese, no attention was paid to preserve the valuable plant wealth. Biotic effects due to shifting of cultivation, illicit cuttings of trees, abuse of users rights, lack of access and control on annual fires in forest etc., affected plant growth and brought forest to a poor condition (Rao, 1985). Various other factors e.g. mining operations, tourism and tourist development in coastal areas, clearing of natural forest for urbanisation, overgrazing, over exploitation of green leaves, fruits and wood by human beings for fodder and fuel purposes especially in Gazibag Sadulsa area in Canacona, islands of river Chapora and other estuarine areas of Mandovi and Zuari rivers have affected mangroves of Goa (Kothari and Rao, 1991, 1995). Abiotically, high velocity of winds and cyclones have also affected mangroves and other coastal vegetation adversely in Goa.

Because of all the above biotic and abiotic factors, growth of inland forest and mangrove species are affected severely and a number of species are becoming vulnerable, e.g. species of *Bruguiera*, *Sonneratia* etc., in estuarine areas and *Canarium strictum*, *Glycophloa* spp., *Sageraea laurifolia*, etc. in forest areas.

CONSERVATION MEASURES

To save the valuable plant wealth of Goa from the above mentioned threats, conservation is the only alternative. For *in situ* conservation, Forest department of Goa has developed nurseries of mangroves in natural habitat at Chorao island, Cumberjua canal and Banastari areas. Under the social forestry programme, ca 4,00,000 seedlings of mangroves have also been introduced in the surrounding areas of Chorao island with a view to enrich mangrove vegetation of Goa. To create mass awareness, environmental education programme in Chorao (Salim Ali) Bird Sanctuary is designed by WWF on the plot donated by Goa Government. For protection of natural forest and wild life, Ministry of Environment and Forest has declared one National Park and four wild life sanctuaries. Since Goa is a beautiful international tourist place, local people should also extend support to the Government authorities and their programmes to save the important, forest wealth and fragile ecosystem like mangroves. For multiplication of rare, economic and endemic plants, tissue culture and genetic engineering are also useful for *ex situ* conservation. To create awareness among common people, use of broadcasting media like Radio, Television and documentary films, etc., will also serve as an important tool for environmental protection. Based on recommendations of a group of biologists led by senior author at the Indian Institute of Public Administration, New Delhi, 1995, ca. 17 point Action Plan was suggested including the last one i.e. a separate 'National Biodiversity Authority' may be established to control and co-ordinate the multi-disciplinary activities of various agencies involved at National and regional levels in the study of Biodiversity (Singh and Kothari, 1996).

REFERENCES

- Banerjee, L.K., A.R.K. Sastry and M.P. Nayar 1989. *Mangroves of India, Identification Manual*, Botanical Survey of India, Calcutta.
- Dalgado, D.G. 1898. *Flora de Goa e Sawantwadi*. Lisbon.
- Garcia da Orta 1563 (1891). *Colloquios dos simples e Drogas da India*, 2 Vols. Lisbon, edited and annotated by Conde de Ficalho.
- Kothari, M.J. and K.M. Rao 1990. Studies in Mangroves of Goa. *Indian Botanical Contactor* 7: 185-188.
- Kothari, M.J. and K.M. Rao 1991a. Environmental impact on Mangroves of Gujarat. *Indian Botanical Contactor*. 8: 51-57.
- Kothari, M.J. and K.M. Rao 1991b. Two new records for Goa and Gujarat *Indian Botanical Contactor*. 8: 58-61.
- Kothari, M.J. and K.M. Rao 1994. *Dolichandrone spathacea* (Bignoniaceae) - A little known plant for Goa *J.Econ. Tax. Bot.* 19(2): 323-324.
- Kothari, M.J. and K.M. Rao 1995. Interesting ecosystem of Mangroves along west coast of India (Goa and Gujarat State) In: A.K. Pandey (ed.) *Taxonomy and Biodiversity*. CBS Publishers and Distributors, Delhi. pp 52-58.
- Raghavan, R.S. and N.P.Singh 1983. Endemic and Threatened Plants of Western India in *Pl.Cons. Bull.* 3: 1-16.
- Rao, R.S. 1978. Floristic patterns along the Western Ghats of India. *Notes R. Bot. Gard. Edinburgh* 37: 95-110.
- Rao, R.S. 1985-86. *Flora of Goa, Diu, Daman, Dadra and Nagar haveli* 2 Vols. Botanical Survey of India, Howrah.
- Rao, R.S. and K. Hemadri 1968. A new species of *Manisuris* (Poaceae) from Goa. *Bull. Bot. Surv. India* 10 (1) : 106-109.

Singh, N.P. and M.J. Kothari 1996. Phytodiversity of India An overview in *Society of Forest and Environmental Managers (SOFEM)* Bhopal. (in press).

Vartak, V.D. 1966. *Enumeration of plants of Gomantak, India, Poona.*



Rhizophora mucronata showing habit with prop roots and having hypocotyls



General view of mangroves showing thickets of *Avicennia marina*, *A. officinalis* with under ground growth of *Acanthus ilicifolius*



Bruguiera gymnorrhiza - a flowering and fruiting twig
Fruiting and flowering twig of *B. gymnorrhiza*



Calophyllum inophyllum in flowering and fruiting

GUJARAT

**R. P. Pandey
V. Singh**

Gujarat state is situated between $20^{\circ} 1'$ and $24^{\circ} 7'$ N latitude and $68^{\circ} 4'$ and $70^{\circ} 4'$ E longitude, occupying an area of about 1,96,024 sq km. It is bounded by Rajasthan on the north-east, by Madhya Pradesh on the east and by Maharashtra on the south. On the north-western fringe it has a common border with Pakistan. An important feature of the state is its long coastal line along western, southern and south-western border, probably the longest as compared to any other Indian state. The general configuration of the surface is virtually the same as in whole of peninsular India. On the basis of height above sea level, the slope and ruggedness of relief, the entire area of Gujarat can be divided into following four physiographic units:

Kutch Peninsula

The peninsula of Kutch with its convex southern coast is quasi-insular in its outline. The central upland part of Kutch peninsula is dominated by folded parallel Jurassic ridges and low hillocks (300–465 m) running east-west. The main range of hillocks in central upland is on the south of Bhuj extending north-west upto Gadili. The incision of rivers, both from north and south and their tributaries cause reduction in central highland of peninsula into narrow ridges characterised by a large number of small depressions and ruggedness of relief. Surrounding the central highlands are coastal lowlands called 'Rann'. The parallel rivers (Khari, Naira, Kanakavathi, Prukmavati) flowing both to south and to north have furrowed the lowlands and created bed-lands in the area adjacent to sea called Salt Pans. The rivers flowing to north don't have an open outlet and are lost in the narrow lowland-a part of Rann. Occasionally this coast of Rann of Kutch is fringed with mangrove swamps. The coast south of Khori creek is dotted with a number of islands, while the western coastal region is badly dissected by small rivers. The southern coastal lowland is located close to Kathiawar and is traversed by a number of north-south parallel streams with flat surface rising to a height of 8 m over a distance of about 30 km. This area receives more rainfall than other parts of Kutch. Moreover, Rann of Kutch occupies an area of about 7000 sq km South-east to main Rann is a little Rann which occupies an area of 4000 sq km. Here also the

central portion forms the table land sloping on all sides. Both the Ranns are dry during winter and summer, while during monsoon they turn to water logging. The Rann is a dry bed of remnant of an arm of the sea which once connected the Narmada rift with Sindh and separated Kutch from the mainland.

Saurashtra Peninsula

The lower tortoise-shaped part of Gujarat between Gulf of Kutch and Gulf of Cambay forms the Saurashtra peninsula. The central part of it is called Kathiawar plateau, which covers more than half of the area of Saurashtra. It is highly eroded by rivers flowing in all directions. The usual elevation of this area is 100 m except Manda hills (340 m) in the east of Rajkot-Gondal axis and Gir range (643 m). The foot zones of these hill ranges are densely forested and a part of it is occupied by Gir National Park. The other important hills of biological interest are Girnar (1117 m) which is detached from Gir range in north by the headward erosion of the river Ojat and Barda - Alech hill (298 m) in the vicinity of Porbandar.

In the north of Kathiawar plateau is located Rajkot plateau, which is drained by the river Aji flowing into Gulf of Kutch. In the west of it is located Gondal-Jetpur plateau which extends as far South as Junagarh and separated from Rajkot plateau by westward extension of Manda hills interposed between Rajkot and Gondal. The west flowing river Bhadar drains this area. The north-eastern part of Saurashtra, touching little Runn on the north and plains of Mehsana on the east, is called Dhrangadhra-Wadhwan - Wankaner plateau. The rivers Bhanbhan and Bhagara drain this area. Amreli- Palitana plateau is like an 'upland basin, drained by river Shetrunji.

The central uplands of Saurashtra slope towards coasts resulting into lowlands. A narrow strip (5-8 km wide) bordering Gulf of Kutch is a ill-drained, desolate salt waste resembling little Runn. The coastal low-lands between Okha creek and Jodiya are gently sloping, traversed by several south-north parallel rivers. The western coast between Porbandar and Dwarka faces a comparatively deep sea, backed by low lands around Meda creek which experiences ingress of tidal water several kilometre inland and have occasional patches of Mangrove swamps. The northern half of south-western coast between Porbandar and Veraval is occupied by saline wasteland. The southern coast of Saurashtra is arc-shaped, projecting into Arabian sea. The coastal lowlands extend to about 30 km north from sea

shore upto Gir forest range. With the sole exception of the Shetrunji river, which emerges from northern slope of Gir, most of the rivers in coastal lowlands emerge from a series of residual hills not far from the coast.

The Hilly terrain

The extreme south-eastern part of the state is traversed by Sahydari hills which add a great deal to the forest wealth of Gujarat. Further, along the south-eastern border, Satpura range separates the state from Khandesh tract of Maharashtra. The eastern boundary of state with Madhya Pradesh is dominated by Vindhyan range and on the northern boundary the Aravalli range separates the state of Gujarat from Rajasthan.

Arid and semi-arid plains

The northern part of Gujarat comprising north-western part of Banaskantha district is virtually arid. The area along the Deesa-Palanpur axis is gravelly. The Banas-Saraswati doab extending westwards as far as Radhanpur is a semi-arid plain area which degenerates westwards into saline soils near little Rann. The area between Saraswati and Sabarmati, drained by river Rupan and its tributaries is a gently sloping level land with gravel soils on the east and deep-sedimentation and clayey soils on the west. It is known as 'Mehsana plains'. The extensive plain area between Sabarmati on the north and Tapti on the south is covered with agricultural plains. The area between Mahi and the Narmada is a well-known black soil tract of Gujarat. The Narmada-Tapti doab - a rectangular strip of land extending inwards from Gulf of Cambay for a distance of over 100 km, is a flat area furrowed in the centre by the river Kim and its tributaries. The southern part of Gujarat, south of the Narmada, is sub-humid where landscape bears the imprint of heavier rainfall and shows a markedly different floral character and crop pattern.

The soils of Gujarat differ in their mode of origin, colour, texture and general appearance. The alluvial soils usually occur in river valleys, on the terraces and along the coasts. The river alluvial soils are alkaline, rich in lime, nitrogen and potash and locally called 'Goradu' in the region between Saraswati and Mahi rivers. Such soils are medium in fertility. However, the soils of central plains of Gujarat from Vishwamitri in the south to Banas in the north are rather less fertile with low water holding capacity and with very little organic matter. Such soils are locally called as 'Besar' in Kaira district. The coastal and deltaic alluvial soils form a

girdle along the southern coasts of Saurashtra, along narrow coastal belt of Broach, Surat and Bulsar and along the western coasts of Saurashtra and Kutch. Such soils are saline, ill-drained and with sandy texture.

The black soils cover major part of Saurashtra plateau and the basin of Narmada and Tapti. However, typical black-soils resembling black cotton soils of the Deccan may be noticed in the districts of Baroda, Broach, Surat and Bulsar. The northern and north-eastern parts of the state are covered with less productive desert soils typical of Rajasthan desert. Lateritic soils are rather less common in Gujarat and usually confined to the margins of Saurashtra plateau. Besides above, some local soils viz. Ghad in the areas flooded in rainy season, Kyari or clay-loam and Dhar provide fertile base for cultivation.

The state exhibits a transitional climate between heavy rainfall area of Konkan and very little rain fall area of arid Rajasthan. In major part of the state, the average annual maximum temperature lies between 35° C to 42.5° C isotherms during summers. However, the temperature is lowest along the western coasts of Kutch and Saurashtra varying from 30° C to 36° C showing obviously the maritime influences which modify considerably the summer distribution of temperature. The maximum temperature during winter does not seem to be influenced by the proximity of sea and appears fairly uniform, fluctuating between 24° C to 25.5° C. The isotherms are east-west and the maximum temperature increases steadily from north (23° C) to south (30° C) during January. The mean minimum temperatures varies from 10° C in the north to 12.5° C in the south.

The average annual relative humidity is about 50 per cent in all parts of state except the coastal areas where the moisture content of the atmosphere is moderately high round the year with a maximum (90 %) during summer against 75 to 80 % in other parts of the state. The daily variations in relative humidity indicate that it is maximum during morning hours.

Gujarat receives much of its rainfall from south-west monsoon between June to September. The maximum rainfall (1000 mm) per annum is received in southern parts of Gujarat viz. Bulsar, Dangs, Surat and eastern part of Broach including Rajpipla hills. Further north, in Baroda, Panchmahal, Kaira and eastern part of Ahmedabad, the rainfall decreases from 1000 to 800 mm, while in the west of Ahmedabad including whole of Saurashtra there is again a gradual fall in rainfall from 800 mm

to 400 mm. The northern part of Gujarat and the Kutch peninsula further show a decrease in rainfall from 400 to 100 mm per annum.

The great variations in physiography, soil type, temperature and rainfall in Gujarat in different zones characteristically influence the phytodiversity of the state as dealt here under.

VEGETATION

The total area of Gujarat under forest cover is about 19,320 sq km and the general pattern of the vegetation is xerophytic in nature. The major proportion of forest is found along the eastern border of the state and hilly regions of Saurashtra and North Gujarat, occupying an area of 16,544.33 sq km i.e. about 8.99 per cent of the area of state.

The state has not been botanised systematically, however, sporadic collections have been made from different regions. Therefore, there are urgent needs for extensive and intensive botanical explorations in the state for better understanding of the biodiversity, with special reference to biologically interesting areas. As per present status of our knowledge, the phytodiversity and floral composition of Gujarat may be classified into following heads :

1. Dry deciduous forest

This forest type includes (i) dry teak forest and (ii) dry non-teak forest. The former type occurs in Rajpipla, Chhotandepur, Panchmahal, Sabarkantha, Junagarh and Amreli districts, while non-teak forest are mainly located in some part of Banaskantha and Rajkot districts. The only difference between these forest types is that in dry teak forest, *Tectona grandis* dominates the community, while in latter type it is very poorly represented and dominating species is *Anogeissus latifolia* or *Acacia chundra*. The associates are, however, common to both and include : *Butea monosperma*, *Diospyros melanoxylon*, *Mitragyna parviflora*, *Schleichera oleosa*, *Lannea coromandelica*, *Terminalia crenulata* and *Boswellia serrata* in abundance which sometimes dominate the forest community in certain ranges. The scattered tree species include : *Haldina cordifolia*, *Albizia lebbek*, *A. odoratissima*, *Bauhinia racemosa*, *Bridelia retusa*, *Buchanania lanzen*, *Careya arborea*, *Cochlospermum religiosum*, *Dalbergia latifolia*, *D. paniculata*, *Emblica officinalis*, *Garuga pinnata*, *Hymenodictyon excelsum*, *Sterculia urens*, *Pterocarpus marsupium*, *Desmodium*

oogeinensis, etc. Most of these trees are 8 m or more high and constitute sun-loving top layer. The tree species which are rather less tall and constitute middle layer include: *Holarrhena pubescens*, *Wrightia tinctoria*, *Aegle marmelos*, *Alangium salvifolium*, *Casearia elliptica*, *Flacourtia indica*, *Gardenia turgida*, *Mallotus philippensis*, *Ziziphus xylopyrus*, etc. Dense clumps of *Dendrocalamus strictus* may also be noted scattered here and there.

The common shrubs associated with the tree canopy and covering rather open and isolated hillocks include, *Carissa congesta*, *Capparis sepiaria*, *Maytenus emarginatus*, *Mimosa hamata*, *Cassia auriculata*, *Trema orientalis*, *Xeromphis spinosa*, *Woodfordia fruticosa*, etc. The twiners and climbers which further increase the density of forest include: *Abrus precatorius*, *Acacia pinnata*, *Asparagus racemosus*, *Aspidopteris cordata*, *Butea parviflora*, *Cansjera rheedii*, *Celastrus paniculata*, *Cissus repanda*, *Clematis hedysarifolia*, *Combretum ovalifolium*, *Cryptolepis buchanani*, *Cylista scariosa*, *Hiptage bengalensis*, *Millettia recemosa*, *Pueraria tuberosa*, *Ventilago denticulata*, *Wattakaka volubilis*, *Ziziphus rugosa*, etc.

The ground flora is predominantly monsoonic type and include : *Acanthospermum hispidum*, *Achyranthes aspera*, *Anisochilus carnosus*, *Barleria prattensis*, *Blainvillea acmella*, *Cassia absus*, *C. tora*, *Clitoria biflora*, *Curcuma inodora*, *Dieliptera roxburghiana*, *Trachyspermum stictocarpum*, etc. The common grasses are *Apluda mutica*, *Dichanthium annulatum* and species of *Arthraxon*, *Eragrostis*, *Panicum*, etc.

2. Tropical moist deciduous forest

The subhumid southern part of Gujarat extending over Bular, Dang and Surat districts where annual rainfall sometimes exceeds 1000 mm is dominated by tropical moist deciduous forest wherein no single species dominates the vegetation. However, *Tectona grandis* and *Shorea robusta* are rather more abundant. The other evergreen and deciduous associate species are : *Terminalia crenulata*, *T. alata*, *T. chebula*, *Anogeissus latifolia*, *Dalbergia latifolia*, *Lagerstroemia parviflora*, *Pterocarpus marsupium*, *Schleichera oleosa*, *Dillenia pentagyna*, *Miliusa tomentosa*, *Trema orientalis*, *Kydia calycina*, *Clausena heptaphylla*, *Olea dioica*, *Oroxylum indicum*, *Bambusa arundinacea*, etc. During monsoon these forest resemble the evergreen forest, however, some species shed their leaves during March-April except *Tectona grandis* which shed its leaves during winter

season. The climbers which considerably add to the evergreen nature of the forest include : *Diploclisia glauscescens*, *Dioscorea belophylla*, *D. hispida*, *D. oppositifolia*, *Cayratia carnosia*, *Ventilago maderaspatana*, *Derris heyneana*, *Hyptage benghalensis*, etc.

A number of epiphytic and terrestrial orchids, characteristic of moist forest, further enrich the phytodiversity of these forest. The important species are : *Aeridis crispum*, *A. maculosum*, *Dendrobium barbatulum*, *D. microbulbon*, *D. ovatum*, *D. peguanum*, *Habenaria commelinifolia*, *H. furcifera*, *H. gibsonii* var. *foliosa*, *H. grandifloriformis*, *H. longicorniculata*, *H. marginata* var. *fusifera*, *Malaxis mackinnonii*, *Nervilia aragoana*, *N. discolor*, *Oberonia falconeri*, *Peristylus lawii*, *Platanthera susannae*, *Vanda tessellata*, *Zeuxine strateumatica*, etc.

The ground flora is dominated mainly by shade-loving species of *Ageratum*, *Abutilon*, *Cassia*, *Cleome*, *Eupatorium*, *Cynoglossum*, etc. at high altitude and at low elevations the characteristic species of dry deciduous forest make their home.

3. Scrub forest

The scrub forest are distributed in arid and semi-arid plains of north Gujarat, Kutch uplands and highlands of Saurashtra plateau where rainfall is very limited. The vegetation presents an open appearance wherein xerophytic spinous trees and shrubs in stunted form are sparsely distributed. The density and composition of vegetation vary from place to place. The typical members of the scrub forest are, *Acacia senegal*, *A. farnesiana*, *A. leucophloea*, *Balanites aegyptiaca*, *Capparis decidua*, *Dichrostachys cinerea*, *Commiphora wightii*, *Euphorbia caducifolia*, *Ziziphus nummularia*, *Z. mauritiana*, *Kirganelia reticulata*, *Mimosa hamata*, *Cassia auriculata*, *Salvadora oleoides*, *Prosopis cineraria*, etc. At certain locations the scrub forest are intermixed with some typical dry deciduous elements viz. *Aegle marmelos*, *Butea monosperma*, *Capparis grandis*, *Cassia fistula*, *Cordia gharaf*, *Diospyros melanoxylon*, *Holoptelea integrifolia*, *Maytenus emarginatus*, *Miliusa tomentosa*, etc.

The important climbers and twiners which form the clumps of trees and shrubs rather dense include *Cryptolepis buchmanii*, *Gymnema sylvestre*, *Holostemma ada-kodien*, *Mucuna pruriens*, *Abrus precatorius*, *Canavalia gladiata*, *Cissampelos pariera*, *Aristolochia indica*, *Dioscorea hispida*, *Cardiospermum halicacabum*, etc. Besides above, some stem

parasites viz. *Cassytha filiformis*, *Cuscuta chinensis*, *Dendrocalamus falcata*, *Viscum articulatum*, etc. also enrich the phytodiversity of the plains of Gujarat.

The ground flora of scrub jungles is ephemeral. During winters and summers the area looks almost barren, while during rainy season several herbs viz. *Acanthospermum hispidum*, *Bidens biternata*, *Blumea eriantha*, *Dipteracanthus patulus*, *Martynia annua*, *Pupalia lappacea*, *Solanum virginianum*, *Tephrosia purpurea*, *Tribulus terrestris*, *Tridax procumbens*, *Vernonia cinerea*, etc. together with species of *Amaranthus*, *Boerhavia*, *Cassia*, *Cleome*, *Corchorus*, etc form a green carpet. The common grasses which further enrich the phytodiversity during monsoon period include : *Aristida adscensionis*, *Bothriochloa pertusa*, *Brachiaria ramosa*, *Echinochloa colonum*, *Heteropogon contortus*, *Desmostachya bipinnata*, *Themeda quadrivalvis*, *Schima nervosum*, etc. and the species of *Chloris*, *Eragrostis*, *Cenchrus*, etc. Sometimes the ground flora is infested by the parasites like *Buchnera hispida*, *Orobanche aegyptiaca*, *O. cernua*, *Sopubia delphinifolia*, *S. trifida* and *Striga* species.

4. Mangrove forest and halophytic vegetation of saline tracts

Mangroves are xerophytic, salt tolerant components of phytodiversity which grow in physiologically dry soils of coastal ecosystem. The total area occupied by mangroves in India is estimated to be 6740 sq km which is about 7 % of the world mangroves. In Gujarat the mangroves grow mainly along western coasts of Kutch and Saurashtra peninsula covering an area of about 260 sq km. The important species of mangroves are, *Avicennia marina*, *A. officinalis*, *Aegiceras corniculata*, *Bruguiera gymnorhiza*, *Ceriops tagal*, *Rhizophora conjugata*, *R. mucronata*, etc.

The area between uplands of Kutch and Saurashtra and the sea coasts, including Great Rann and Little Rann, constitutes the major saline tract in Gujarat. Most of this area, Ranns in particular, from November to March is a barren salt crusted dry tract which remains flooded during rest part of the year. The vegetation in this tract is characteristically xerophytic and halophytic and form the intermediate belt between mangroves on the coasts and scrub and deciduous vegetation on the uplands. The most common species of saline tracts are *Alhagi pseudalhagi*, *Atriplex stocksii*, *Corchorus depressus*, *Cressa cretica*, *Haloxylon recurvum*, *H. salicornicum*, *Indigofera oblongifolia*, *Juncus maritimus*, *Malachra capitata*, *Lycium barbarum*,

Salsola baryosma, *Sesuvium sesuvioides*, *S. portulacastrum*, *Suaeda fruticosa*, *S. maritima*, *Spinifex littoreus*, *Trianthema triquetra*, *Arthrocnemum indicum*, *Peplidium maritimum*, *Salicornia brachiata*, *Cassia italica*, etc.

The notable grasses of saline tracts are, *Aeluropus lagopoides*, *Cenchrus biflorus*, *Chloris bartata*, *C. montana*, *Chrysopogon fulvus*, *Dactyloctenium scindicum*, *Crypsis schoenoides*, *Cynodon dactylon*, *Desmostachya bipinnata*, *Eleusine compressa*, *Elyonurus royleanus*, *Eremopogon foveolatus*, *Perotis indica*, *Saccharum spontaneum*, *Sehima nervosum*, *Urochondra setulosa*, etc. and species of *Eragrostis*, *Aristida* and *Cymbopogon*.

Near the sea coasts are often formed the dunes of considerable height which are covered with plants like *Ipomoea pes-capre*, *Cyperus arenarius*, *C. conglomeratus*, *Indigofera cordifolia*, *Launaea sarmentosa*, *Spinifex littoreus*, *Arnebia hispidissima*, *Chlorophytum tuberosum*, *Corbichonia decumbens*, *Crotalaria burhia*, *Farsetia jacquemontii*, *Halopyrum mucronatum*, *Limonum stocksii*, *Peganum harmala*, *Psilostachys sericea*, *Tribulus alata*, *Zygophyllum simplex*, etc.

Along the coasts, particularly southern coasts, man-made forest of *Casuarina equisetifolia* may be noticed together with *Prosopis juliflora*.

5. Aquatic and Wetland vegetation

The important habitats for aquatic and marshland flora are lakes, ponds, flood plains, tidal marshes, rivers, canals, artificial reservoirs, etc. distributed throughout the area which provide variable emporia for hydrophytes. The total wetland area of Gujarat is about 5,24,287 ha of which 3,94,627 ha is covered by natural wetlands and 1,29,660 ha by man-made wetlands. The major wetlands of the state are Nalsarovar and Kutch. The hydrophytic vegetation of Gujarat may be grouped into following life-forms in relation to substratum, water and air :

Free-floating : The species like *Azolla pinnata*, *Eicchornia crassipes*, *Pistia stratiotes*, *Spirodela polyrrhiza*, *Lemna gibba*, *L. paucicostata*, *L. trisula*, *Utricularia gibba*, *Wolffia arrhiza*, *W. microscopia* etc, constitute this group.

Rooted with floating leaves/ shoots : The common species forming this group are *Ipomoea aquatica*, *Nymphaea nouchali*, *N. pubescens*, *Nymphoides indica*, *Nelumbo nucifera*, *Potamogeton nodosus*, etc.

Rooted submerged : The species viz. *Ottelia alismoides*, *Potamogeton crispus*, *Vallisneria spiralis*, *Aponogeton natans*, etc. constitute this group.

Suspended submerged : *Blyxa echinosperma*, *B. octandra*, *Ceratophyllum demersum*, *Hydrilla verticillata*, *Najas graminea*, *N. marina*, *N. minor*, *Nechamandra alternifolia*, *Potamogeton pectinatus*, *P. perfoliatus*, *Zannichellia palustris*, etc. are the chief components of this group.

Emerged : The species like, *Aeschynomene indica*, *Limnophila indica*, *Polygonum glabrum*, *Sagittaria sagittifolia*, *Typha angustata*, *Veronica anagallis-aquatica*, etc. constitute this group of hydrophytes.

Marshy : The plants growing in swampy and muddy habitats are counted under this head viz. *Alternanthera sessilis*, *Ammannia baccifera*, *Bacopa monnieri*, *Bergia ammannioides*, *Caesulia axillaris*, *Cochlearia cochlearioides*, *Hoppea dichotoma*, *Hygrophila auriculata*, *Phyla nodiflora*, *Sphaeranthus indicus* and species of *Polygonum*, *Cyperus*, *Eriocaulon*, etc.

Some of the wetland species grow in specific associations, while others may form pure stands viz. *Azolla*, *Eichhornia*, etc. The paucity of wetland flora may be due to rocky bottom and wide amplitude of water level. The wetland flora along the river-beds is rather characteristic in the sense that species of *Crinum*, *Rotala*, *Salix*, *Tamarix* etc. inhabit mainly the river-beds.

6. Weeds and aliens

About 52 % of the area of the state is under cultivation. A large number of weeds compete with crops resulting in the decrease of yield. The weeds are well equipped for dissemination by wind, man and animals. It is interesting to note that weeds of winter season crops are not represented in the weed flora of summer and rainy season crops or vice-versa. This indicates that weeds have certain periodicity in germination which seems to be responsible for the occurrence of a particular weed community dur-

ing a crop season. Further, majority of weeds are annual and therophytes excepting few which propagate by seeds as well as root-stocks.

The common weeds associated with the winter season (Rabi) crops are: *Argemone mexicana*, *Anagalis arvensis*, *Asphodelus tenuifolius*, *Carthamus oxyacantha*, *Chenopodium album*, *C. murale*, *Cynodon dactylon*, *Echinops echinatus*, *Euphorbia hirta*, *Farsetia hamiltonii*, *Fagonia schweinfurthii*, *Fumaria indica*, *Lepidium sativum*, *Medicago sativa*, *Melilotus alba*, *M. indica*, *Oxalis corniculata*, *Pluchea lanceolata*, *Plantago amplexicaulis*, *P. ovata*, *Polycarpaea corymbosa*, *Rumex dentatus*, *Sonchus oleraceus*, *Verbascum chinense* etc. Some grasses like *Dactyloctenium aegyptium*, *Eragrostis pilosa*, *E. tremula*, *Polypogon monspeliensis* etc. also compete with the crops.

The typical weeds associated with the summer crops are *Alhagi mourorum*, *Solanum nigrum*, *S. virginianum*, *Tribulus terrestris*, *Withania somnifera*, *Ziziphus nummularia*, etc.

In comparison to winter and summer seasons, the density of rainy season weeds is much more higher due to more humus and moisture contents during rainy season. The common weeds of rainy season crops (Kharif) are, *Achyranthes aspera*, *Alysicarpus hamosus*, *A. vaginalis*, *Alternanthera sessilis*, *Ammannia baccifera*, *Aristolochia bracteolata*, *Bergia ammannioides*, *Boerhavia diffusa*, *Caesulia axillaris*, *Catharanthus pusillus*, *Cleome gyandra*, *C. viscosa*, *Celosia argentea*, *Commelina albescens*, *C. benghalensis*, *Corchorus aestuans*, *C. tridens*, *C. trilocularis*, *Crotalaria medicaginea*, *Convolvulus prostratus*, *Digera muricata*, *Eclipta alba*, *Euphorbia clarkeana*, *E. granulata*, *E. hirta*, *E. prostrata*, *Gisekia pharnaceoides*, *Heliotropium marifolium*, *H. strigosum*, *Indigofera cordifolia*, *I. hochstetteri*, *I. linifolia*, *I. linnaei*, *Kohautia aspera*, *Launaea procumbens*, *Leucas cephalotes*, *L. nutans*, *Mollugo cerviana*, *M. nudicaulis*, *Nothosaerva brachiata*, *Oldenlandia corymbosa*, *Pulicaria angustifolia*, *Phyllanthus fraternus*, *P. maderaspatensis*, *Portulaca oleracea*, *Rostellularia prostrata*, *R. quinquangularis*, *Sida cordifolia*, *S. ovata*, *Spermacoce hispida*, *S. pusilla*, *Tephrosia purpurea*, *Trianthema portulacastrum*, *Trichodesma indicum*, *Vernonia cinerea*, *Vicoa indica*, *Withania somniferum*, *Xanthium strumarium* etc. The common grasses and sedges competing with the crops are : *Cyperus rotundus*, *Cynodon dactylon*, *Aristida adscensionis*, *Eragrostis* spp., *Ochthochloa compressa*, *Echinochloa colonum*, *Cenchrus ciliaris*, *C. biflorus*, *C. setigerus*, *Dichanthium annulatum*, etc.

In irrigated fields, a number of undesirable weeds from catchment areas accelerate the competition with crops e.g. *Antirrhinum orontium*, *Arenaria serpyllifolia*, *Astragalus tribuloides*, *Gastrocotyle hispida*, *Hypocoum procumbens*, *Kochia indica*, *Lophochloa pumila*, *Malcolmia africana*, *Malva sylvestris*, *Oenanthe javanica*, *Phalaris minor*, *Psammogeton canescens*, *Biophytum sensitivum*, etc.

FLORISTIC DIVERSITY

The floristics of Gujarat comprises 2106 species belonging to 890 genera under 161 families as under (Table I) :

Table I
The number and percentage of different groups of higher plants

Taxonomic group	Family		Genera		Species	
	No.	%	No.	%	No.	%
ANGIOSPERMS						
DICOT	126	78.26	682	76.78	1525	72.28
MONOCOT	31	19.25	204	22.76	577	27.52
GYMNOSPERMS	4	2.49	4	0.46	4	0.20
Total	161	100.00	890	100.00	2106	100.00

A perusal of above table reveals that Gymnosperms show very limited diversity in the area and all the taxa are monotypic. Among angiosperms, the dicotyledons maintain maximum diversity from specific level to family level. Further, the polypetalous dicots show rather more diversity as they consist 717 species (34.04%) under 290 genera and 70 families in comparison to gamopetalous group which maintains about 623 species (29.58 %) under 305 genera and 36 families. Monochlamydeae shows minimum diversity among dicots as only 185 species (8.78 %) belonging to 87 genera and 20 families inhabit the area.

Among monocots the maximum diversity exists in Poaceae, Cyperaceae and Orchidaceae which together constitute about 74 % part of this group, while rest 26 % species are distributed to 28 different families.

An analysis of ten dominant families (Table II) reveals that Poaceae shows maximum diversity, both in respect of number of species and genera and Fabaceae stands on the second place in respect to the number of species only. The monocot family Cyperaceae stands on the third place, as it contains 129 species, however, the number of genera they belong to is very limited (14 genera). Moreover, the most poorest diversity in respect of number of species among ten dominant families is recorded in Lamiaceae and as regard the number of genera the family Convolvulaceae. These dominant families, comprising about 1084 species, constitute 51.47 % part of the total phytodiversity of the state.

Table II
Ten dominant families with more than 40 species

Name of Family	No. of Genera	No. of Species
Poaceae	100	269
Fabaceae	57	209
Cyperaceae	14	129
Asteraceae	62	106
Acanthaceae	35	81
Malvaceae	15	69
Euphorbiaceae	25	67
Convolvulaceae	12	64
Scrophulariaceae	28	46
Lamiaceae	18	44

The minimum diversity among dicotyledonous plants was recorded in Dilleniaceae, Magnoliaceae, Fumariaceae, Cochlospermaceae, Geraniaceae, Averrhoaceae, Simaroubaceae, Haloragaceae, Lecythidaceae, Punicaceae, Sonneratiaceae, Turneraceae, Trapaceae, Caricaceae, Begoniaceae, Cactaceae, Alangiaceae of polypetalous group and Goodeniaceae, Budlejaceae, Hydrophyllaceae, Gesneriaceae and Martyniaceae of gamopetalous group as they contain single species. The monochlamydeous families like Basellaceae, Phytolaccaceae, Piperaceae, Lauraceae, Proteaceae, Santalaceae, Connabaceae, Casuarinaceae, Salicaceae and Ceratophyllaceae also consist single species and as such maintain minimum diversity. Similarly among monocotyledons

Haemodoraceae, Taccaceae, Smilacaceae, Pandanaceae, Butomaceae, Aponogetonaceae, Zannichelliaceae and Ruppiaceae are monotypic.

Table III
Dominant Genera

Name of genera	Number of species
<i>Cyperus</i>	62
<i>Ipomoea</i>	28
<i>Indigofera</i>	26
<i>Crotalaria</i>	24
<i>Euphorbia</i>	24
<i>Fimbristylis</i>	23
<i>Cassia</i>	21
<i>Hibiscus</i>	18
<i>Scirpus</i>	18
<i>Eragrostis</i>	16

The table (I and III) indicate that there is no direct relationship between different taxonomic levels and the degree of diversity as family Cyperaceae stands on 9th place as regard the number of genera while the genus *Cyperus* shows maximum diversity as regard the number of species and occupy first position in the state. Similarly Convolvulaceae stands on the tenth place, while genus *Ipomoea* contains second maximum number of species in the state. Caesalpinoideae finds no place in the list of 10 dominant families, but the genus *Cassia* stands on 7th place as regard the number of species. Moreover, the ratio of species between monocotyledons to dicotyledons is 1:2.6, of genera 1:3.3 and of the family 1:4.06 which is rather low as compared to the corresponding ratio for whole India (1:7) but it is more or less comparable to Gangetic plain (1:2.2) and Rajasthan (1:2.7). It further confirms the general rule that within the same floral region, the smaller the flora, the smaller the species - genus ratio i.e. poor diversity.

PHYTOGEOGRAPHICAL ANALYSIS OF FLORISTIC DIVERSITY

The phytodiversity of Gujarat is not only quantitatively rich but also qualitatively, as it maintains a mixture of elements migrated from different phytogeographical regions of the world. So far no systematic account is available on the phytogeographical composition of phytodiversity of this region except the some sporadic information on exotics. During present study the authors analysed that the vegetation of Gujarat is composed of the following elements :

Indian element	39.41 %
Perso-Arabian element (Western element)	19.42 %
Indo-Malayan element (Eastern element)	13.77 %
General element	27.39 %

The Indian element represented by 830 species includes the taxa of wide spread occurrence in the subcontinent and the endemics which together constitute about 39.41 % of the phytodiversity of Gujarat. Majority of the taxa have migrated from the neighbouring state of Maharashtra, Rajasthan and Gangetic plains.

A perusal of ten dominant families (Table IV) of neighbouring states and Gujarat revealed that most of them are common and they also show great resemblance with India as a whole. However, the position of floristically rich families may differ slightly. The vegetation of south and south-eastern parts of the state shows close affinity (60 %) to Deccan peninsula, the north-eastern and Kutch peninsula shows affinities (75 %) with the flora of Rajasthan desert, the semi-arid plains of central Gujarat show affinities with Gangetic plains. The common species are mostly the species of wide distribution which occur from sea level to 1000 m.

Next comes the general element which includes the pantropical, pleuriregional species, species of warm countries and exotics introduced from various parts of the world viz. Mexico, Europe, north and south America, Australia, China, Japan etc. The general element containing 577 species constitutes 27.39 % part of the phytodiversity. Among exotics unlike Rajasthan, the Australian element is rather better represented (92 species) in Gujarat in comparison to American elements (62 species).

Table IV
Position of ten dominant families in India, Gujarat and other neighbouring states

Gujarat state (Present study)	India	Gangetic Plain	Rajasthan	Maharashtra
Leguminosae	Poaceae	Poaceae	Poaceae	Leguminosae
Poaceae	Orchidaceae	Leguminosae	Leguminosae	Poaceae
Cyperaceae	Leguminosae	Cyperaceae	Asteraceae	Acanthaceae
Asteraceae	Asteraceae	Asteraceae	Cyperaceae	Cyperaceae
Acanthaceae	Rubiaceae	Scrophulariaceae	Acanthaceae	Euphorbiaceae
Malvaceae	Cyperaceae	Malvaceae	Euphorbiaceae	Asteraceae
Euphorbiaceae	Euphorbiaceae	Acanthaceae	Convolvulaceae	Rubiaceae
Convolvulaceae	Lamiaceae	Euphorbiaceae	Scrophulariaceae	Orchidaceae
Scrophulariaceae	Acanthaceae	Convolvulaceae	Lamiaceae	Convolvulaceae
Lamiaceae	Scrophulariaceae	Lamiaceae	Malvaceae	Lamiaceae

The Perso-Arabian element (western) finds third position in Gujarat constituting 19.42 % part of the flora of Gujarat. It includes the species coming from Africa, Mediterranean region, Madagascar, North African - Indian desert belt, Western Asia, Arabia, Persia, Turkey, Indus plain, Sahara Sindh or Sudano - Rajasthan etc. A comparison with Rajasthan revealed that the percentage of western element decreases southwards from 30.55 % in Rajasthan to 19.42 % in Gujarat. Within the state, the percentage of western element is highest in north - eastern region and Kutch peninsula in comparison to other parts of the state. The reasons for the dominance may be identical climatic and edaphic conditions and large scale degradation of the habitats which invite rather xerophytic pioneer species to make their home. Lack of perfect geographical barriers on the northern and western boundary and invasion of species through sea route are the other causes for higher percentage of western element in north - eastern region and Kutch peninsula.

The Indo-Malayan element constitutes about 13.77 % part of phytodiversity. It includes the species coming from Malaysian peninsula, China, Burma, Thailand, Indonesia, Indo-China and other central, eastern and South-east Asian countries. The gradual fall of Eastern element towards the west further finds support as in Eastern India it constitutes 24.33 % part of the flora, 22 % in central India and 23.31 % in southern India. Probably the presence of Sahyadri, Satpura and Vindhyan hill ranges along the eastern and north-eastern boundary of Gujarat act as a barrier in the migration of Indo-Malayan element towards west. The recent rise of Himalayan and Siwalik have also put some check on the invasion of central and East Asian elements. Within Gujarat, the maximum percentage of eastern element is found in southern zones, which further decreases westwards due to adverse climatic and edaphic conditions since Indo-Malayan element flourish rather better in humid climate.

ENDEMISM

In India about 33 % flowering plants are believed to be endemic. Gujarat also provides specific habitats for speciation and as such about 16 species listed below are confined to Gujarat.

Arthraxon lancifolius var. *hindustanicus*

Canscora khandalensis

Ceropegia odorata
Chlorophytum bharuchae
Cyperus dwarkensis
Dipcadi ursulae var. *longiracemosae*
Fuirena tuwensis
Helichryum cutchicum
Psilostachys sericea
Sesbania concolor
Solanum purpureilineum
Tamarix kutchensis
T. stricta
Tephrosia axillaris
T. jamnagarensis
Viola cinerea var. *stocksii* forma *kathiawarensis*

The most important to mention here is that some taxa viz. *Chlorophytum bharuchae*, *Cyperus dwarkensis*, *Helichryum cutchicum*, *Tamarix kutchensis*, *T. stricta*, *Tephrosia jamnagarensis* and *Viola cinerea* var. *stocksii* forma *kathiawarensis* are confined to limited localities in Kutch and Saurashtra peninsula only in the state and, therefore, need immediate conservation measures since any physical change in their ecosystems may finish the specific germplasm of these species for ever. Since the endemic populations in general are poor in density and abundance, they all need *in-situ* conservation and multiplication through *ex-situ* methods.

THREATENED AND RARE TAXA

Besides the endemics as mentioned above, there are several other species which form very scattered thin populations within limited range of their distribution. The reasons may be inadequate reproductive mechanism, inviability of seeds, low range of adaptation or habitat destruction by way of biotic interferences. These species are, *Abelmoschus tuberculatus* and its variety *deltoideifolius*, *Atylosia goensis*, *Agave lurida*, *Alysicarpus ovalifolius*, *Ammannia desertorum*, *Anogeissus sericea* var. *nummularia*, *Blumea bovei*, *Canscora concanensis*, *Campanula colorata*, *Campylanthus ramosissimus*, *Chlorophytum borivilianum*, *Convolvulus auricomus* var. *volubilis*, *C. microphyllus* var. *boissieri*, *C. rottlerianus* var.

tenella, *C. stocksii*, *Corallocarpus conocarpus*, *Cyperus papyrus*, *Dactyliandra welwitschii*, *Dalechampia scandens* var. *corodofana*, *Dendrophthoe falcata* var. *coccinia*, *Dignathia hirtella*, *Eriolaena candollei*, *Euphorbia perbracteata*, *Exacum lawii*, *Grewia tiliifolia* var. *leptopetala*, *Habenaria gibsonii* var. *foliosa*, *Heliotropium bacciferum* var. *suberosum*, *Indigofera coerulea* var. *monosperma*, *I. oreophila*, *Ipomoea kotschyana*, *Ipomoea vagans*, *Ischaemum santapau*, *Isachne santapau*, *Kaempferia rotunda*, *Lolium stocksii*, *Manisuris clarkei*, *Nepata hindostana* var. *woodrowii*, *Neptunia plena*, *Pavonia certocarpa*, *Parahyparrhenia bellariensis*, *Premna resinosa*, *Prosopis stephaniana*, *Schweinfurthia papilionacea*, *S. pterosperma*, *Scilla hohenackeri*, *Solanum arundo*, *S. elaeagnifolium*, *Taverniera cuneifolia*, *Tephrosia collina* var. *lanuginocarpa*, *T. uniflora* subsp. *petrosa*, *Tribulus rajasthanensis*, *Trigonella uncata*, *Torenia indica*, *Vigna khandalensis*, *Wrightia doliocarpa*, *Xanthium pungens*, *Ziziphus glaberrima* etc. The danger of extinction of such elements is also ahead, therefore, to ensure the survival of germplasm necessary measures need to be taken for their protection, conservation and multiplication.

Besides above, the over exploitation of some species viz. *Cassia senna*, *Commiphora wightii*, *Tecomella undulata* have also brought them on the doors of extinction. Maximum afforestation of such economic species is therefore necessary to balance the ecosystem. Recent biotechnological methods may also be applied for their multiplication. Further, the germplasm of depleting plant resources may also be preserved in seed banks, the habitats need to be protected by establishing more Biosphere Reserves, National Parks and Wildlife Sanctuaries. Presently efforts made in this direction include the establishment of four National Parks viz. Gir National Park at Junagarh, Vansda National Park at Valsad, Marine National park at Jamnagar, Velavadar National park at Bhavnagar and Eleven wildlife sanctuaries viz. Gir Lion Sanctuary (Junagarh), Nalsarovar Bird Sanctuary (Ahmedabad and Surendranagar), Alternative Home for Asiatic Lion (Jamnagar), Khijadiya Bird Sanctuary (Jamnagar), Hingol gadhn Nature Education (Rajkot), Jessore Sloth Bear Sanctuary (Banaskantha), Narayan Sarovar Chinkara (Kutch), Marine Wild-life Sanctuary (Jamnagar), Ratanmahal Bird Sanctuary (Panchmahal), Wild Ass Sanctuary (Surendranagar) and Dhumkhal Sloth Bear Wild-life Sanctuary (Bharuch). Further, the establishment of botanical garden may also play a vital role in *ex-situ* conservation and multiplication of the germplasm which is widely scattered and where *in-situ* conservation is not possible.

WILD RELATIVES OF CROP/CULTIVATED PLANTS

The wild genetic material which may be used for the improvement of crops and other useful cultivated plants has been given due considerations in biodiversity convention. In India about 323 wild relative species of crop plants have been reported (Arora and Nayar, 1985). Of these only about 5.57 % occurs in Gujarat which indicates the paucity of very important germplasm and needs for conservation.

Table IV
Cultivated species and their probable wild relatives

Crop/Cultivated species	Wild relatives
Cereals and Millets	
<i>Oryza sativa</i>	<i>O. nivara</i>
<i>Panicum miliare</i>	<i>Digitaria cruciata</i>
<i>P. sumatrense</i>	<i>P. psilopodium</i> and <i>Digitaria cruciata</i>
<i>Pennisetum americanum</i>	<i>P. purpureum</i>
<i>Setaria italica</i>	<i>S. verticillata</i>
<i>Sorghum bicolor</i>	<i>S. halepense</i>
<i>Saccharum officinarum</i>	<i>Erianthus ravennae</i> , <i>Saccharum spontaneum</i> and <i>S. bengalense</i>
<i>Zea mays</i>	<i>Coix aquatica</i> , <i>C. lacryma-jobi</i> , <i>C. gigantea</i> and <i>Trilobachne cookei</i>
<i>Eleusine coracana</i>	<i>E. indica</i> and <i>E. compressa</i>
<i>Echinochloa frumentacea</i>	<i>E. crusgallii</i>
Leguminous crops	
<i>Vigna dalzelliana</i>	<i>V. aconitifolia</i> , <i>V. khandalensis</i> and <i>V. umbellata</i>
<i>V. radiata</i>	<i>V. trilobata</i> and <i>V. radiata</i> var. <i>sublobata</i>
<i>Clitoria ternatea</i>	<i>C. biflora</i>
<i>Cicer arietinum</i>	<i>Vigna mungo</i> var. <i>silvestris</i>

Crop/Cultivated species	Wild relatives
<i>Cajanus cajan</i>	<i>Atylosia sericea</i> and <i>A. scarabaeoides</i>
<i>Bauhinia purpurea</i>	<i>B. variegata</i>
<i>Medicago sativa</i>	<i>M. laciniata</i> , <i>M. polymorpha</i>
<i>Pisum sativum</i>	<i>Lathyrus sativus</i>
<i>Trifolium alexandrinum</i>	<i>T. resumpinatum</i>
<i>Lablab purpureus</i>	<i>Canavalia ensiformis</i> and <i>C. virosa</i> ,
<i>Trigonella foenum-graecum</i>	<i>T. corniculata</i>
Fruit crops	
<i>Musa paradisiaca</i>	<i>Ensete superbum</i>
<i>Ficus carica</i>	<i>F. palmata</i> and <i>F. drupacea</i>
<i>Morus alba</i>	<i>M. indica</i>
<i>Murraya paniculata</i>	<i>M. koenigii</i>
<i>Syzygium cumini</i>	<i>S. jambos</i> , <i>S. heyneanum</i> and <i>S. rubicundum</i>
<i>Ziziphus mauritiana</i>	<i>Z. oenoplia</i> , <i>Z. rugosa</i> and <i>Z. xylopyrus</i>
<i>Carissa congesta</i>	<i>C. spinarum</i>
<i>Manilkara hexandra</i>	<i>Mimusops elengi</i>
<i>Citrullus lanatus</i>	<i>C. colocynthis</i>
Vegetable crops	
<i>Abelmoschus esculentus</i>	<i>A. tuberculatus</i> , <i>A. ficulneus</i> and <i>A. manihot</i>
<i>Allium cepa</i>	<i>Dipcadi serotinum</i>
<i>Zingiber officinalis</i>	<i>Z. zerumbet</i>
<i>Amaranthus caudatus</i>	<i>A. hybridus</i> , <i>A. graecizans</i> , <i>A. spinosus</i> , <i>A. tricolor</i> , <i>A. viridis</i> and <i>A. lividus</i>
<i>Capsicum annum</i>	<i>C. frutescens</i>
<i>Curcuma longa</i>	<i>C. amada</i> , <i>C. inodora</i> and <i>C. pseudomontana</i>
<i>Cucumis melo</i>	<i>C. prophetarum</i> and <i>C. setosus</i>

Crop/Cultivated species	Wild relatives
<i>C. sativus</i>	<i>C. callosus</i>
<i>Luffa acutangula</i> var. <i>acutangula</i>	<i>L. acutangula</i> var. <i>amara</i>
<i>L. cylindrica</i>	<i>L. echinata</i>
<i>Momordica charantia</i>	<i>M. balsamina</i> , <i>M. dioica</i> and <i>M. cochinchinensis</i>
<i>Trichosanthes anguina</i>	<i>T. cucumerina</i> and <i>T. dioica</i>
<i>Moringa oleifera</i>	<i>M. concanensis</i>
<i>Portulaca pilosa</i> ssp. <i>grandiflora</i>	<i>P. pilosa</i> ssp. <i>pilosa</i> , <i>P. tuberosa</i> and <i>P. oleracea</i>
<i>Solanum melongena</i>	<i>S. incanum</i>
<i>Trachyspermum ammi</i>	<i>T. roxburghianum</i>
<i>Dioscorea alata</i>	<i>D. bulbifera</i> , <i>D. hispida</i> and <i>D. pentaphylla</i>
<i>Phoenix dactylifera</i>	<i>P. acaulis</i> and <i>P. sylvestris</i>
Oil-seed crops	
<i>Carthamus tinctorius</i>	<i>C. oxyacantha</i>
<i>Sesamum indicum</i>	<i>S. laciniatum</i> and <i>S. prostratum</i>
<i>Brassicacampestris</i> var. <i>sarson</i>	<i>B. trilocularis</i> and <i>B. quadrivalvis</i>
Fibre crops	
<i>Corchorus capsularis</i>	<i>C. aestuans</i> , <i>C. olitorius</i> and <i>C. trilocularis</i>
<i>Crotalaria juncea</i>	<i>C. retusa</i>
<i>Hibiscus cannabinus</i>	<i>H. caesius</i> and <i>H. sabdariffa</i>
Miscellaneous	
<i>Nicotiana tabacum</i>	<i>N. plumbaginifolia</i>
<i>Catharanthus roseus</i>	<i>C. pusillus</i>
<i>Physalis peruviana</i>	<i>P. minima</i>

An analysis of the table IV revealed that maximum wild relatives are available for vegetable crops i.e. 37 wild relatives for 18 vegetable crops; the legumes find second position (17 : 11), the edible fruits find 3rd place (14 : 9), and cereals and millets (17 : 10) stand thereafter. The poorest cytogenetic affinities with wild flora were noted in oil yielding (6: 3) and fibre yielding (6 : 3) crop plants. Moreover, about 100 wild relatives of 57 crop species enrich the phytodiversity of Gujarat.

ECONOMIC POTENTIALITY OF PHYTODIVERSITY

The economic potentiality of phytodiversity determines its importance for existence and values for conservation, particularly to establish priorities. Gujarat is fortunately very rich in economic plant resources and many of them have potentiality to add to the economy of the state. Some of these plants are dealt here under.

Medicinal plants : The therapeutic properties of plants have created wide interest among people to learn about plants which may be used as a source for new drugs. The tribal communities of Gujarat have acquired a deep knowledge in this field due to their long association with the forest. The important plants used for the treatment of various diseases are, *Abutilon indicum*, *Acacia nilotica* subsp. *indica*, *A. senegal*, *Ageratum conyzoides*, *Adhatoda zeylanica*, *Achyranthes aspera*, *Aerva javanica*, *Amaranthus tricolor*, *Aristolochia bracteolata*, *Asparagus racemosus*, *Alhagi pseudalhagi*, *Argemone mexicana*, *Balanites roxburghii*, *Boswellia serrata*, *Butea monosperma*, *Bauhinia racemosa*, *Bergia suffruticosa*, *Barleria prionitis*, *Belpharis sindica*, *Boerhavia diffusa*, *Cadaba fruticosa*, *Cocculus pendulus*, *Cleome brachycarpa*, *C. gynandra*, *C. vahliana*, *C. viscosa*, *Cadaba fruticosa*, *Capparis decidua*, *Corchorus depressus*, *C. fascicularis*, *C. olitorius*, *C. tridens*, *Commiphora wightii*, *Crotalaria burhia*, *Cassia auriculata*, *C. occidentalis*, *Citrullus colocynthis*, *Cucumis prophetarum*, *Calotropis procera*, *Cordia gharaf*, *Convolvulus auricomus*, *C. microphyllus*, *Cuscuta hyalina*, *Cistanche tubulosa*, *Clerodendrum phlomidis*, *Chenopodium album*, *Cucumis prophetarum*, *Cyperus rotundus*, *Cynodon dactylon*, *Dactyloctenium aegyptium*, *D. scindicum*, *Datura metel*, *Dicoma tomentosa*, *Echinops echinatus*, *Eclipta alba*, *Enicostema hyssopifolium*, *Evolvulus alsinoides*, *Euphorbia caducifolia*, *E. dracunculoides*, *E. hirta*, *Ephedra foliata*, *Fagonia indica* var. *schweinfurthii*, *Glinus lotoides*, *Grewia tenax*, *Heliotropium eichwaldii*, *Haloxylon recurvum*, *Indigofera linifolia*, *I. oblongifolia*, *Ipomoea pestigridis*, *Leucas aspera*, *Lycium barbarum*, *Maytenus emarginatus*,

Mimosa hamata, *Ocimum americanum*, *Oxalis corniculata*, *Pedaliium murex*, *Peganum harmala*, *Portulaca oleracea*, *P. quadrifida*, *Phaseolus trilobus*, *Prosopis cineraria*, *Pulicaria crispera*, *Pergularia daemia*, *Phyllanthus fraternus*, *Rivea hypocrateriformis*, *Ricinus communis*, *Sarcostemma acidum*, *Salvadora oleoides*, *S. persica*, *Sisymbrium irio*, *Sida cordifolia*, *S. ovata*, *Solanum nigrum*, *S. virginianum*, *S. albicaule*, *Striga gesnerioides*, *Suaeda fruticosa*, *Tamarix aphylla*, *Tribulus terrestris*, *Tephrosia purpurea*, *Tecomella undulata*, *Vernonia cinerea*, *Vitex negundo*, *Vollutarella ramosa*, *Withania somnifera*, *Xanthium strumarium*, *Ziziphus mauritiana*, *Z. nummularia*, *Zygophyllum simplex*, etc.

Timber yielding plants : Timber is an essential item for the economic development of an area, particularly for building articles, agricultural equipments, furniture, match box industry, sports articles, boxes, packing cases and various other house hold articles. The common timber yielding plants are : *Acacia chundra*, *A. leucophloea*, *A. nilotica* subsp. *indica*, *A. senegal*, *Albizia lebbeck*, *A. procera*, *Adina cordifolia*, *Anogeissus latifolia*, *A. pendula*, *Aegle marmelos*, *Ailanthus excelsa*, *Azadirachta indica*, *Bambusa arundinacea*, *Bombax ceiba*, *Butea monosperma*, *Cassia fistula*, *C. siamea*, *Cordia dichotoma*, *C. gharaf*, *Dalbergia latifolia*, *D. sissoo*, *Flacourtia indica*, *Garuga pinnata*, *Gmelina arborea*, *Lagerstroemia lanceolata*, *Melia azedarach*, *Desmodium oojeinensis*, *Pithecellobium dulce*, *Prosopis cineraria*, *P. juliflora*, *Pterocarpus marsupium* var. *acuminatus*, *Sapindus emarginatus*, *Shorea robusta*, *Tamarix aphylla*, *Tectona grandis*, *Tecomella undulata*, *Terminalia arjuna*, *T. bellirica* and *T. crenulata*.

Besides above, the plants like *Hymenodictyon excelsum*, *Kydia calycina*, *Lanea coromandelica*, *Spondias pinnata*, *Wrightia tinctoria*, etc. have also found reputable place in timber industry.

Gum and Resin yielding plants: The chief components which yield gum and resin are *Acacia senegal*, *A. chundra*, *A. farnesiana*, *A. nilotica* ssp. *indica*, *Alhagi pseudalhagi*, *Azadirachta indica*, *Boswellia serrata*, *Commiphora wightii*, *Garuga pinnata*, *Prosopis cineraria*, *P. juliflora*, *Pterocarpus marsupium* var. *acuminatus*, *Sterculia urens*, and *Terminalia crenulata*.

Tannin yielding plants : The main tannin yielding plants are, *Acacia leucophloea*, *A. nilotica* subsp. *indica*, *Albizia lebbeck*, *Anogeissus pendula*, *Avicennia marina*, *A. officinalis*, *Cassia auriculata*,

C. occidentalis, *Tamarindus indica*, *Tamarix aphylla*, *T. dioica*, *T. troupii*, *Brugiera gymnorhiza*, *Rhizophora mucronata* and *Ziziphus mauritiana*.

Dye yielding plants : The chief dye yielding species are, *Acacia chundra*, *Abrus precatorius*, *Achyranthes aspera*, *Adhatoda zeylanica*, *Arnebia hispidissima*, *Alhagi pseudalhagi*, *Butea monosperma*, *Cassia auriculata*, *C. fistula*, *Indigofera coerulea*, *I. tinctoria*, *Kirganelia reticulata*, *Peganum harmala*, *Phyllanthus fraternus*, *Wrightia tinctoria* and *Ziziphus xylopyrus*.

Fibre yielding plants : Fibre is a very important item for commerce and industry. The local demand is usually met with the species like, *Abutilon indicum*, *Acacia leucophloea*, *A. nilotica* subsp. *indica*, *Aeschynomene indica*, *Agave americana*, *Bauhinia racemosa*, *Bombax ceiba*, *Butea monosperma*, *Calotropis gigantea*, *C. procera*, *Cassia auriculata*, *Cordia dichotoma*, *C. gharaf*, *Cryptostegia grandiflora*, *Corchorus capsularis*, *C. olitorius*, *Crotalaria burhia*, *Desmostachya bipinnata*, *Ficus benghalense*, *Helicteres isora*, *H. vitifolius*, *Leptadenia pyrotechnica*, *Luffa acutangula*, *Malachra capitata*, *Pavonia zeylanica*, *Pergularia daemia*, *Pongamia pinnata*, *Saccharum benghalense*, *S. spontaneum*, *Sida rhomboidea*, *S. ovata* and *Urena lobata*

Plants used as famine food : Wild food is the base for survival for many tribal communities in interior areas, especially during famine. Many of them are also sold in the market and add to the economy of the people. The important food providing species are : *Acacia senegal*, *Achyranthes aspera*, *Aerva javanica*, *Brachiaria ramosa*, *Capparis decidua*, *Citrullus colocynthis*, *C. lanatus*, *Cucumis melo* var. *culta*, *Cyperus rotundus*, *Cenchrus biflorus*, *C. setigerus*, *Dactyloctenium aegyptium*, *Ephedra foliata*, *Fagonia indica* var. *schweinfurthii*, *Grewia tenax*, *Indigofera cordifolia*, *I. linifolia*, *I. tinctoria*, *Panicum antidotale*, *Prosopis cineraria*, *Salvadora oleoides*, *S. persica*, *Setaria verticillata*, *Tamarindus indica*, *Tribulus terrestris*.

Edible fruit yielding plants : The common fruit yielding plants in Gujarat are, *Annona squamosa*, *Buchanania lanzan*, *Capparis decidua*, *Citrullus lanatus*, *Cucumis melo*, *Cordia dichotoma*, *C. gharaf*, *Cyperus bulbosus*, *Dillenia pentagyna*, *Diospyros melanoxylon*, *Emblica officinalis*, *Grewia tenax*, *Hibiscus sabdariffa*, *Limonia acidissima*, *Meyna laxiflora*, *Miliusa tomentosa*, *Nelumbo nucifera*, *Nymphaea pubescens*, *N. stellata*, *Opuntia elatior*, *Pithcellobium dulce*, *Phoenix sylvestris*, *Spondias*

pinnata, *Salvadora oleoides*, *S. persica*, *Terminalia catappa*, *Ziziphus mauritiana*, *Z. nummularia*, *Z. rugosa* and *Z. xylopyrus*.

Vegetable yielding plants : The common vegetable yielding plants in the state are, *Amaranthus tricolor*, *A. viridis*, *Amorphophallus campanulatus*, *Anethum graveolens*, *Basella rubra*, *Capparis decidua*, *Chenopodium album*, *Coccinia grandis*, *Dioscorea bulbifera*, *D. oppositifolia*, *Euphorbia caducifolia*, *Holostemma annularium*, *Madhuca indica*, *Momordica balsamina*, *M. dioica*, *Moringa oleifera*, *Oxalis corniculata*, *Portulaca oleracea*, *Suaeda fruticosa*, *Telosma pallida*, *Trianthema portulacastrum* and *Trichosanthes dioica*.

Fodder yielding plants : The common fodder yielding plants of Gujarat are, *Alhagi pseudalhagi*, *Dichanthium annulatum*, *Dactyloctenium scindicum*, *D. aegyptium*, *Bothriochloa pertusa*, *Chrysopogon fulvus*, *Cynodon dactylon*, *Eleusine compressa*, *Eremopogon foveolatus*, *Heteropogon contortus*, *Medicago sativa*, *Panicum antidotale*, *Sehima nervosum* and *Sorghum halepense*.

Oil yielding plants : Some plants yield non edible oil which is used in medicines, varnishes, paints, as lubricant, for soap making and in perfumery. The important species where seed is the source of oil are, *Argemone mexicana*, *Azadirachta indica*, *Citrullus colocynthis*, *Derris indica*, *Guizotia abyssinica*, *Madhuca indica*, *Mimusops elengi*, *Ricinus communis* and *Schleichera oleosa*. The leaves of *Cymbopogon martinii* and *C. citratus* and roots of *Vetiveria zizanoides* also possess volatile oil.

Besides above, tender branches of *Acacia nilotica* subsp. *indica*, *Azadirachta indica*, *Cassia auriculata*, *Ficus benghalensis* and *Salvadora persica* are used as tooth brushes. *Bauhinia racemosa* and *Diospyros melanoxylon* provide leaves for Biri making, *Aloe barbadensis*, *Balanites aegyptiaca*, *Vitex negundo*, *Haloxylon multiflorum* and *Euphorbia dracunculoides* are chiefly used as a substitute of soap and detergent. *Borassus flabellifer* and *Phoenix sylvestris* are used in beverages.

An analysis of economically important plants, their density, frequency and abundance in the area revealed that some of them may be utilized on commercial scale and may prove a new source for revenue to the state. These species are, *Calotropis procera*, *Aerva javanica*, *Saccharum*

benghalense (fibre as stuffing material), *Capparis decidua* (pickles), *Acacia senegal*, *Sterculia urens* (gum and resins), *Citrullus colocynthis*, *Azadirachta indica*, *Jatropha curcas* (non-edible oil), *Citrullus lanatus* (edible oil), *Balanites aegyptiaca*, *Azadirachta indica*, *Plantago ovata* (medicine), *Butea monosperma* (plates and saucers), *Bauhinia racemosa*, *Diospyros melanoxylon* (Biri making), *Acacia chundra*, *Butea monosperma* (dye), *Avicennia marina*, *A. officinalis*, *Bruguiera gymnorhiza*, *Cassia auriculata*, *Ziziphus mauritiana* (tannin), etc.

MAJOR THREATS

The major threats to the biodiversity in Gujarat state include recurring drought which not only naturally exerts pressure on biodiversity, but also compels the man and live-stock to exploit the vegetation for their survival to the extent leaving only stoney, eroded wastelands. In addition to recurring drought, the fragile ecosystems are also largely subjected to biotic interferences viz. felling of trees for timber and reclamation of land for agriculture after clearing the forest. Further, certain micro-forest products are collected in a very unscientific way, resulting in the death of plants and shrinking of populations e.g. *Commiphora wightii*. The highest pressure on vegetation is exerted by man for fire-wood. The lopping, coppicing and amputating the branches of trees degrade the vegetation. The demand of woody biomass for fuel purpose has greatly increased in Gujarat due to increase in population, therefore, under-shrubs and woody herbs are also cut or uprooted by the local people for fire.

Grazing pressure further accelerate the deterioration of vegetation. The hungry herds of camels, sheeps, goats etc. eat away the last bit of greenery and as such the natural vegetation is not only damaged, but is gradually being reduced in quality and new undesirable exotic species have invaded the area.

The developmental activities viz. construction of roads, railway lines, bridges, dams and mining activities are very much responsible for habitat destruction in Gujarat. The exploration for oil and armed forces establishments further lead to progressive degradation of resources. The destruction of vegetation by one way or the other results in the loss of surface soil by water or wind erosion, lower the soil fertility and converts the large areas into unproductive wastelands - all result in loss of biodiversity. The cumulative effect of all these processes brings about significant changes

in hydrology and micro-climate of the area which further results in an irreversible damage to biodiversity.

The urbanisation and industrialization, besides habitat destruction lead to air pollution and acid rains, which cause great damage to the biodiversity. Besides floods, the ingress of tidal sea water increases the salinity which cause the loss in biomass and notable change in biodiversity composition in Gujarat.

The wetland ecosystems in Gujarat also face various forms of environmental problems due to encroachment, siltation, weed infestation, pollution, etc.

CONSERVATION STRATEGIES

The biodiversity supports human survival in myriad ways, notably through health, food and industry. It is, therefore, imperative that effective conservation measures are taken to maintain equilibrium in natural ecosystems because unless a total view is taken of ecological sustainability, the environment will continue to be vulnerable. The current pressures on the biodiversity are due to both ignorance and compulsions of survival. The demand of human and livestock populations on the biodiversity need to be regulated through protection or sustainable use and through developing alternative sources of livelihood. To put a check on becoming the species extinct and genetically eroded due to loss of natural ecosystems the following conservation strategies may be adopted in Gujarat.

In-situ Conservation : In-situ conservation requires planned and systematic management of clearly identified target species in its natural habitats. Thus, the goal for the managers of genetic resources is to maintain a dynamic system to harmonize the conservation of genetic resources with sustainable use of much of the land area. Such objectives may be achieved by establishing Biosphere Reserves, Conservation plots, Sacred groves, National Parks and Wildlife Sanctuaries etc. Government of Gujarat has established four National Parks and eleven wildlife sanctuaries, as described earlier, where under the umbrella of Flag species, the phytodiversity is conserved and consumed in a sustainable manner. For coastal vegetation including mangroves and sea grasses, Marine National Park has been established to maintain the ecological balance. Keeping in view the different physiographic units and their floristic diversity, the

present protected areas are not worth and, therefore, more conservation sites need to be identified in Gujarat through extensive botanical explorations and monitoring the plant wealth.

Ex-situ Conservation : The complexity of the interaction between species in their natural ecosystems is such that any modification of these ecosystems is likely to lead to the loss of species or atleast variants. Further, certain threatened, rare or endemic taxa are so widely spread that *in-situ* conservation is not possible due to the lack of geographical barriers or other socio-economic reasons. Such taxa need to be multiplied and conserved outside their natural habitats viz. in the botanical gardens where they may disseminate their seeds and propagules for self propagation under semi-natural conditions. So far no serious efforts have been made in this direction in Gujarat. The notable sites where *ex-situ* conservation practices may be followed include Botanical Gardens Waghai (Dangs), the Retreat Botanical Garden-Shahibag (Ahmedabad), Gujarat University USSC Botanic Garden-Ahmedabad, Botanical Garden (Motibag), Gujarat Agriculture University, Junagarh, Experimental Garden, Deptt. of Biosciences, Saurashtra University, Rajkot and University Botanical Garden south Gujarat University , Surat.

Through gene banks: The long term storage of seeds as gene bank may be useful for maintaining the diversity of rare and threatened germplasm. So far no efforts have been made by state government in this direction except that some germplasm of agri-horticultural importance has been preserved in the cold storage modules of NBPGR, New Delhi.

Public awareness and involvement of people : Research alone can not help to restore the biodiversity loss unless there is a political will, awareness and involvement of the people in conservation programmes. Government of Gujarat is very particular on this subject in creating awareness among the people and educating them on far reaching implications of ecological degradation. The Narmada Dam movement is good example of it. Further, in various eco-developmental schemes, there has been an active participation of the local people in Gujarat.

The principles of sustainable utilization of resources has also been given due consideration in Gujarat, as a result of which the forest cover of Gujarat has considerably increased during recent years.

REFERENCE

- Arora, R.K. and E.R. Nayar 1985. Wild relatives and related species of crop plants in India - Their diversity and distribution. *Bull. Bot. Surv. India* **25**: 35-45.



Rhizophora mucronata : a fruiting twig showing 'Vivipary' -
Pirotan island Jamnagar District



A view of *Avicennia marina* : a common and dominant mangrove
species through the Gujarat coast-Jambusar creek, Bharuch

HARYANA

S. Kumar

The state of Haryana was formed on the 1st November, 1966 as a result of reorganisation of Punjab. Haryana is rightly called the "*cradle of ancient culture*" as it was the home of the legendary "Bharata" dynasty which has given the name "Bharat" to India. Also, it was at Kurukshetra that Lord Krishna preached Arjuna "the sermon of devotion to duty" as embodied in Gita. The famous battle of Mahabharata between Pandavas and Kauravas was also fought at Kurukshetra which is situated in Haryana.

Haryana lies between 74° and 78° E longitude and 27° and 31° N latitude. It is one of the smallest but richest states of Indian republic with an area of *ca* 44212 sq km and is bounded in the east by Uttar Pradesh and Delhi, in the west by Punjab, Himachal Pradesh in the north and Rajasthan in the south. The state comprises of 19 districts.

Haryana has a diversified topography ranging from the flat alluvial plains in the central part to the steep and precipitous Siwalik terrain in the north-east. The three broad topographic zones in Haryana are

Mountainous tract: This tract is largely constituted by Siwaliks in Ambala district and to a small extent by fragmented extension of Aravali hills in Gurgaon and Mahendragarh district. The elevation varies from 300-1500m. The slopes are generally steep and characterised by frequent vertical slopes particularly in Siwaliks. The highest point lies in Morni hills which represent some features of outer Himalayas.

Alluvial plains: The larger part of the state is constituted by Indo-gangetic plains marked with a vast stretch of flat land with occasional local undulations. This area is of vital economic importance as agriculture is being practised in this region. There is vast expanse of saline alkaline soil in this zone.

Sand-dunes: These are heaps of sand forming part of the Rajasthan desert and lying in Sirsa, Hisar, Bhiwani, Gurgaon and Mahendragarh districts. The mobile sand dunes pose a big problem of soil erosion by wind and threaten the prosperity of fertile plains.

The larger part of the state except hilly areas of Ambala and Yamunanagar district is arid or semiarid marked by acute moisture deficiency. Gurgaon, Faridabad, Mahendragarh, Hisar, Bhiwani, Sirsa, part of Rohtak and Jind districts are moisture deficient almost for the entire year because of high evapo-transpiration and low precipitation. The moisture surplus occurs in July-August in Ambala, Yamunanagar, Kurukshetra, Kaithal, Karnal, Sonapat, part of Rohtak and Jind district. The bulk of the precipitation received through South-West monsoon occurs during July-August. The distribution of rainfall varies. Severe drought is a characteristic feature of Gurgaon, Mahendragarh, Hisar, Sirsa, Bhiwani, Rohtak and Jind district. However, floods are also seen in these districts.

The temperature exhibits great diurnal and seasonal variations. The summer temperature reaches upto 48° (50°C) whereas in the winter it falls below 0°C particularly in Hisar, Gurgaon, Bhiwani and Mahendragarh districts. The climate of most of the state is of dry tropical type except of Morni hills of Ambala district which is subtropical.

Table I
Average rain fall in five districts of Haryana

Sl. No.	District	June-Sept. (cm)	Dec.-March (cm)	Annual rainfall
1.	Ambala	70.80	11.05	87.06
2.	Gurgaon	47.98	4.70	56.08
3.	Hisar	31.01	4.75	38.76
4.	Karnal	46.84	6.96	57.58
5.	Rohtak	42.67	5.26	50.19

(Source: Nair 1978)

During summer, winds of high velocity (up to 125 km/hour) and duststorms are quite common. Gurgaon, Mahendragarh, Sirsa, Hisar, Bhiwani and part of Rohtak and Jind districts are seriously affected by duststorms. The Relative humidity is generally low for greater part of the year except during monsoon seasons.

The soil generally consists of Indo-gangetic alluvium with beds of sedimentary rocks which form a series of outer layers of Aravali rocks of the Delhi system.

They are composed of an upper thick group of quartzites, limestones and lower group of states. The soil of Ambala district is mostly loamy in nature, slightly alkaline having enough potash and phosphorus but low nitrogen content. Soil of Karnal district is sandy to sandy loamy, highly alkaline with deficiency of phosphorus. Surface soils of Rohtak district are loamy with increasing clay content with depth. These soils are neutral or slightly alkaline and deficient in nitrogen and phosphorus. The soils of Sirsa, Bhiwani and Hisar districts are loamy with clay increasing with depth.

Agriculture is the mainstay of more than 80 per cent people in Haryana. The foodgrain production which was nearly 25.92 lakh tonnes at the time of inception of state leaped up to 102.65 lakh tonnes (almost 4 times) in 1992-93. Haryana has contributed 34.54 lakh tonnes of wheat, 11.61 lakh tonnes of rice towards the central pool in the year 1993-94. Rice, wheat, jowar (jwar), bajra, maize, barley, pulses, sugarcane, cotton, oilseeds and potato are the major crops of state. Now, more emphasis is being laid on growing cash crops like sugarcane, cotton and oilseeds besides encouraging farmers to grow new crops like sun-flowers, soybean, fruit and vegetables. Efforts are being made to encourage extensive and intensive farming in the state.

The state has made rapid progress in the field of industry with a strong industrial base and infra-structure. It produces largest number of tractors in the country, about 1/4th of total number of bicycles and 1/3rd of country's production of sanitary wares. Panipat the "Weaver's city of India" is famous for its exquisite, hand-tufted woollen carpets and colourful handloom products. The number of small and rural industries has risen significantly giving a boost to rural economy. Besides, the state is developing model industrial townships at many places with foreign collaboration.

Haryana is the first totally electrified state of India. It is a beneficiary of multipurpose project on Sutlej and Beas sharing benefits with Punjab and Rajasthan. Major irrigation projects in state are Western Yamuna canal, Bhakra canal system and Gurgaon canal. The Jui, Sewani and Jawaharlal Nehru lift irrigation schemes to carry irrigation water against gravity flow to avoid areas have served as a check against the spread of the Rajasthan desert. Techniques of drip and sprinkler irrigation are being followed in highly undulating and sandy tracts of Haryana.

VEGETATION

Since Haryana was separated from the erstwhile Punjab in the year 1966, the earlier account of vegetational studies deals with Punjab plains as a whole. J.L. Stewart (1869) dealt with botanical and vernacular names and uses of economically important trees, shrubs and herbs. The principal grasses of Hisar were photolithographed by Coldstream (1889) whereas J.F. Duthie (1850 onwards) made extensive collections from Hisar district (now furcated into three viz. Bhiwani, Sirsa and Hisar). Coventry (1901) gave a catalogue of the principal trees and shrubs of Punjab. Bamber (1916) botanised in the Punjab and Jand K state. Parker (1918) dealt with trees and shrubs of earstwhile Punjab, Hazara and Delhi. Sabnis (1940-41) publised a list of plants of Punjab and adjoining hilly region.

The recent plant collectors and botanists from Haryana are M.B. Raizada (Hisar) O.P. Sharma (erstwhile Punjab), T.A.Rao (Gurgaon) J.N. Vohra (Karnal, Ambala) N.C. Nair (Hisar), V.J. Nair (Rohtak and Hisar), S.P.Jain (Kurukshetra, Karnal) R. Kumar (Faridabad). The collections of M.B. Raizada and O.P. Sharma are housed in the herbaruim of FRI, Dehradun (DD) wheras of T.A. Rao, J.N.Vohra, N.C. Nair and V.J. Nair in herbarium of BSI, Northern Circle, Dehradun (BSD). Collections of S.P. Jain are kept at Kurukshetra University, Botany Department herbarium and that of R. Kumar at Delhi. Besides these workers, attempts have been made for plant collection from Hisar (Harsukh), Ambala (Gupta) and Chandigarh (P.N. Mehra) which are available in FRI herbarium. Nair (1978) and Nair and Nair (1963, 1964a,b, 1966) published a number of new plant records from Punjab plains which included Haryana also. Notable contributions for study on botany of Punjab are of Duthie (1881-1888), Maheshwari (1963), Nair (1978) and Nair and Nair (1963, 1964a,b, 1966), Jain *et al.* (1982) and Kumar (unpublished, 1995).

The vegetation of Haryana is chiefly composed of three major floristic elements viz. Tropical cosmopolitan, Eastern Indo-Malayan and Western Desert elements.

Tropical cosmopolitan elements

This is the chief component of floristic diversity of Haryana comprising more than 55% of total vegetation. It represents widespread

elements of tropical countries including Indian subcontinent. The vegetation of *ca* 10 districts in Haryana is mainly composed of tropical cosmopolitan element.

Western deserts elements

It comprises the Indian desert, African, W. Asian and Mediterranean elements mainly confined to dry arid regions viz. Bhiwani, Hisar, Mahendragarh and Sirsa districts in Haryana. It is about 25% of total vegetation.

Eastern Indo-Malayan elements

The other major component of vegetation is Indo-malayan element which together with Asian as well as African element constitute about 12% of total floristic wealth of Haryana.

The other floristic elements represented in Haryana are Temperate and New world elements which form the remaining 8% of vegetation chiefly confined to hilly regions of Siwaliks in Ambala and Yamunanagar districts.

The flora of Haryana is having close similarity with the adjoining states of Delhi, Uttar Pradesh, Punjab and Rajasthan and quite a larger number of species are common. However, a close scrutiny of floristic composition indicates that there is more representation of eastern elements vis-a-vis western elements in Haryana than Rajasthan whereas Delhi and U.P. show the reverse trend.

The studies based on sporadic floristic surveys are not sufficient for a complete account of flora of Haryana

The forest area on 1st November, 1966 was 1,38,165 hectares. In the year 1973, the total forest area under the control of forest department stood at *ca* 168488 hectares. (Table - II)

Table II
Various types of forests

Sl.No.	Type of Forest	Area (ha)
1.	Reserved Forest	22846
2.	Protected Forest	106571
3.	Unclassed Forest	6216
4.	Closed forest u/s 38 of Indian Forest Act	3311
5.	Closed forests u/s 4 and 5 of Land Preservation Act	29544
Total		1,68,488

However, as per recent estimate based on satellite data, the total forest cover in Haryana is only 513 sq km out of a total of about 4,74,965 sq km of the whole country making it the least forested state of India (Anonymous, 1993). Out of total geographical area of *ca* 44212 sq km only *ca* 1.2% is under actual forest cover. (Table - III)

Table III
District-wise forest cover

Sl. No.	Name of District	Geographi- cal area	Dense Forest	Open Forest	Total	% to Geographical area
1.	Ambala	3832	262	113	375	9.79
2.	Bhiwani	5099	2	4	6	0.12
3.	Faridabad	2150	4	7	11	0.51
4.	Gurgaon	2716	10	9	19	0.70
5.	Hisar	6315	4	5	9	0.14
6.	Jind	3306	5	1	6	0.18
7.	Karnal	3721	1	2	3	0.08
8.	Kurukshetra	3740	26	9	35	0.94
9.	Mahendragarh	3009	9	24	33	1.10

Sl. No.	Name of District	Geographical area	Dense Forest	Open Forest	Total	% to Geographical area
10.	Rohtak	3841	6	9	15	0.39
11.	Sirsa	4276				
12.	Sonepat	2207		1	1	0.05
Total		44212	329	184	513	1.16

The important vegetation types found in Haryana may be classified as follows

Northern tropical dry deciduous forest

This forest type extends over the north-eastern (except Ambala district) and south-eastern parts of the state. The annual rainfall varies from 50-110cm. The important tree species include *Shorea robusta*, *Terminalia tomentosa*, *Lannea coromandelica*, *Mallotus philippinensis*, *Bauhinia variegata*, *Cassia fistula*, *Anogeissus latifolia*, *Dalbergia sissoo*, *Bombax ceiba*, *Garuga pinnata*. The shrubs are represented by *Woodfordia fruticosa*, *Carissa spinarum*, *Zizyphus* spp., *Clerodendrum viscosum*, etc. The important grasses found in these forests are *Eulaliopsis binata*, *Dichanthium annulatum*, *Chrysopogon montanus*, *Heteropogon contortus* and species of *Cymbopogon* and *Apluda*. Bamboos occur in mixture with other miscellaneous species.

In south-eastern part of the state comprising the Gurgaon, Rewari and Faridabad districts the following forest composition can be seen- *Anogeissus pendula* scrub, *Salvadora-Tamarix* scrub, *Phoenix* scrub, Babul forest and *Butea* forest.

Northern tropical thorn forest

This forest type is distributed in western and south-western parts of the state covering Hisar, Sirsa, Bhiwani and Mahendragarh districts. The rainfall varies from 25-50 cm. Salipe-alkali soils are common in this region. *Acacia* is the chief constituent of this region represented by

Acacia nilotica, *A. senegal* and *A. leucophloea*. The other important tree species are *Anogeissus pendula*, *Butea monosperma*, *Prosopis cineraria*, *Tamarix aphylla*, *Azadirachta indica*, *Salvadora oleoides*, *S. persica*, etc. The vegetation can be further divided into following categories.

Vegetation of loose sand dunes : There is hardly any vegetation during summer months as sand piled up into dunes runs away with great speed of wind. In rainy season, however, the sand gets set and stray seeds carried by wind are lodged in the sand and germinate. The pioneers are *Aerua persica*, *Arnebia hispidissima*, *Calligonum polygonosides*, *Calotropis procera*, *Cenchrus biflorus*, *C. ciliaris*, *Crotalaria burhia*, *Eragrostis ciliaris*, *Farsetia hamiltonii*, *Leptadenia pyrotechnica* and *Zizyphus nummularia*. Out of these, *Arnebia*, *Calligonum*, *Crotalaria* and *Leptadenia* are typical loose sand-dune species known as "Psammophytes". They are not found in stabilized soils. Large shrub of *Calligonum* and *Leptadenia* are sometimes seen growing on the crest of sand-dunes. The characteristic tree species of this habitat are *Prosopis cineraria*, *Acacia nilotica*, *Balanites aegyptiaca* and *Tecomella undulata*. *Citrullus colocynthis* is also seen growing on loose sand-dunes.

Vegetation of stabilized dunes : Sand-dunes get stabilized due to encroachment of vegetation. Besides tree species like *Acacia nilotica*, *Balanites aegyptiaca*, *Prosopis cineraria* and *Tecomella undulata* the common elements found on these dunes include *Acacia jacquemontii*, *Boerhavia diffusa*, *Calligonum polygonoides*, *Calotropis procera*, *Capparis decidua*, *Clerodendrum phlomidis*, *Leptadenia pyrotechnica*, *Lycium europaeum*, *Maytenus emarginatus*, *Pupalia lappacea*, *Salvadora oleoides* and *Zizyphus nummularia*.

Vegetation of spread out sand : Loose spread out sand is easily colonized by *Aerua persica*, *A. pseudotomentosa*, *Arnebia hispidissima*, *Blepharis linearifolia*, *Citrullus colocynthis*, *Crotalaria burhia*, *Farsetia jacquemontii*, *Sericostoma pauciflorum*, *Zizyphus nummularia* and species of *Cenchrus* and *Cyperus* in rainy season, pure strands of *Acacia*, *Calligonum* and *Leptadenia* are sometimes seen on large tracts. The sand stabilizes due to prolonged weathering and open thorny scrub vegetation is seen which include *Acacia jacquemontii*, *A. nilotica*, *Balanites aegyptiaca*, *Calotropis procera*, *Capparis decidua*, *Maytenus emarginatus*, *Mimosa hamata*, *Prosopis cineraria*, *Securinega leucopyrus*, *Salvadora oleoides* and *Zizyphus nummularia*. At some places pure strands of

Balanites aegyptiaca and *Salvadora oleoides* are also noticed for long distances.

During rainy season, the stabilised soil is converted into thick green carpet of herbaceous vegetation. The species of *Achyranthes*, *Aerua*, *Boerhavia*, *Cenchrus*, *Digera*, *Eragrostis*, *Fagonia*, *Heliotropium*, *Indigofera*, *Mollugo*, *Tribulus*, *Tridax* and *Zaleya* are the chief component of this vegetation. In winter these species are replaced by *Argemone mexicana*, *Carthamus oxyacantha*, *Echinops echinatus*, *Gastrocotyle hispida*, *Justicia peploides*, *Psammogeton canescens* and *Solanum nigrum*. In summer *Boerhavia diffusa* and *Solanum surattense* are the only species seen on this soil.

Perennial climbers like *Coccinia grandis*, *Cocculus hirsutus*, *C. pendulus*, *Ephedra foliata*, *Maerua oblongifolia*, *Momordica balsamina*, *Pentatropis spiralis*, *Pergularia daemia* and *Rhynchosia minima* are found among the bushes.

Vegetation of isolated hillocks : There are a few isolated rocky hills in Gurgaon, Hisar and Rohtak districts. The bulk of the vegetation on these hillocks consists of spinous trees and hardy shrubs. *Acacia senegal*, *Anogeissus pendula*, *Balanites aegyptiaca*, *Boswellia serrata*, *Cordia dichotoma* and *Wrightia tinctoria*, etc. are characteristic tree species of this habitat. The thorny shrubby vegetation is represented by *Abutilon indicum*, *Capparis decidua*, *C. sepriaria*, *Euphorbia nivulia*, *Hibiscus micranthus*, *Maerua oblongifolia*, *Maytenus emarginatus*, *Mimosa hamata*, etc. *Corbichonia decumbens*, a typical lithophyte is found only on the rocks. During rainy season, species of *Aristida*, *Cenchrus*, *Corchorus*, *Euphorbia*, *Melanocenthrus*, *Tribulus* and *Vernonia* form a thick carpet of herbaceous vegetation on hills. Climbers are represented by species of *Ipomoea*, *Melothria*, *Pergularia* and *Rhynchosia*.

Sub-tropical Pine forest

Sub-tropical vegetation is confined to a small portion of Morni hills in Ambala district. The vegetation is relatively very rich. *Pinus roxburghii* is an important constituent of this type and occurs gregariously in patches. The other chief tree species are *Acacia catechu*, *Anogeissus latifolia*, *Bauhinia variegata*, *Caryopteris wallichiana*, *Cassia fistula*, *Clerodendrum fragrans*, *C. indicum*, *Colebrookea oppositifolia*, *Phyllanthus embelica*, *Desmodium oojenensis*, *Shorea robusta*, etc.

The shrubs are represented by *Carissa spinarum*, *Dodonaea viscosa*, *Jasminum* spp, *Rhus* spp. and *Woodfordia fruticosa*.

Crops

The central part of Haryana is highly fertile and irrigated by a network of canals. There is very little or no wild vegetation in this region. Kharif and rabi season crops are the main crops of the state.

Kharif crop includes *Cajanus cajan*, *Crotalaria juncea*, *Cyamopsis tetragonolobus*, *Gossypium* spp., *Hibiscus cannabinus*, *Oryza sativa*, *Pennisetum typhoides*, *Sesamum indicum*, *Sorghum vulgare*, *Vigna unguiculata* and *Zea mays*.

The main rabi crops grown in Haryana are *Brassica campestris* var. *sarson*, *Cicer arietinum*, *Hordeum vulgare*, *Lens culinaris*, *Linum usitatissimum*, *Pisum sativum*, *Trigonella foenum-graecum* and *Triticum aestivum*. Sugarcane (*Saccharum officinarum*) is grown in January-April and harvested during cold season.

Garden crops

The chief cold season garden crops grown in Haryana include *Allium cepa* (Onion, Pyaj), *Allium sativum* (Garlic, Lahsun), *Beta vulgaris* (Beet root, Chukandar), *Brasasica olerarcea* var. *capitata* (Cabbage, Bandgobhi) *Brassica juncea* (Leaf mustard, Sarson), *Coriandrum sativum* (Coriander, Dhania), *Daucus carota* (Carrot, Gajar), *Raphanus sativus* (Raddish, Muli), *Spinacea oleracea* (Spinach, Palak). The common summer month curcubits include *Citrullus lanatus* (Watermelon, Tarbuj), *Cucumis melo* (Melon, Kharbuja), *Cucumis melo* var. *momordica*, *C. melo* var. *utilissimus* (Kakri), *Lagenaria siceraria*, *Luffa aegyptiaca* (Ghia tori), *L. acutangula* (Tori), *Momordica charantia* (Bitter Gourd, Karela) *Trichosanthes dioica* (Parwal).

The weeds of rainy season found associated with crops are species of *Aeschynomene*, *Artemisia*, *Celosia*, *Cleome*, *Corchorus*, *Crotalaria*, *Demostachya*, *Digera*, *Euphorbia*, *Heliotropium*, *Justicia*, *Leucas*, *Polycarpea*, *Trianthema*, etc.

The weeds of winter season includes *Coronopus didymus*, *Fumaria indica*, *Oxalis corniculata* and species of *Anagallis*, *Antirrhinum*,

Asphodelus, Cirsium, Cotula, Lathyrus, Lolium, Medicago, Melilotus, Orobanche, Polypogon, Potentilla, Sisymbrium, Spargula, Spargularia, Trigonella, etc.

The riverside weeds include *Anagallis arvensis, Potentilla supina, Ranunculus sceleratus* and *Salvia plebia*.

The weeds of wastelands around villages, towns, old garden sites, along railway lines and roads and in fallow fields include *Amaranthus spinosus, Argemone mexicana, Cannabis sativa, Cassia obtusifolia, Erigeron bonariensis, Solanum surattense* and *Xanthium strumarium*

Aquatic plants

The water bodies in Haryana include ponds, lakes, canals besides rivers. The submerged hydrophytes include species of *Ceratophyllum, Hydrilla, Najas, Potamogeton, Vallisneria* and *Zannichellia*. The other aquatic plant species which have free floating upper parts and roots in the mud include *Ipomoea reptans, Lophotocarpus guyanensis, Marsilea minuta, Nymphaea nouchali, Potamogeton nodosus* and *Sagittaria sagittifolia*.

Free floating species consists of *Aponogeton natans, Azolla pinnata, Eichhornia crassipes, Lemna paucicostata, L. trisulca, Sporodela polyrrhiza, Trapa natans* var. *bispinosa, Utricularia inflexa* var. *stellaris, Wolfia microscopica*.

The marginal vegetation comprises species of *Alternanthera, Cyperus, Cynodon, Echinochloa, Fimbristylis dichotoma, Glinus, Hemarthria, Phyla nodiflora, Scirpus* spp., *Typha angustata, T. elephantina, Verbascum chinense, V. thapsus*. A little away from margins *Achyranthes aspera, Ageratum conyzoides, Alhagi maurorum, Corchorus capsularis, Cynodon dactylon, Chenopodium ambrosioides, Centella asiatica, Eclipta prostrata, Grangea maderaspatana, Paspalidium flavidum*, species of *Polygonum, Rorippa indica, Sporobolus marginatus* and *Vetiveria zizanioides*. The trees found growing on margins of canals and rivers include species of *Acacia, Ficus, Dalbergia, Prosopis, Tamarix*, etc.

The marshy vegetation includes *Bacopa monnieri*, *Fimbristylis dichotoma*, *Hemarthria depressa*, *Lophotocarpus guayanensis*, *Monochoria vaginalis*, *Sagittaria sagittifolia*, species of *Typha* and *Veronica anagallis-aquatica*. The tree species found on marshy localities include *Acacia nilotica*, *Butea monosperma*, *Phoenix sylvestris* and *Tamarix aphylla*.

FLORISTIC DIVERSITY

The total number of plant species found in Haryana is about 1227 falling under *ca* 642 genera representing 134 families, the ratio of genera to species being 1:1.91 and families to species being 1: 9.16. The ten largest families in Haryana are shown in Table IV which clearly indicate that Poaceae is the largest family represented by 129 species falling under 59 genera and Boraginaceae being smallest of the group of 10 represented by 26 species under 10 genera. On comparison with number of plant species in a particular family in relation to Indian flora (Table V) Malvaceae is the largest family (26.67%) followed by Convolvulaceae (16.13%), Boraginaceae (12.32%), Fabaceae (10.48%), Cyperaceae (10.57%) and Poaceae (10.25%). This is because of the lesser number of species in Malvaceae, Boraginaceae and Convolvulaceae in comparison to Poaceae, Fabaceae and Cyperaceae. The monogeneric/monotypic families in Haryana are shown in Table VI with their representative genera. The monotypic/monogeneric families are very important for conservation point of view due to rarity of taxa represented by them.

Table IV
Ten Dominant Families

Sl. No.	Name of the family	Number of genera	Number of species	Ratio (Genus/Species)
1.	Poaceae	59	129	1:2.19
2.	Fabaceae	41	106	1:2.59
3.	Asteraceae	61	93	1:1.52
4.	Cyperaceae	11	56	1:5.09
5.	Euphorbiaceae	17	44	1:2.59
6.	Malvaceae	12	36	1:3.00
7.	Lamiaceae	20	34	1:1.70

Sl. No.	Name of the family	Number of genera	Number of species	Ratio (Genus/Species)
8.	Acanthaceae	17	32	1:1.82
9.	Convolvulaceae	8	30	1:3.75
10.	Boraginaceae	10	26	1:2.60

Table V
Ten dominant families in relations to India

Sl. No.	Name of the family	Number of species in Haryana	Number of species in India	Percentage value in relation to India
1.	Poaceae	129	1291	9.99
2.	Fabaceae	106	1141	9.29
3.	Asteraceae	93	803	11.58
4.	Cyperaceae	56	545	10.27
5.	Euphorbiaceae	44	523	8.41
6.	Malvaceae	36	93	38.70
7.	Lamiaceae	34	435	7.81
8.	Acanthaceae	32	500	6.40
9.	Convolvulaceae	30	189	16.30
10.	Boraginaceae	26	209	12.44

Table VI
Monogeneric/Monotypic families

Sl. No.	Name of the family	Name of the genus
1.	Aponogetonaceae	<i>Aponogeton</i>
2.	Balanitaceae	<i>Balanites</i>
3.	Butomaceae	<i>Butomus</i>
4.	Cannaceae	<i>Canna</i>
5.	Casuarinaceae	<i>Casuarina</i>

Sl. No.	Name of the family	Name of the genus
6.	Ceratophyllaceae	<i>Ceratophyllum</i>
7.	Cuscutaceae	<i>Cuscuta</i>
8.	Moringaceae	<i>Moringa</i>
9.	Najadaceae	<i>Najas</i>
10.	Nelumbonaceae	<i>Nelumbo</i>
11.	Punicaceae	<i>Punica</i>
12.	Sparaganiaceae	<i>Sparagania</i>
13.	Sphenocleaceae	<i>Sphenoclea</i>
14.	Trapaceae	<i>Trapa</i>
15.	Typhaceae	<i>Typha</i>

Cyperus is the largest genus represented by 27 species followed by *Ipomoea* (18), *Euphorbia* (15) and *Indigofera* (14). (Table VII). In Haryana, 15 monotypic genera are also reported so far. Monotypic genera in Haryana are given in Table VIII.

Table VII
Ten largest plant genera

Sl. No.	Name of the genus	Number of species in Haryana	Number of species in India
1.	<i>Cyperus</i>	27	65
2.	<i>Ipomoea</i>	18	60
3.	<i>Euphorbia</i>	15	80
4.	<i>Indigofera</i>	14	60
5.	<i>Eragrostis</i>	13	36
6.	<i>Acacia</i>	11+2 var.	32
7.	<i>Crotalaria</i>	10	97
8.	<i>Ficus</i>	10	89
9.	<i>Fimbristylis</i>	10	50
10.	<i>Panicum</i>	10	34

Table VIII
Monotypic genera

S.No.	Name of the genus	Name of the species
1.	<i>Butomus</i>	<i>Butomus umbellatus</i>
2.	<i>Caesulia</i>	<i>Caesulia axillaris</i>
3.	<i>Catamixis</i>	<i>Catamixis baccharoides</i>
4.	<i>Colebrookea</i>	<i>Colebrookea oppositifolia</i>
5.	<i>Dactyliandra</i>	<i>Dactyliandra welwitschii</i>
6.	<i>Hydrilla</i>	<i>Hydrilla verticillata</i>
7.	<i>Lawsonia</i>	<i>Lawsonia inermis</i>
8.	<i>Millingtonia</i>	<i>Millingtonia hortensis</i>
9.	<i>Nothosaevra</i>	<i>Nothosaerva brachiata</i>
10.	<i>Nyctanthes</i>	<i>Nyctanthes arbor-tristris</i>
11.	<i>Pedaliium</i>	<i>Pedaliium murex</i>
12.	<i>Ricinus</i>	<i>Ricinus communis</i>
13.	<i>Sphenoclea</i>	<i>Sphenoclea zeylanica</i>
14.	<i>Tamarindus</i>	<i>Tamarindus indica</i>

RARE AND ENDANGERED TAXA

Since the vegetation of Haryana is very sparse (except a few thick pockets in Ambala Siwaliks) due to various climatic/biotic influences, the number of plants per species is very less as compared to other regions. The rare/threatened taxa assume greater importance in this context. A list of rare and threatened species is presented in Table IX. Surprisingly, there are no endemic taxa reported so far from Haryana as the vegetation is common with that of bordering states of U.P., Delhi, Punjab and Rajasthan. Rare and threatened species are economically important and needs special attention for conservation.

Table IX
Rare and endangered taxa

Name of the Species	Status*
<i>Cochlearia cochlearioides</i>	I
<i>Ailanthus excelsa</i>	I

Name of the Species	Status*
<i>Boswellia serrata</i>	I
<i>Moringa pterigosperma</i>	I
<i>Acacia catechu</i>	I
<i>A nilotica</i> var. <i>tomentosa</i>	V
<i>Mimosa hamata</i>	I
<i>M. himalayana</i>	I
<i>Bauhinia vahlii</i>	I
<i>Crotalaria mysorensis</i>	R
<i>Erythrina suberosa</i>	R
<i>Pueraria tuberosa</i>	R
<i>Terminalia arjuna</i>	I
<i>Caesulia axillaris</i>	I
<i>Erigeron asteroides</i>	R
<i>Cyathocline purpurea</i>	I
<i>Pulicaria angustifolia</i>	I
<i>Vicoa vestita</i>	R
<i>Manilkara hexandra</i>	I
<i>Dregea volubilis</i>	V
<i>Centaureum centaurioides</i>	I
<i>Exacum pedunculatum</i>	R
<i>Hoppea dichotoma</i>	I
<i>Cordia dichotoma</i>	I
<i>Hemigraphis latebrosa</i>	R
<i>Lepidagathis hamiltoniana</i>	I
<i>Justicia quinqueangularis</i>	I
<i>Nyctanthes arbor-tristis</i>	V
<i>Pogostemon benghalensis</i>	V
<i>Trema politoria</i>	R
<i>Iseilema prostratum</i>	I

ECONOMIC USES

A list of economically important plants of Haryana is presented in Table X indicating about the rich floristic wealth of this region which has so far been neglected on this aspect. Even with a conservative estimate there are more than 400 economically important plant taxa out of a total of 1227 species found in Haryana which comes out to be about 1/3rd of total floristic wealth. This one pointer is more than sufficient to indicate the importance of this botanically hitherto neglected state which deserves more attention for conservational measures than many other floristically richer states.

CONSERVATION MEASURES

Being an agricultural state, much attention was not paid earlier for conservation of wild flora, causing much greater harm to vegetation. Ironically more areas were brought under cultivation with the advent of green revolution since late sixties. The so called developmental activities further took their toll at the cost of wild plants which were mute spectator of their ruthless removal. The situation is not changed even now as more and more areas are being brought under developmental plans. It is high time that serious thinking is done to stop indiscriminate felling and subsequent removal of wild species so that the remaining plant wealth could be saved. Although belatedly, some efforts are already in the offing as state forest department, wasteland development board and some NGO's have taken up afforestation programmes in various districts and results are quite encouraging. Besides, some selected areas around lakes/waterbodies were developed as tourist spots viz. Badkhal lakes, Surajkund, Sohana lake, etc. These were kept "green" to attract more and more people to visit these spots. However, these efforts are too little to cope up with the problem of dwindling vegetation cover of Haryana which requires more intensive and extensive afforestation programmes, eco-development of selected areas and *ex situ* conservation of threatened species/taxa besides cultivation of some economically important plants in fields. For this, local people should be taught about the importance of the vegetation in general and some economically important plant species in particular so that they can be motivated to take up their cultivation and also contribute for conservation of important plant taxa in their region.

Table X
Economically important plants

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>Abelmoschus ficulneus</i>		+					+		
<i>A. moschatus</i>			+						
<i>Abrus precatorius</i>	+						+		
<i>Abrus precatorius</i>	+						+		
<i>Abutilon fruticosum</i>				+			+		
<i>A. glaucum</i>		+		+			+		
<i>A. indicum</i>	+						+		
<i>Acacia catechu</i>					+			+	+
<i>A. farnesiana</i>			+						
<i>A. jacquemontii</i>				+	+	+			
<i>A. leucophloea</i>		+		+	+			+	+
<i>A. modesta</i>	+							+	
<i>A. nilotica subsp. tomentosa</i>					+	+		+	
<i>A. pennata</i>	+				+	+			
<i>A. senegal</i>	+	+		+			+	+	+
<i>A. tortu</i>				+	+				
<i>Acalypha indica</i>	+								

M = Medicinal, E = Edible, E.O. = Essential Oil, Fo = Fodder, D = Dye.

Mi = Miscellaneous, Fi = Fibre, W = Wood, G/R = Gum/Resin, P = Perfumes

Name of the Species	M	E	F.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>Acanthospermum hispidum</i>	+		+						
<i>Achyranthes aspera</i>	+								
<i>Adhatoda zeylanica</i>	+		+			-			+
<i>Aegle marmelos</i>	+	+	+						
<i>Agave mexicana</i>	+								
<i>Ailanthus excelsa</i>	+			+				+	
<i>Alhagi maurorum</i>	+				+				
<i>Alisma plantago</i>	+								
<i>Alstonia scholaris</i>	+							+	
<i>Anni majus</i>	+								
<i>Andrographis echioides</i>	+								
<i>Anethum graveolens</i>	+		+						
<i>Anisomeles indica</i>	+		+						
<i>Annona squamosa</i>	+	+							
<i>Anogeissus latifolia</i>	+								+
<i>A. pendula</i>								+	
<i>Anthocephalus chinensis</i>			+					+	
<i>Aponogeton crispus</i>		+							
<i>A. natans</i>		+							
<i>Aristida funiculata</i>				+		+			
<i>Aristolochia bracteolata</i>	+								

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>A. elegans</i>	+								
<i>Arnebia hispidissima</i>					+				
<i>Artabotrys hexapetalus</i>	+		+						
<i>Artemisia capillaris</i>	+		+						
<i>Asclepias curassavica</i>	+					+	+		
<i>Asparagus adscendens</i>	+								
<i>A. gracilis</i>	+								
<i>A. racemosus</i>	+								
<i>Averrhoa carambola</i>		+				+		+	
<i>Azadirachta indica</i>	+					+		+	
<i>Bacopa monnieri</i>	+								
<i>Barleria prionitis</i>	+								
<i>Basella alba</i>	+				+				
<i>Bauhinia purpurea</i>	+			+				+	
<i>B. racemosa</i>	+						+	+	
<i>B. vahlii</i>		+			+		+	+	
<i>Boerhavia diffusa</i>	+								
<i>Bombax ceiba</i>	+			+					+
<i>Borreria articularis</i>	+			+					
<i>Boswellia serrata</i>	+					+		+	+
<i>Buddleja asiatica</i>		+				+			

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>Butea monasperma</i>					+	+		+	+
<i>Cadaba fruticosa</i>	+								
<i>Caesalpinia pulcherrima</i>	+			+					
<i>Calotropis gigantea</i>									
<i>C. procera</i>									
<i>Capparis decidua</i>	+	+						+	
<i>C. zeylanica</i>	+	+							
<i>Carissa spinarum</i>		+			+			+	
<i>Carthamus tinctorius</i>	+				+				
<i>Cassaria elliptica</i>					+	+		+	
<i>Cassia auriculata</i>	+				+			+	
<i>C. fistula</i>	+								
<i>C. occidentalis</i>	+	+							
<i>Catharanthus pusillus</i>	+								
<i>C. roseus</i>	+								
<i>Celastrus paniculata</i>	+								
<i>Celosia argentea</i>	+								
<i>Celtis australis</i>	+	+				+		+	
<i>Centaurium centaurioides</i>	+								
<i>Centella asiatica</i>	+								
<i>Centipeda minima</i>	+	+							

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>Commiphora roxburghii</i>	+								+
<i>Convolvulus arvensis</i>	+								
<i>C. microphyllus</i>	+								
<i>Corchorus aestivans</i>	+								
<i>C. capsularis</i>								+	
<i>C. depressus</i>	+								
<i>C. fascicularis</i>	+								
<i>C. olitorius</i>	+						+		
<i>C. tridens</i>								+	
<i>Cordia dichotoma</i>	+	+							+
<i>C. rothii</i>	+	+					+		
<i>Crataeva odora</i>	+							+	
<i>Crinum deflexum</i>	+								
<i>Crotalaria albida</i>	+							+	
<i>C. burhia</i>				+			+		
<i>C. juncea</i>				+			+		
<i>C. medicaginea</i>				+			+		
<i>C. spectabilis</i>	+						+		
<i>Cryptolepis buchmanii</i>						+	+		
<i>Cymbopogon jwarancusa</i>	+		+	+					
<i>C. martinii</i>			+						

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>C. schoenanthus</i>	+			+					
<i>Cynodon dactylon</i>	:			+					
<i>Cynoglossum wallichii</i>	+								
<i>Cyperus kylingia</i>	+		+			+			
<i>C. rotundus</i>			+						
<i>Dalbergia sissoo</i>				+				-	-
<i>Datura innoxia</i>	+								
<i>Deeringia amaranthoides</i>	+	+					!		+
<i>Dendrophthoe falcata</i>	+				!				
<i>Desmodium motorium</i>				+					
<i>Desmostachya bipinnata</i>							+		
<i>Dichanthium amulatum</i>				+					
<i>Dioana tomentosa</i>	+								
<i>Digera muricata</i>	:			+		+			
<i>Dioscorea belophylla</i>	+	+							
<i>Diospyros cordifolia</i>						+		!	
<i>D. exculpta</i>		+						:	
<i>Dodonaea viscosa</i>		+	+		+			+	
<i>Dregea volubilis</i>	+						+		
<i>Duranta repens</i>								+	
<i>Echinochloa colona</i>				+					

Name of the Species	M	E	E.O. (¹)	Fo	D	Mi	Fi	W	G/R
<i>E. cruegalli</i>				+					
<i>Echinops echinatus</i>	+					+			
<i>Eclipta prostrata</i>	+								
<i>Ehretia acuminata</i>		+		+				+	
<i>E. aspera</i>	+			+				+	
<i>Elytaria acaulis</i>	+								
<i>Eriophorum comosum</i>								+	
<i>E. variegata</i>	-								
<i>Eulophia campestris</i>	-								
<i>Euphorbia helioscopia</i>	+								
<i>E. hirta</i>	+								
<i>E. nerifolia</i>	+								
<i>E. nivulica</i>	+								
<i>Euphorbia longana</i>		+			+				
<i>Evolvulus alstrinoides</i>	+								
<i>Exacum pedunculatum</i>	+								
<i>E. tetragonum</i>	+								
<i>Fagonia arabia</i>	+								
<i>Fursetia hamiltonii</i>	+	+							
<i>Ficus jacquemontii</i>	+	+							

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/K
<i>F. corica</i>	+	+				+			
<i>F. cunia</i>	+		+				+		
<i>F. palmata</i>		+					+		
<i>F. racemosa</i>		+		+				+	
<i>Flacourtia indica</i>		+			+			+	
<i>Galium aparine</i>	+				+	+			
<i>Gisekia pharnaceoides</i>	+			+					
<i>Gmelina arborea</i>	+							+	
<i>G. luteoalbium</i> subsp. <i>affine</i>	+								
<i>Grewia elastica</i>							+	+	
<i>G. flavescens</i>		+		+		+			
<i>G. oppositifolia</i>				+			+	+	
<i>G. subinaequalis</i>		+						+	
<i>G. tenax</i>		+				+			
<i>Haplophragma adenophyllum</i>								+	
<i>Helicteres isora</i>	+			+			+	+	
<i>H. ellipticum</i>	+				+				
<i>Hesperethusa crenulata</i>	+							+	
<i>Heteropogon contortus</i>	+				+	+			
<i>Hibiscus cannabinus</i>						+	+		
<i>H. ficulneus</i>	+						+		

Name of the Species	M	E	E.O. (F)	Fo	D	Mj	Pi	W	G/R
<i>H. nuxabilis</i>	+					+	-		
<i>H. sabdariffa</i>	+					+	+		
<i>H. surattensis</i>	+					+	+		
<i>H. syriacus</i>	+	+				+	+		
<i>H. trionum</i>	+						+		
<i>H. vitifolius</i>							+		
<i>Happaa dichotoma</i>	+								
<i>Hypsis suaveolens</i>	+		-			-			
<i>Lehnocarpus frutescens</i>	-					+			
<i>Indigofera astragalina</i>				+		-			
<i>I. curulifolia</i>		+		+					
<i>Ipomoea dichroa</i>	+					+			
<i>I. digitata</i>	-					+			
<i>I. eriocarpa</i>	+	+		+					
<i>I. maxima</i>	+					+			
<i>I. pes-tigridis</i>	+					+			
<i>Exora coccinea</i>	+								
<i>Jasminum humile</i>	+		+		+				
<i>J. multiflorum</i>	+								
<i>J. officinale</i>			+			-			
<i>J. sambac</i>					+				

Name of the Species	M	E	EO (P)	Fa	D	Mi	Fi	W	G/R
<i>Kalanchoe spathulata</i>	+					+			
<i>Kickxia ramosissima</i>	+								
<i>Kigelia pinnata</i>	+								
<i>Kirganelia reticulata</i>	+				+	+			
<i>Kydia calycina</i>				+			+	+	
<i>Lactuca sativa</i>	+	+						+	
<i>Lagerstroemia indica</i>	+							+	
<i>L. speciosa</i>					+	+		+	
<i>Lanium amplexicaule</i>	+								
<i>Lamna coromandelica</i>					+			+	-
<i>Lawsonia inermis</i>			+		+			+	-
<i>Lepidium sativum</i>	+			+		+			
<i>Leptodermis pyrotechnica</i>				+			+		+
<i>Leucaena leucocephala</i>				+		+			
<i>Leucas cephalotes</i>	+		+						
<i>Limnophila indica</i>	+								
<i>L. rugosa</i>	+		+						
<i>Ludwigia perennis</i>	+								
<i>Lycium europaeum</i>		+				+			
<i>Manilkara hexandra</i>	+	+						+	
<i>Martynia annua</i>	+		+						

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>Medicago sativa</i>				+	+	+			
<i>Melochia corchorifolia</i>							+		
<i>Merremia hederacea</i>	+								
<i>Micromeria biflora</i>						+			
<i>Millingtonia hortensis</i>						+			
<i>Minusops elengi</i>		+				+		+	
<i>Mitragyna parvifolia</i>				+			+	-	
<i>M. macrophylla</i>	+				+				
<i>Monochoria vaginalis</i>	+								
<i>Morus alba</i>	+	+		+				+	
<i>Morinda tomentosa</i>		+			+			+	
<i>Maringa pterigosperma</i>	+	+		-		+			
<i>Mucuna prurita</i>	+	+							
<i>Murraya paniculata</i>	+	+	+					+	
<i>Myrsine africana</i>	+	+							
<i>Nelumbo nucifera</i>	+					+			
<i>Nerium indicum</i>	+					+			
<i>Nicotiana plumbaginifolia</i>						+			
<i>N. rustica</i>						+			
<i>Nyctanthes arbor-tristis</i>	+				+	+			
<i>Nymphaea nouchali</i>	+	+				+			

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>N. stellata</i>	+	+							
<i>Ocimum basilium</i>	+		+			+			
<i>O. cantum</i>	+		+			+			
<i>O. sanctum</i>	+	+	+						
<i>Olea europea</i>	+	+				+			
<i>Oligochaeta ramosa</i>				+					
<i>Opuntia coccinellifera</i>	+					+			
<i>O. dillenii</i>	+	+					+		
<i>O. elator</i>	-	+					+		
<i>Oroxylum indicum</i>	+	+				+		+	
<i>Desmodium oojeinensis</i>				+	+			+	
<i>Oxalis corniculata</i>	+	+							
<i>Oxystelmu secamone</i>	+	+							
<i>Panicum antidotale</i>	+			+		-			
<i>P. astroangulneum</i>		+		+					
<i>Papaver rhoas</i>	+					+			
<i>P. somniferum</i>	+					+			
<i>Parkinsonia aculeata</i>		+		+		+			
<i>Pavonia zeylantica</i>	+						+		
<i>Pedaliium murex</i>	+								
<i>Pentatropis spiralis</i>	+	+							

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>Pergularia daemia</i>	+	+							
<i>Peristrophe bicalyculata</i>			+	+		+			
<i>Phoenix humilis</i>		+					+		
<i>P. sylvestris</i>		+				+		+	+
<i>Phyllanthus emblica</i>	+	+						+	
<i>P. fraternus</i>	+								
<i>P. urinaria</i>	+					+			
<i>P. virgatus</i>	+								
<i>P. minima</i>	+	+							
<i>Pinus roxburghii</i>			+			+		+	
<i>Piper longum</i>	+								
<i>Pithecellobium dulce</i>		+		+		+		+	
<i>Plantago amplexicaulis</i>	+								
<i>P. ovata</i>	+								
<i>Plumbago zeylanica</i>	+								
<i>Plumeria aculeata</i>	+							+	
<i>Pogostemon benghalensis</i>	+		+						
<i>P. microcarpum</i> var. <i>lenticulare</i> *	+		+		+	+			
<i>Premna mucronata</i>	+	+						+	+
<i>Prosopis cineraria</i>		+			+			+	
<i>P. juliflora</i>	+	+						+	

Name of the Species	M	E	L.O. (P)	Go	D	Mi	Fi	W	G/R
<i>Prunus persica</i>	+	+	!					+	
<i>Psidium guajava</i>	+	+			-	+			
<i>Psoralea plicata</i>					-	+			
<i>Pterospermum acerifolium</i>	+	+				+		+	
<i>Pueraria tuberosa</i>	+	+		!					
<i>Punica granatum</i>	+	+							
<i>Putranjiva roxburghii</i>	+		-	!				!	
<i>Quisqualis indica</i>	+	+				+p			
		+						<i>Rhus mysorensis</i>	
<i>Sicinus communis</i>	!		!			!			
<i>Sorippu indica</i>	+	+							
<i>S. montana</i>	+								
<i>Suellia tuberosa</i>	+								
<i>Songia pectinata</i>	+								
<i>Saccharum arundinaceum</i>						!			
<i>S. benghalense</i>						+	!		
<i>S. spontaneum</i>						-			
<i>Sagittaria sagittifolia</i>	+					-			
<i>Salvadora oleoides</i>				+		-			
<i>Sapium sebiferum</i>	+					-			
<i>S. maritimus</i>		+	!	+					

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>Scoparia dulcis</i>	+			+					
<i>Securinega leucopyrus</i>		+				+			
<i>S. virosa</i>	+				+			+	+
<i>Sesamum indicum</i>	+	+							
<i>Sesbania bispinosa</i>						+	+	+	
<i>S. grandiflora</i>						+		+	
<i>S. sesban</i>	+	+				+	+	+	
<i>Setaria glauca</i>		+		+		+			
<i>S. verticellata</i>		+		+		+			
<i>Shorea robusta</i>			+			+		+	
<i>Sida acuta</i>	+						+		
<i>S. cordifolia</i>	+						+		
<i>Stymbrium irio</i>	+	+				+			
<i>Solanum erianthum</i>	+								
<i>S. nigrum</i>	+								
<i>S. surattense</i>	+								
<i>Sonchus asper</i>	+	+							
<i>S. brachyotus</i>	+	+		+					
<i>S. oleraceus</i>	+			+				+	
<i>Sparangium ramosum</i>	+								
<i>Spergula arvensis</i>	+				+				

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>Sphaeranthus senegalensis</i>	+					+			
<i>Sphenoclea zeytunica</i>		+							
<i>Spondias pinnata</i>	+	+				+		+	
<i>Sirebhus asper</i>	+	+		+		+	+	+	
<i>Sueda fruticosa</i>	+			+		+			
<i>Swietenia mahagoni</i>					+				+
<i>Tamarindus indica</i>	+					+		+	
<i>Tamarix aphylla</i>	+			+	+			+	
<i>T. dioica</i>					+	+		+	
<i>T. troupii</i>	+				+			-	
<i>Tecoma stans</i>	+					+			
<i>Tecomella undulata</i>				+				+	
<i>Tectona grandis</i>	+			+		+		-	
<i>Terminalia arjuna</i>	+				+	+		+	
<i>T. bellerica</i>	+					+		+	
<i>T. chebula</i>	+				+	+			+
<i>T. tomentosa</i>					+	+		+	+
<i>Tinospora cordifolia</i>	+								
<i>Toona ciliata</i>			+					+	
<i>Trapa natans</i> var. <i>bispinosa</i>		+							
<i>Trema politoria</i>							+	+	

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>Tribulus alatus</i>	+				+	+			
<i>T. terrestris</i>	+					+			
<i>Trichodesma amplexicaule</i>	+	+							
<i>Trigonella corniculata</i>	+					+			
<i>T. foenum-graecum</i>	+					+			
<i>Triumfetta rhomboidea</i>	+					+	+		
<i>T. rotundifolia</i>	+					+			
<i>T. pilosa</i>							+		
<i>Typha angustata</i>	+	+				+			
<i>T. elephantina</i>						+			
<i>Urena lobata</i>	+					+	+		
<i>Uraria picta</i>	+								
<i>Vallisneria spiralis</i>	+	+				+			
<i>Verbascum thapsus</i>	+								
<i>Verbena officinalis</i>	+		+						
<i>Veronica angallis-aquatica</i>	+						+		
<i>Vetiveria zizanioides</i>			+			+			
<i>Viola serpens</i>	+								
<i>Vitis vinifera</i>	+								
<i>Vitex negundo</i>	+								

Name of the Species	M	E	E.O. (P)	Fo	D	Mi	Fi	W	G/R
<i>Withania somnifera</i>	+								
<i>Woodfordia fruticosa</i>	+				+			+	
<i>Wrightia tinctoria</i>					+	+		+	
<i>Zinnia elegans</i>	+					+			
<i>Zyzyphus mauritiana</i>		+			+			+	
<i>Z. nummularia</i>		+		+					
<i>Z. oenoplia</i>		+				+			
<i>Zygophyllum simplex</i>	+	+		+					

REFERENCES

- Ambasta, S.P., K. Ramchandran, K. Kashyapa, and R. Chand 1986. *The Useful Plants of India* P.I.D., C.S.I.R., N. Delhi.
- Bamber, C.J. 1916. *Plant of Punjab. A Descriptive Key to the Flora of the Punjab, North- West Frontier Province and Kashmir*. London.
- Coldstream, W. 1889. *Illustrations of Some of the Grasses of the Southern Punjab being Photo-Lithograph*. Illustrations of some of the Principal grasses found at Hissar with short descriptive letter press. Calcutta.
- Coventry, E.M. 1901. *A Catalogue of the Trees and Shrubs of the Punjab*. Lahore.
- Duthie, J.F. 1883. *A List of Grasses of North-Western India. Indigenous and Cultivated*. Roorkee.
- Duthie, J.F. 1885. Report on an Examination of the Indigenous Grasses and Other Fodder Yielding Plants growing on the Hissar Bir land. Roorkee.
- Jain, S.P., Singh, J.S. and Verma, D.M. 1982. Flora of North-East Haryana (India). *J. Econ. Tax Bot.* 3: 152-176.
- Maheshwari, J.K. 1963. *The Flora of Delhi*. CSIR, New Delhi.
- Nair, N.C. 1978. *Flora of Punjab Plains*. *Rec. Bot. Surv. India* 21(1): 1-326.
- Nair, N.C. and V.J. Nair 1963. Some plant records for the Punjab plain. *Bull. Bot. Surv. India* 5: (3 and 4): 219-222.
- Nair, N.C. and V.J. Nair 1964a. Some new records for the Punjab plain II. *Bull. Bot. Surv. India* 6(1): 69-71.
- Nair, N.C. and V.J. Nair 1964b. Some new plant records for the Punjab Plain III. *Bull. Bot. Surv. India* 6(3 and 4): 299-300.
- Nair, N.C. and V.J. Nair 1966. New plant records for the Punjab Plain IV. *Bull. Bot. Surv. India* 8(3 and 4): 351-353.

Parker, R.N. 1918. *A Forest Flora of the Punjab with Hazara and Delhi*. Lahore (3rd Edn. 1956).

Sabnis, T.S. 1940-41. A contribution to the flora of Punjab Plains and its associated hill regions. *J. Bombay Nat. Hist Soc.* 42: 124-149, 342-379, 533-586.

Stewart, J.L. 1869. *Punjab Plants comprising Botanical and Vernacular Names and Uses of Most of the Trees, Shrubs and Herbs of Economic Value Growing within the Province*, Lahore.

HIMACHAL PRADESH

H.J. Chowdhery

Himachal Pradesh covers an area of 55,673 sq km in the north-western corner of India between 75° - 79° N longitude and 28° - 33° E latitude. It is bounded by Jammu and Kashmir in the north, Tibet (China) in the east, Uttar Pradesh in the south - east, Haryana in the south and Punjab in the west. Physiographically Himachal Pradesh can be divided into southern and northern regions. Southern region is as hot as plains of Punjab. Northern region has a temperate summer and winter with extreme cold and heavy snow fall. The state has 12 districts.

The terrain of the state is mountainous with varying altitude ranging from 250 m to about 7000 m above sea level. Himachal is drained by a number of perennial rivers having high hydel power generation potential. Some of the important rivers are Chenab, Ravi, Beas, Sutlej and Yamuna. The river Beas originates from 'Vyas Kund' near Rohtang pass in Himachal Pradesh. Apart from these, Baspa, Paber, Giri, Gambhar, Chandra, Bhaga, etc., are some other important rivers which ultimately joins the main rivers. Himachal has some important high altitude passes also. The important ones are - Bara, Lacha-La, Shipki-La, Rohtang pass, Sach-pass, Rupin pass and Kunzum-La. The famous old Hindustan-Tibet road runs through this state on hill tops via Sarahan, Chora, Ponda, Nichar to Wangtu.

The average rainfall of the state is about 182 cm. The northern region has less rain fall as compared to southern parts. Maximum rainfall is noticed at Dharmasala in Kangra district whereas, areas near Indo-Tibetan border are arid, dusty with heavy snowfall and are covered with snow nearly from December to May. The temperature also varies throughout the state. The south-western parts adjoining Punjab, Haryana and Uttar Pradesh have higher temperature as compared to north-eastern parts adjoining Jammu and Kashmir, Tibet and hilly regions of Uttar Pradesh.

Geologically Himachal Pradesh is divided into three zones-northern, central and southern (Wadia, 1957).

The northern zone, which is also termed as Tibetan zone is represented in Kinnaur and Spiti regions. It consists of almost unbroken

sedimentary deposit sequence from Cambrian to Cretaceous. The slates and quartzites are the oldest belts and generally non fossiliferous. It is overlain by conglomerates followed by red quartzite of lower Silurian age passing into lime stone and marl (clayey soil). The lime stones are gradually replaced by quartzite overlain by beds of Upper Permian age. It is followed by conglomerates overlain by Calcareous sand-stone and dark micaceous shale of Permian. These are covered by fossiliferous beds from Triassic and lower and middle Jurassic. This is followed by Spiti shales with ammonite fossils of the upper Jurassic age and is overlain by the Giumal sand-stone and Chikkim lime stones and shales representing Cretaceous system.

The central zone is mainly composed of lime stones, slate and quartzites and conglomerates of unknown age. The slates are overlain by a series of conglomerates of boulder-slate and pink dolomitic lime stone overlain by carboniferous shale followed by quartzite bed.

The southern zone is made up of Tertiary beds consisting of grey and red gypseous shales with subordinate bands of lime stone and grey sand-stones with bright red nodular clay followed by red or purple clays overlain by sandstones.

The soil type and texture varies from place to place in the state. The soils below 1000 m altitude are generally sandy loam varying from light grey to brown in colour. Such soils are not very deep, and bounded in pebbles, stones and boulders well irrigated and drained and are neutral.

On hilly slopes between 100 - 1600 m altitude the soils generally are grey to black coloured, loam or silt loam with fine texture. Such soils are drought prone due to quick internal drainage and are neutral to some what acidic. Between 1600 - 2200 m altitude the soils are fine textured and dark brown in colour. Such soils vary from silt loams to dry loams with less gravel. At higher elevations above 2200 m, the soils are shallower, well drained and dark brown in colour. These soils are silty loam to loams and are acidic in nature.

Himachal Pradesh falls in the Western Himalayan biotic province within the Sino-Himalayan subzone of the Boreal biogeographic zone (Rodgers, 1985 and Khoshoo, 1993). The Western Himalaya in a wider sense covers the states of Jammu and Kashmir, Himachal Pradesh and hills of Uttar Pradesh upto the western border of Nepal (Central Himalaya).

The Western Himalayan ranges of Himachal Pradesh can broadly be divided into three regions or zones

1. **Outer Himalaya:** The Outer Himalayan region of the state touches the Punjab plains and is criss-crossed by a large number of valleys. This region is most thickly populated in the state.
2. **Inner or Central Himalaya:** The Inner or Central Himalayan region has high mountains with narrow valleys and is thinly populated.
3. **Alpine Himalayan region:** The Alpine Himalayan region remains covered by snow nearly 6 months of the year and is least populated. The people of this region migrates to the warmer parts of the state in winter months and return to their native places as the snow start melting.

The earlist attempt of plant collection in Himachal Pradesh was made by William Moorcroft, who collected plants from Kangra, Kulu, Lahul and Spiti (1819 - 1821). George Govan, a civil surgeon stationed at Saharanpur (U.P.) and in-charge of Saharanpur Botanical Garden also made collections from Himachal Pradesh in 1828. He also established a nursery at Nahan in Sirmur district (H.P.) for growing plants of the hills. The countess of Dalhousie made pioneering attempts to collect plants from Simla in 1829 and about 600 specimens so collected were sent to Sir W.J. Hooker. J.F. Royle who succeeded G. Govan at Saharanpur made collections from Kinnaur, Simla and Bashahr around 1830. Victor Jacquemont, a French botanist visited areas of Kinnaur and Spiti bordering Tibet and Simla in 1830. In the same year R. Inglis, a member of Asiatic Society of Bengal made plant collections from Himachal Pradesh. General Walker and his wife made Collections from Simla and their collections were also sent to Sir W.J. Hooker. Among others who collected plants in and around Simla and contributed to Sir W.J. Hooker's herbarium were Colonel Munro, Lt. Col. Edward Madden, J.E. Winterbottom, Richard Strachey. Michael Pakenham Edgeworth, the first ecologist of India, also made collections from Himachal. Lord William Hay and Lance collected plants from different places in Himachal and sent their collections to Edgeworth. R.S. Simpson made collection from Simla in 1847. Hawtayne Parish also made collections from Mandi and Kulu in the same year. James William Grant made collections from Kinnaur in 1850. Sir Henery Collett collected plants from and around Simla in 1885. J.S. Gamble also collected

extensively from Simla and surrounding areas in 1877 and D. Brandis from Bashahr and other areas in 1881. J.F. Duthie, superintendent of Saharanpur Botanical Garden made several collection trips to different places of Himachal in 1892 and 1893. J.H. Lace made collections from Chamba and surrounding areas between 1891-1896, While G.A. Gammie made collections from this area between 1892-94. Among other worth mentioning explorers of the 19th century are J.D. Cunningham, T. Thomason, J.D. Herbert, G. Watt, H.A. Jaeschke, A.W. Hedye, J.R. Drummond, etc.

In the 1st half of the 20th Century significant contributions were made by R.N. Parker from Kulu, Bashahr; Parkinson from Parbatti Valley and other areas; Walter Koelz, Roop Chand Thakur, R.R. Stewart, N.L. Bor, H.A.C. Gill, S.R. Kashyap from Lahul and Spiti; Kartar Singh from Upper Bashahr and Kinnaur; S.P. Sethi, M.V. Laurie, C.R. Brown, G.S. Puri made collections from Lower and Upper Bashahr.

During the 2nd half of the 20th Century Scientist from Botanical Survey of India, Northern Circle, Dehradun made significant contributions to the botany of Himachal Pradesh. M.A. Rau, N.C. Nair, U.C. Bhattacharyya, T.A. Rao, P.K. Hajra, H.J. Chowdhery made frequent and periodical visits to various parts of Himachal Pradesh and have made extensive plant collections. Based on the available material and literature, Botanical Survey of India has brought out the "Flora of Himachal Pradesh" in 3 volumes (Chowdhery and Wadhwa, 1984).

Scientists from Regional Research Laboratory, Jammu; National Botanical Research Institute, Lucknow; Central Drug Research Institute, Lucknow and some Universities have also made collections from different localities of this state.

VEGETATION

The enormous variation in the altitude, latitude and longitude of the Himalayas has added to the multiplicity of habitats and provides diverse microclimates and ecological niches for all the living beings. The Western Himalayan region which includes Jammu and Kashmir, Himachal Pradesh and hilly regions of Uttar Pradesh (Garhwal and Kumaon) receives very less rains as compared to its eastern counterpart, the Eastern Himalaya. As a result the Western Himalayan flora in due course of time has evolved

and established it self as drought resistant and cold loving while the Eastern Himalayan flora developed into moist evergreen type. Moreover, the Western Himalayan flora is species deficient whereas, the Eastern Himalayan flora is species rich.

Himachal Pradesh with its undulating topography, varying degrees of altitudes ranging from 450 m to nearly 7000 m, subtropical to sub-arctic climate has diverse and rich vegetation from tropical deiduous to alpine meadows and cold deserts.

The vegetation of Himachal Pradesh can be broadly classified into

I.	Tropical	below 1000 m
II.	Subtropical	between 1800 - 2000 m
III.	Temperate	between 1800 - 3500 m
IV.	Subalpine	between 3500 - 4000 m
V.	Alpine	above 4000

However, depending upon the location, topography and climatic conditions these types may overlap.

I. TROPICAL VEGETATION

This type has been further divided into several subtypes with different nomenclatures by various workers. However, in the present study two subtypes are recognised.

1. Moist mixed deciduous Sal forest

Such forest occur in the Siwalik ranges and the slopes of lesser Himalaya upto an altitude of about 1000 m. These forest are dominated by *Shorea robusta*. In certain places pure stands of Sal forest can be seen. *Anogeissus latifolia*, *Terminalia alata*, *Acacia* spp., *Buchanania lanzan*, *Terminalia tomentosa*, *Pinus roxburghii*, *Phyllanthus emblica*, *Cassia fistula*, *Mallotus philippensi*, *Dendrocalamus strictus* are some of the important associates in these forest. *Murraya koenigii*, *Adhatoda zeylanica*, *Indigofera pulchella*, *Colebrookia oppositifolia*, *Woodfordia fruticosa*, *Nyctanthus arbor-tristis* are some prominent shrubby elements. Species of *Chrysopogon*, *Eulaliopsis*, *Heteropogon* are some of the common grasses of this area.

2. Mixed deciduous forest

These forest occur upto an altitude of 1500 m on exposed slopes. *Dalbergia sisso*, *Grewia optiva*, *Toona ciliata*, *Terminalia alata*, *Bombax ceiba*, *Bauhinia variegata*, *Desmodium oojeinensis*, *Mallotus philippensis*, *Albizia procera*, *Haldina cordifolia*, *Acacia* spp., *Lannea coromandelica*, *Aegle marmelos*, *Feronia linonia*, *Ehertia laevis*, *Kydia calycina*, *Mitragyna parvifolia*, *Flacourtia indica* are the dominant tree species associated with *Dendrocalamus strictus*, *Nyctanthus arbor-tristis*, *Carissa opaca*, *Dodonaea viscosa*, *Woodfordia fruticosa*, *Adhatoda zeylanica* etc. Along the river banks *Holoptelea integrifolia* is seen quite frequently, *Bauhinia vahali* is a common and conspicuous liana in these forest creeping on the tree tops and crowns.

In the arid regions semi-desert type of vegetation dominated by *Capparis decidua*, *C. spinosa*, *Acacia* spp, *Ziziphus* spp, *Calotropis gigantea*, *Carissa spinarum*, *Flacourtia indica* alongwith several species of grasses is seen.

In certain tropical and subtropical valleys the vegetation is dominated by *Olea cuspidata*, *O. ferruginea*, *Punica granatum*, *Prinsepia utilis*, *Zanthoxylum*, *Acacia modesta*, *Pistacia*, *Rubus ellipticus*, *Pinus roxburghii*, etc., with other associates like *Pyrus pashia*, *Coriaria nepalensis*, *Rhus cotinus*, *R. semialata*, *Indigofera*, *Desmodium*, etc. On the hilly slopes in drier regions, dense patches of *Euphorbia royleana* are prominent.

II. SUBTROPICAL VEGETATION

Based on the composition this type is further divided into two subtypes.

1. Subtropical Pine forest

Blue pine or *Pinus roxburghii* (Chil) predominates such forest which typically occupies the top canopy with fewer shrubby elements. However, in places where moist conditions prevail, broad-leaved elements also occur mainly evergreen oaks in association other broad leaved species and grasses.

Apart from *Pinus roxburghii*, other species seen are *Terminalia chebula*, *Mallotus philippensis*, *Pyrus pashia*, *Syzygium cumini*, *Albizia*

chinensis, *Phyllanthus emblica*, *Acacia catechu*, *Carissa opaca*, *Dodonaea viscosa*, *Rubus ellipticus*, *Crataegus crenulata*, *Flacourtia indica*, *Myrsine africana*, *Woodfordia fruticosa*, *Colebrookia oppositifolia*, *Berberis*, *Indigofera pulchella*, *Murraya koenigii* etc as common associates. Some of the common grasses are the species of *Chrysopogon*, *Cymbopogon*, *Dicanthium*, *Heteropogon*, *Themeda*, etc.

In moist locations *Quercus incana*, *Quercus glauca*, *Pyrus pashia*, *Rhododendron arboreum* are found. On the exposed slopes in chil forest *Euphorbia royleana* association with *Carissa spinarum* is commonly encountered.

2. Subtropical dry evergreen forest

These are scrub forest of small leaved evergreen trees dominated by shrubby elements and several thorny species which are more prominent on hot dry exposed slopes. *Olea cuspidata*, *Acacia modesta*, *Pistacia* predominate these forest. The other worth mentioning associates are *Punica granatum*, *Prinsepia utilis*, *Rubus ellipticus*, *Pyrus pashia*, *Coriaria nepalensis*, *Rhus cotinus*, *Rhus semialata*, *Indigofera gerardiana*, *Desmodium tiliaefolium*, *Zanthoxylum alatum*, *Dodonaea viscosa*. Several herbs also make their appearance during rainy season alongwith many grasses. The important grassy elements are the species of *Themeda*, *Heteropogon*, *Cymbopogon*, *Saccharum*, *Eulaliopsis*, *Chrysopogon* etc.

III. TEMPERATE VEGETATION

These forest are of 2 types- Himalayan Moist Temperate forest and Himalayan Dry Temperate forest.

1. Himalayan moist temperate forest

These are predominantly coniferous forest. Although the number of dominant gymnospermous species is small in such forest but pure stands of individual species are common and the species forming pure stands depends on the altitude and climatic conditions. Amongst the conifers species of *Abies*, *Cedrus*, *Picea*, *Pinus*, *Cupressus* and *Taxus* are prominent alongwith broadleaved elements. The dominant broad leaved taxa are the species of *Quercus* commonly associated with *Rhododendron arboreum*. Other species of *Rhododendron* occur at higher altitudes towards east. The

common deciduous plants are the species of *Acer*, *Corylus*, *Aesculus*, *Betula*, *Prunus*, *Ulmus*, *Carpinus* etc. Members of the family Lauraceae such as *Litsea*, *Lindera* and *Persea* are common. *Ilex*, *Euonymus* are some other common evergreen tree elements. Dwarf bamboos like species of *Arundinaria* are typical of these forest. *Indigofera*, *Desmodium*, *Rubus*, *Viburnum*, *Strobilanthes*, etc. are typical shrubby elements whereas, *Senecio*, *Dipsacus*, *Plectranthus*, *Impatiens*, *Heracleum* are commonly associated herbs in these forest.

Based on the presence of *Quercus* species at different altitudinal zones with their coniferous associates, the Himalayan Moist Temperate forest may be divided into

(a) Lower Western Himalayan Temperate Forest

This type is broadly divided into the following five subtypes

(i) Ban oak (*Quercus incana*) forest : These forest are found between 1800-2300 m and are dominated by *Quercus incana*, often with *Q. lanuginosa* and *Q. glauca* along the shady ravines with other common associates like *Rhododendron arboreum*, *Lyonia ovalifolia*, *Persea odoratissima*, *Litsea umbrosa*, *Myrica sapida*, *Symplocos crataegoides*, *Benthamedia capitata* and few climbers like *Rosa moschata*, *Hedera* etc. Many epiphytic mosses and lichens frequently grow on these trees. Few other epiphytes like ferns, *Arum*, *Sedum* and orchids also make their appearance during rainy season. The grasses are very few and the bamboos are generally absent except for *Arundinaria falcata* which grows in shady places.

(ii) Moru oak (*Quercus dilatata*) forest : These forest occur between 2000-2500 m in the form of a narrow belt (very much similar to *Quercus incana* type) in Sutlej valley.

(iii) Moist deodar forest: Such forest occur almost in the same altitudinal zone as 'Ban' and 'Moru' oak i.e. between 1700-2500 m. These are characteristically pure *Cedrus* forest commonly associated with *Pinus wallichiana* and *Picea*. Other important elements of this type are *Quercus incana*, *Rosa macrophylla*, *Berberis* spp., *Lonicera angustifolia*, *Strobilanthes wallichii*, *Boenninghausenia*, *Deutzia staminea* and ferns like *Adiantum*, *Oreopteris* etc while, *Galium asperifolium*, *Salvia glutinosa*,

Fragaria vesca, *Indigofera herterantha*, *Viola canescens*, *Oxalis corniculata*, *Desmodium tiliaefolium* are important herbaceous elements.

(iv) **Western mixed coniferous forest:** Also referred as 'Fir' forest, these occur at an altitude of about 2400-3000 m and mostly above 'Deodar' forest.

Such forest are dominated by several conifers species of *Picea*, *Cedrus*, *Abies*, *Pinus wallichiana*. The second storey elements are *Quercus dilatata*, *Q. incana*, *Q. semi carpifolia*, *Acer acuminatum*, *A. caesium*, *A. cappadocicum*, *Euonymus grandiflorus*, *Ulmus wallichiana*, *Taxus baccata* ssp. *wallichiana*, *Betula alnoides*, *Juglans regia*, *Corylus colurna*, *Celtis australis* whereas the common shrubby elements are *Deutzia compacta*, *Ribes himalense*, *Viburnum nervosum*, *Skimmia*, *Strobilanthes*, etc. Certain commonly occurring bamboos are *Arundinaria falcata*, *Thamnocalamus spathifloras*. While the species of *Fragaria*, *Viola*, *Valeriana* are some of the common herbaceous taxa mixed with several grasses. Species of *Clematis*, *Vitis* and *Hedera nepalensis*, *Schinandra grandiflora* etc. are the common climbers in these forest.

(v) **Moist temperate deciduous forest:** These forest commonly occur between 1800-2750 m altitude in moist hollow depressions as a strip along hill streams and gentle slopes. The common elements in these forest are *Acer caesium*, *A. cappadocicum*, *Acer sterculiaceum*, *Aesculus indica*, *Betula alnoides*, *Carpinus* spp., *Celtis australis*, *Fraxinus micrantha*, *Juglans regia*, *Pyrus lanata*, *Ulmus* spp., *Abies pindrow*, *Prunus cornuta*, etc. followed by *Cornus* spp, *Corylus jacquemontii*, *Euonymus tingens*, *Lyonia ovalifolia*, *Rhododendron arboreum*, *Taxus baccata* ssp. *wallichiana*, *Rhus* spp. and a common bamboo-*Arundinaria* spp.. The shrubby elements are species of *Berberis*, *Cotoneaster*, *Ribes*, *Viburnum*, *Jasminum humile*, *Deutzia compacta*, *Strobilanthes atropurpureus*, etc.

The common herbaceous taxa in these forest are species of *Aconitum*, *Polygonum*, *Impatiens*, *Polygonatum*, *Aruncus dioicus*, *Filipendula vestita* and few fern species. The common climbers are *Hedera nepalensis*, *Vitis* spp.

(b) Upper western temperate Himalayan forest

Based on the dominant species these forest are subdivided into the following

(i) **Kharsu oak (*Quercus semicarpifolia*) forest** : Such forest occur all along the outer and moist ranges between 2500-3300 m altitude. The common elements are *Quercus semicarpifolia*, *Picea smithiana*, *Pinus wallichiana*, *Rhododendron arboreum*, *Ilex dipyrena*, *Prunus padus* with shrubby associates like *Rosa macrophylla* and species of *Viburnum*, *Berberis*, *Spiraea*, *Indigofera*. The common herbaceous elements are several species of ferns, *Geranium*, *Rumex*, *Viola*, *Anemone*, *Iris*, *Polygonum*, *Daphne*, *Fragaria vesca* and grasses.

(ii) **Western Himalayan upper oak-fir forest** : Such forest occur along the higher ranges between 2600 to 3400 m altitude. The common elements which predominates these forest are *Abies pindrow*, *Pinus wallichiana*, *Picea smithiana*, *Quercus semicarpifolia*, *Taxus baccata* ssp. *wallichiana*, *Corylus jacquemontii*, *Pyrus lanata*, *Betula utilis*, *B. alnoides*, *Sorbus foliolosa* with shrubs like *Rubus niveus*, *Rosa macrophylla*, *Rosa sericea*, *Rhododendron campanulatum*, *Indigofera gerardiana* and species of *Berberis*, *Viburnum*, *Spiraea*, *Strobilanthes*, *Cotoneaster* while the herbaceous flora is represented by species of *Geranium*, *Aquilegia*, *Primula*, *Ranunculus*, *Fragaria*, *Senecio*, *Galium*, *Inula*, *Polemonium*, *Silene*, *Rheum*, *Valeriana*, *Ainsliaea aptera*, *Podophyllum hexandrum* etc. *Schisandra grandiflora*, *Vitis* spp. are some of the common climbing taxa.

2. Himalayan dry temperate forest

This type of forest are found in the inner Himalayan ranges with very less rainfall and the precipitation is mainly in the form snowfall during winter months. Generally conifers predominates such forest of which *Cedrus deodara*, *Pinus gerardiana*, *Juniperus* are more significant. Amongst the broad leaved elements, species of *Acer*, *Quercus*, *Fraxinus* are more common. The shrubby layer is by and large common with that of the moist zone but the plant like species of *Astragalus*, *Artemisia*, *Ephedra* are more prominent.

Based on the species composition, location and altitude, the Himalayan dry temperate forest have been divided into 5 subdivisions which are found often localized in certain areas

(a) **Dry broad-leaved and coniferous forest (*Quercus ilex*-*Pinus gerardiana* forest)**

Located between the altitude of 2000-2400 m these forest are

dominated by *Quercus ilex*, *Acer pentapomicum*, *Pinus gerardiana*, *Celtis australis*, *Fraxinus xanthoxyloides*, *Rhus succedanea*, *Parrotia jacquemontiana*, *Olea cuspidata*, *Zanthoxylum alatum* along with prominent shrubby species of *Artemisia*, *Lonicera*, *Berberis*, *Sophora mollis*, *Rosa webbiana*, *Daphne oleoides*, *Plectranthus rugosus*, etc. Several species of grasses belonging to the genera like *Agrostis*, *Agropyron*, *Eragrostis*, *Phleum*, *Setaria* are quite common. Climbers are not found in such forest.

(b) Dry temperate coniferous forest (Chilgoza or Neoza Pine forest, 2000-3500 m)

Such forest are found in the inner drier valleys of certain areas. The most dominant species are *Pinus gerardiana*, *Cedrus deodara*. The other prominent taxa are the species of *Artemisia*, *Caragana*, *Lonicera*, *Fraxinus*, *Ephedra gerardiana*, *Daphne oleoides*, *Prunus jacquemontii*, etc.

(c) Dry deodar forest

These are found in certain inner dry valleys between 2100-3200 m altitude. The main component of such forest are *Pinus wallichiana*, *Picea smithiana*, *Cedrus deodara* associated with *Corylus* spp. The prominent shrubs are the species of *Viburnum*, *Desmodium*, *Lonicera*, *Smilax*, *Rubus*, *Berberis*, *Plectranthus* while species of *Viola*, *Impatiens*, *Salvia*, *Fragaria*, *Silene*, *Primula*, *Thalictrum*, etc. are the common herbs.

(d) West Himalayan dry temperate deciduous forest

Such forest occur in dry arid zone between 3000-3600 m altitude which are dominated by *Pinus wallichiana*. Interestingly the pine trees in these forest are heavily infested with *Arceuthobium minutissimum* a minute parasitic angiosperm which causes severe damage to the timber and produces witches-brooms in the host, it is also the smallest flowering plant of the Himalaya. Other prominent species are *Pinus gerardiana*, *Abies spectabilis*, *Betula utilis*, *Juniperus communis*, *J. macropoda*, *J. indica*, *Sorbus foliosa*, *Rhododendron anthopogon*, *R. campanulatum*, *Ephedra*, *Lonicera* and *Salix* spp.

(e) West Himalayan dry Juniper forest

These are characteristically low height, open evergreen forest in certain inner dry zones between 2500-4300 m altitude. *Juniperos*

macropoda, *Fraxinus xanthoxyloides*, *Rosa webbiana*, *R. sericea*, *Ribes grossularia* etc. are some of the common constituents of these forest.

IV. SUBALPINE VEGETATION

The subalpine vegetation appears above the timber line or tree limit. This vegetation is in the form of stunted, scattered bushes. On the basis of this subalpine vegetation is termed as 'The High Montane Mixed "Stunted Forest"'

The common elements of this type are stunted bushes of *Betula utilis*, *Juniperus communis*, *J. indica* as pure stand or in association with *Rhododendron anthopogon*, *R. campanulatum*, *R. lepidotum*, *Cotoneaster* spp, *Lonicera* spp., *Rosa* spp., *Berberis* spp., *Astragalus* spp., etc. In the moist places along the streams herbaceous elements such as the species of *Ranunculus*, *Caltha*, *Pedicularis*, *Potentilla*, *Gentiana*, *Polygonum*, *Geranium*, *Anemone*, *Epilobium* are commonly encountered.

V. ALPINE VEGETATION

The Alpine vegetation can be divided into three types based on the species composition and climatic conditions etc.

1. Alpine scrub

The alpine scrub are commonly met with in the rocky places, ridges and stony slopes. These are of two types

(a) Moist alpine scrub

Such scrub develop on the rocks which have low calcium contents. *Rhododendron anthopogon* is the dominant element with species of *Lonicera*, *Swertia*, *Stellaria*, *Cotoneaster*, *Sedum*, *Potentilla*, *Corydalis*, *Astragalus*, *Silene*, *Rheum*, *Polygonum*, *Caltha*, *Cassiope* as common associates.

(b) Dry alpine scrub

These are generally found on rocks rich in lime contents. *Juniperus* is the most dominant form while, species of *Artemisia*, *Draba*, *Berberis*,

Rosa, Meconopsis, Saxifraga, Salix, Anaphalis, Caragana, Sedum, Taraxacum, Carex, Potentilla, etc., are other common associates.

2. Alpine meadows

The Alpine meadows present one of the most spectacular and colourful view of the Himalayan flora in the flowering season i.e. from May till the end of rainy season July-August. At an altitude of 4000 m or above, the climatic conditions are extremely severe and hostile and only some highly specialized type of herbaceous elements are capable of surviving here. The majority of them can survive the extreme cold conditions being burried under thick cover of snow during winter months and as soon as favourable season approaches, the snow starts melting and these dormant herbs swing into action and the whole alpine meadow is transformed into a fascinating mat of blue, red, violet, pink, yellow coloured flowers. The majority of alpine meadow plants are perennial in nature and perenate through rhizomes, root, root stocks, runners, suckers, bulbs, tubers or bulbils. These meadows are very rich in organic matter which is accumulated due to the dead remains of plants and continuously drenched by the melting snow from the surrounding snow clad peaks. At places the alpine meadows are replaced by glacier moraines which have almost a similar flora along their margins. The common herbaceous species of alpine meadows are *Saxifraga, Sedum, Androsace, Arenaria, Allium, Anemone, Aster, Anaphalis, Primula, Oxygraphis, Gentiana, Ranunculus, Caltha, Inula, Polygonum, Gagea, Potentilla, Delphinium, Selinum, Taraxacum, Adonis, Aletris, Astragalus, Arnebia, Arabis, Geranium, Senecio, Saussurea, Swertia, Stellaria, Dracocephalum, Erigeron, Picrorhiza, Corydalis, Lagotis, Rheum, Trollius, Waldhemia, Rhodiola, Pseudomertensia, Aconitum* etc. Apart from these a large number grasses and sedges are found growing in these meadows e.g. *Poa, Trisetum, Bromus, Dactylis, Elymus, Festuca, Phleum, Pennisetum, Carex, Kobresia* etc. Certain ground or terrestrial orchids which are known to occur in alpine meadows are *Dactylorhiza hatagirea*, species of *Cypripedium, Goodyera, Herminium, Malaxis* etc.

3. Alpine or Stony deserts

Beyond alpine vegetation which begins above timber line or tree-line and continues upto 4500 m or even upto 5000 m, lies the zone of Alpine desert. The most dominant elements of this zone are lichens and mosses associated with species of *Bergenia, Sedum, Corydalis, Primula,*

Artemisia, *Rumex*, *Polygonum* etc. Many of the plant species develop a cushion like habit in order to combat the extremes of the climatic conditions prevailing in this zone viz., *Arenaria*, *Acantholimon*, *Caragana*, *Saussurea*, *Thylacospermum* etc.

Beyond this zone no vegetation exists however, it is interesting to note that the highest altitude known for a flowering plant is 6300 m and *Christolea himalayensis* a member of the family Brassicaceae was collected from this altitude by Gurudial Singh on Mt. Kamet, at this altitude.

FLORISTIC DIVERSITY

The different vegetational (forest) types of Himachal Pradesh exhibit enormous plant diversity due to its varied topography, soil, climate and geographical location. Extensive studies on the flora and vegetation of Himachal Pradesh have been made by various workers viz., Aitchison, 1868; Watt, 1881; Burkill, 1908; Collett, 1902; Parker, 1918; Joshi, 1952; Puri, 1952; Jain and Bharadwaja, 1951; Rau, 1960, 1972 and 1974; Nair, 1964, 1977; Champion and Seth, 1968; Uniyal, 1973; Kapahi and Sarin, 1979; Aswal and Mahrotra, 1983 and 1985; Trivedi *et al.*, 1981; Chowdhery and Wadhwa, 1984; Hajra and Rao, 1990, etc.

A conspectus of flowering plants showing diversity of genera and species in different families in Himachal Pradesh is presented below (Table I).

Table I
Families showing approximate number
of Genera and Species

Family	Genera	Species
DICOTYLEDONS		
Ranunculaceae	18	116
Paeoniaceae	1	1
Magnoliaceae	3	5
Calycanthaceae	1	1
Schisandraceae	1	1
Menispermaceae	4	5

Family	Genera	Species
Berberidaceae	3	23
Podophyllaceae	1	1
Lardizabalaceae	1	1
Papaveraceae	4	7
Fumariaceae	3	23
Brassicaceae	36	83
Capparaceae	2	5
Violaceae	1	9
Flacourtiaceae	3	4
Pittosporaceae	1	2
Polygalaceae	1	7
Caryophyllaceae	19	65
Portulaccaceae	1	3
Tamaricaceae	1	2
Elatinaceae	1	1
Hypericaceae	1	10
Theaceae	2	2
Saurauiaceae	1	1
Malvaceae	11	27
Bombacaceae	1	1
Sterculiaceae	1	1
Tiliaceae	4	15
Linaceae	2	4
Malpighiaceae	2	2
Zygophyllaceae	1	1
Geraniaceae	3	27
Biebersteiniaceae	1	1
Oxalidaceae	1	1
Balsaminaceae	1	28
Tropaeolaceae	1	1
Rutaceae	8	16
Simaroubaceae	2	2
Meliaceae	3	4
Aquifoliaceae	1	3
Celastraceae	4	11

Family	Genera	Species
Rhamnaceae	6	17
Vitaceae	4	11
Leeaceae	1	1
Sapindaceae	4	4
Aceraceae	1	10
Staphyleaceae	1	1
Sabiaceae	2	4
Anacardiaceae	7	12
Coriariaceae	1	1
Mimosoideae	5	19
Caesalpinioideae	6	34
Papilionoideae	59	225
Rosaceae	23	157
Saxifragaceae	4	36
Parnassiaceae	1	3
Philadelphaceae	2	5
Hydrangeaceae	1	1
Grossulariaceae	1	5
Crassulaceae	4	27
Droseraceae	1	1
Hamamelidaceae	1	1
Haloragaceae	1	1
Hippuridaceae	1	1
Callitrichaceae	1	3
Combretaceae	2	5
Myrtaceae	5	38
Lecythidaceae	1	1
Melastomataceae	1	1
Lythraceae	4	5
Punicaceae	1	1
Onagraceae	5	44
Trapaceae	1	1
Passifloraceae	1	1
Cucurbitaceae	14	28
Begoniaceae	1	6

Family	Genera	Species
Datisceae	1	1
Cactaceae	1	1
Aizoaceae	1	1
Molluginaceae	2	2
Apiaceae	34	92
Araliaceae	4	4
Cornaceae	1	3
Alangiaceae	1	1
Caprifoliaceae	5	31
Rubiaceae	1	7
Valerianaceae	1	7
Dipsacaceae	2	3
Moringaceae	1	4
Asteraceae	94	328
Campanulaceae	5	16
Ericaceae	4	9
Pyrolaceae	1	1
Monotropaceae	1	2
Plumbaginaceae	1	1
Primulaceae	6	42
Myrsinaceae	4	6
Sapotaceae	1	1
Ebenaceae	1	5
Symplocaceae	1	2
Oleaceae	7	21
Apocynaceae	11	14
Asclepiadaceae	14	23
Loganiaceae	1	3
Gentianaceae	10	16
Menyanthaceae	2	4
Polemoniaceae	2	3
Boraginaceae	19	52
Cordiaceae	2	3
Convolvulaceae	8	19
Cuscutaceae	1	9

Family	Genera	Species
Solanaceae	12	28
Scrophulariaceae	29	138
Selaginaceae	1	4
Orobanchaceae	1	2
Lentibulariaceae	1	2
Gesneriaceae	5	7
Bignoniaceae	5	5
Pedaliaceae	1	1
Martyniaceae	1	1
Acanthaceae	21	37
Verbenaceae	12	19
Phrymaceae	1	1
Lamiaceae	40	136
Plantaginaceae	1	1
Nyctaginaceae	3	4
Illecebraceae	1	1
Amaranthaceae	10	26
Chenopodiaceae	11	25
Basellaceae	1	1
Phytolaccaceae	1	1
Polygonaceae	11	65
Aristolochiaceae	1	1
Piperaceae	2	2
Saururaceae	1	1
Lauraceae	6	18
Thymelaeaceae	2	2
Elaeagnaceae	2	3
Loranthaceae	6	12
Santalaceae	2	2
Euphorbiaceae	14	49
Buxaceae	2	4
Daphniphyllaceae	1	1
Urticaceae	12	28
Ulmaceae	3	12
Cannabaceae	1	1

Family	Genera	Species
Moraceae	2	26
Platanaceae	1	1
Juglandaceae	2	3
Myricaceae	1	1
Betulaceae	4	8
Fagaceae	3	11
Salicaceae	2	28
MONOCOTYLEDONS		
Hydrocharitaceae	2	2
Cerataophyllaceae	1	1
Orchidaceae	24	59
Zingiberaceae	7	12
Cannaceae	1	1
Musaceae	1	1
Iridaceae	2	5
Amaryllidaceae	3	17
Hypoxidaceae	2	2
Agavaceae	1	2
Dioscoreaceae	1	5
Liliaceae	26	47
Haemodoraceae	3	3
Pontederiaceae	1	1
Commelinaceae	4	11
Juncaceae	2	17
Typhaceae	1	1
Araceae	6	14
Lemnaceae	3	5
Alismataceae	2	3
Juncaginaceae	1	2
Potamogetonaceae	1	7
Zannichelliaceae	1	1
Eriocaulaceae	1	4
Cyperaceae	9	125
Poaceae	107	327
Bambusaceae	4	6

Table 11
Ten Dominant Families of the Indian Subcontinent

Sl No	Western Himalaya			Eastern Himalaya	North-East	India
	Himachal Pradesh (Chowdhery and Wadhwa, 1984)	Jammu and Kashmir (Kachroo, 1993)	Hills of J.P. H.P., J and K.	(Arunachal Pradesh) (Chowdhery <i>et al</i> 1986)	India (Rao and Murti, 1996)	(Hooker, 1906)
1.	Asteraceae	Asteraceae	Poaceae	Orchidaceae	Poaceae	Orchidaceae
2.	Poaceae	Poaceae	Asteraceae	Leguminosae	Orchidaceae	Leguminosae
3.	Leguminosae	Leguminosae	Leguminosae	Asteraceae	Leguminosae	Gramineae
4.	Rosaceae	Cyperaceae	Cyperaceae	Rubiaceae	Asteraceae	Rubiaceae
5.	Scrophulariaceae	Brassicaceae	Lamiaceae	Poaceae	Cyperaceae	Euphorbiaceae
6.	Lamiaceae	Lamiaceae	Ranunculaceae	Urticaceae	Lamiaceae	Acanthaceae
7.	Cyperaceae	Scrophulariaceae	Brassicaceae	Ericaceae	Scrophulariaceae	Compositae
8.	Ranunculaceae	Rosaceae	Rosaceae	Rosaceae	Acanthaceae	Cyperaceae
9.	Apiaceae	Ranunculaceae	Orchidaceae	Cyperaceae	Euphorbiaceae	Labiatae
10.	Brassicaceae	Apiaceae	Scrophulariaceae	Euphorbiaceae	Rubiaceae	Urticaceae

The floristic analysis of Himachal Pradesh flora reveals that though dicotyledons dominate the flora. The Monocotyledonous family Poaceae is the largest family in this area with *ca* 105 genera and 350 species. A comparison of 10 dominant families of Himachal and Jammu and Kashmir of Western Himalaya; Eastern Himalaya; North East India; India is presented in (Table II). It is evident from the tabulated data that Poaceae which occupies 2nd position in Himachal flora ranks 2nd, 1st, 5th, 1st and 3rd in Jammu and Kashmir, Western Himalaya, Eastern Himalaya, N.E. India and India respectively. The family Orchidaceae with about 1100 species in India finds no place within 10 dominant families of Himachal, though it ranks 9th in Western Himalayan flora. The family Leguminosae occupies 3rd place in Himachal flora is also at 3rd place in J and K, Western Himalaya and North-East India but it ranks 2nd in Eastern Himalaya and India. It is interesting to note the absence of the family Rosaceae, Scrophulariaceae, Ranunculaceae and Apiaceae from within the 10 dominant families of India, on the other hand Rubiaceae, Euphorbiaceae, Acanthaceae, Urticaceae does not figure within the 10 dominant families of Himachal or Jammu and Kashmir or the Western Himalayan flora. Twenty dominant families of Himachal Pradesh presented in Table III.

Table III
Twenty dominant families

Name of the family	Himachal Pradesh		India	
	Genera	Species	Genera	Species
Asteraceae	94	328	167	803
Poaceae	107	321	245	1194
Leguminosae	70	278	167	1141
Rosaceae	23	157	40	432
Scrophulariaceae	29	138	62	368
Lamiaceae	40	136	72	435
Cyperaceae	9	125	38	545
Ranunculaceae	18	116	28	191
Apiaceae	34	92	72	288
Brassicaceae	36	83	64	207
Caryophyllaceae	19	65	28	126
Polygonaceae	11	65	17	163
Gentianaceae	10	61	22	188
Orchidaceae	24	59	184	1229

Name of Family	Himachal Pradesh		India	
	Genera	Species	Genera	Species
Boraginaceae	19	52	43	209
Euphorbiaceae	14	49	84	523
Liliaceae	26	47	54	249
Onagraceae	5	44	6	49
Primulaceae	6	42	10	183
Saxifragaceae	4	36	10	126

Table IV shows the list of genera which dominates the flora of Himachal Pradesh and Jammu and Kashmir within Western Himalaya. It evident from the Table V that *Carex* is the largest genus with about 48 species, *Polygonum* ranks 2nd with 37 species and *Poa* is placed 3rd with about 33 species. Table VI shows the generic and species diversity in the different families of flowering plants in Himachal Pradesh.

Table IV
Dominant Genera in Western Himalaya

Himachal Pradesh (Chowdhery and Wadhwa, 1984)	Jammu and Kashmir (Kachroo, 1993)
<i>Carex</i>	<i>Carex</i>
<i>Polygonum</i>	<i>Taraxacum</i>
<i>Poa</i>	<i>Astragalus</i>
<i>Gentiana</i>	<i>Potentilla</i>
<i>Astragalus</i>	<i>Polygonum</i>
<i>Pedicularis</i>	<i>Nepeta</i>
<i>Saussurea, Cotoneaster</i>	<i>Gentiana</i>
<i>Nepeta, Silene, Cyprus</i>	<i>Saussurea</i>
<i>Artemisia, Potentilla, Corydalis</i>	<i>Artemisia</i>
<i>Ranunculus, Impatiens, Veronica</i>	<i>Ranunculus</i>
<i>Clematis</i>	<i>Pedicularis</i>
<i>Taraxacum</i>	<i>Veronica</i>
<i>Thalictrum</i>	<i>Corydalis</i>

Table V
Twenty dominant genera

Name of Genus	No. of Species
<i>Carex</i>	48
<i>Polygonum</i>	37
<i>Poa</i>	33
<i>Gentiana</i>	28
<i>Epilobium</i>	26
<i>Pedicularis</i>	26
<i>Cotoneaster</i>	25
<i>Saussurea</i>	25
<i>Cyperus</i>	23
<i>Euphorbia</i>	23
<i>Nepeta</i>	23
<i>Impatiens</i>	22
<i>Silene</i>	22
<i>Berberis</i>	21
<i>Corydalis</i>	21
<i>Potentilla</i>	21
<i>Saxifraga</i>	21
<i>Artemisia</i>	20
<i>Salix</i>	20
<i>Senecio</i>	20

Table VI
**Generic and species diversity in
different families**

Generic diversity vis-a-vis Family in Himachal Pradesh flora

Families with	1 genus	81
Families with	2 genera	26
Families with	3 genera	12
Families with	4-5 genera	22
Families with	6-10 genera	14

Families with	11-15 genera	10
Families with	16-25 genera	6
Families with	26-50 genera	5
Families with	51-75 genera	1
Families with	76-100 genera	1
Families with more than	100 genera	1

Species diversity vis-a-vis Family in Himachal Pradesh flora

Families with	1 species	51
Families with	2-10 species	68
Families with	11-30 species	33
Families with	31-50 species	9
Families with	51-75 species	6
Families with	76-100 species	2
Families with more than	100 species	8

Species diversity in the genera of different families of Himachal Pradesh flora

Genera with	1 species	52
Genera with	2 species	16
Genera with	3 species	10
Genera with	4 species	12
Genera with	5 species	12
Genera with	6-10 species	13
Genera with	11-20 species	35
Genera with	21-30 species	16
Genera with	31-50 species	2
Genera with	51-75 species	
Genera with	76-100 species	
Genera with more than	100 species	

Climbers

A large number of climbing species are found in tropical and sub-tropical forest. Some of the prominent climbing species are *Caesalpinia decapetala*, *Codonopsis rotundifolia*, *Convolvulus arvensis*, *Cynanchum*

auriculatum, *Capparis spinosa*, *Cissampelos pariera*, *Cocculus laurifolia*, *Bauhinia vahlii*, *Rosa moschata*, *Hiptage benghalensis*, *Stephania glabra*, *Hedra nepalensis*, *Hoya longifolia*, *Ipomoea eriocarpa*, *Ipomoea nil*, *Porana racemosa*, *Ficus hederacea*, *Ficus sarmentosa*, *Bilderdykia pterocarpa*, *Tylophora hirsuta*, *Polygonum dumetorum*, *Periploca calophylla*, *Trachelospermum lucidum*, *Jasminum dispersum*, *J. grandiflorum*, *J. officinale*, *Cryptolepis buchmanii*, *Trichosanthes tricuspidata*, *Cucumis collosus*, *Diplocyclos palmatus*, *Melothria heterophylla*, *Rhynchosia sericea*, *Vallaris heynei*, *Euonymus echinatus*, *Schizandra grandiflora*, *Parthenocissus semicordata*, etc.

Parasites

Several species of plant parasites can be seen infesting a variety of host plants. Some of the common parasitic plants are species of *Cuscuta* occurring on a large number of trees, shrubs and herbaceous hosts. *Arceuthobium minutissimum* and *A. oxycedri*, the smallest of all the flowering plants of Himachal causes severe damage to the valuable timber of *Pinus* and *Juniperos* species, while many species of *Viscum* are common parasites of the members of Rosaceae. Species of *Scurula* are also seen infecting *Prunus*, *Pyrus*, *Mallotus* and *Populus* trees. *Korthalcella opuntia* is parasitic on various species of *Quercus* and *Taxillus vestitus* is a parasite on *Machilus*. Among the root parasites *Pedicularis*, *Orobanche*, *Latharaea* and *Balanophora* are prominent.

Saprophytes

Saprophytes are not very common and only a few species are known to occur in the area. *Epipogium aphyllum*, *E. roseum*, *Neottia listeriodes*, *Gastrodia orobanchoides* the saprophytic orchids can be seen growing in moist-humid shady places rich in organic matter. In addition to these *Monotropa uniflora* and *Hypopitys lanuginosa* are some other saprophytes.

PHYTOGEOGRAPHICAL AFFINITIES

The enormous diversity of the Indian flora is mainly the outcome of the varying geographical and climatic conditions prevailing in the Indian subcontinent and the migration of plants from widely different adjoining countries particularly Chinese and Malayan in the East and South Oriental, European, African in the West and Tibetan, Siberian in the North (Hooker, 1906). He treated Himalayan region as a distinct

phytogeographical region characteristically distinct from rest of Hindustan (India). The Himalayan region was divided into 3 vertical zones Western Himalaya, Central Himalaya and Eastern Himalaya, these were further subdivided into several provinces. R. Good (1964) and Takhtajan (1969) however, divided the Himalayan region into 3 horizontal zones based on climatic conditions

1. **Dry-Arid zone** (Western and Central Asiatic region/Irano-Turanian): It is represented in the form of small pockets in Sikkim upto Garhwal however, from Himachal Pradesh this zone is almost continuous and wide extending upto Karakorum ranges.
2. **Temperate-Alpine zone** (Sino-Japanese region/Eastern Asiatic): It is found all along the Himalayas from Chitral to Arunachal Pradesh.
3. **Tropical zone** (flanks of Himalaya/mountain sides): This zone runs along the Himalayan foot-hills from the Indus to Brahmaputra.

The Western Himalayan zone has been further divided into 2 subzones (Rau, 1974; Hajra and Rao, 1990; Kachroo, 1993).

- a. North-Western Himalaya comprising of parts of Jammu and Kashmir and Himachal Pradesh.
- b. Western Himalaya includes areas between river Sutlej and Kali river valley on India-Nepal border.

The geological evidences indicate that the formation of North-Western Himalaya was a later event than rest of the Himalayas, in other words the Western Himalayan ranges are much younger than the Eastern Himalaya and these 2 regions have totally different past and sources which have contributed to their flora and fauna. Paulsen (1920); Popov (1926), Stanylikovitch (1948) etc., have suggested that the North-Western Himalaya are the part of Middle Asian floristic area and not of Sino-Japanese area. The dry-arid conditions prevailing particularly in the inner ranges of Western Himalayan region have prompted the migration of western and middle Asian mountainous elements in this area while, elements from the Western and North-Western Chinese mountains have influenced the flora of Eastern ranges. Being much older in age the Chinese mountains have greatly influenced the Himalayan flora and many

species have even migrated westward. According to Hara (1966) there existed a common flora in the whole of East Asia including Japan, China and Himalayas in the Tertiary period. Subsequently during the process of great changes which took place in the topography and climate, the separation of the flora might have taken place. The intermittent glacial and warmer periods in the pleistocene, many species of flora and fauna either survived or lost. Such successive changes in the climate and topography have brought in many new taxa from North, West and East unknown to Himalayan flora.

Studies on the phytogeographical affinities of the Himalayan flora have received the attention of a large number of botanists and phytogeographers from time to time (Hooker, 1854, 1906; Clarke, 1898; Chatterjee, 1940, 1962; Razi, 1955; Puri, 1960; M.A.Rau, 1974; Mani, 1974; A.S.Rao, 1978; R.Good, 1964; Takhtajan, 1969; Rodgers and Panwar, 1988; Kachroo, 1993; etc.). These studies indicate that the Western Himalayan flora has very close affinities with that of Europe, the near east and middle east as compared to the Eastern Himalaya where Chinese elements dominate.

The flora of Himachal Pradesh shows close affinities with the flora of middle Asiatic mountains, North temperate and Arctic regions of Eurasia, the mediterranean, the Chinese mountains and high Tibetan plateau.

1. Affinities with the flora of middle Asiatic mountains: A large number of species occurring in this region are common to Himachal flora, some of the species are *Aconitum rotundifolium*, *Arabidopsis mollissima*, *Achillea millefolium*, *Arenaria serpyllifolia*, *Astragalus densiflorus*, *Arnebia euchroma*, *Artemisia desertorum*, *A. sacrorum*, *Barbarea intermedia*, *Caragana versicolor*, *Chenopodium botrys*, *Cicer microphyllum*, *Draba* spp., *Dilophia salsa*, *Fragaria vesca*, *Geranium* spp., *Hippophae rhamnoides*, *Lloydia serotina*, *Lepidium apetalum*, *Melilotus* spp., *Medicago* spp., *Oxytropis humifusa*, *Pedicularis rhinanthoides*, *Polygonum viviperum*, *P. amphibium*, *Primula moorcroftiana*, *P. sibirica*, *Potentilla bifurca*, *P. multifida*, *Rhodiola quadrifida*, *Ranunculus laetus*, *R. natans*, *Rosa webbiana*, *Saxifraga flagellaris*, *S. sibirica*, *Sagina saginoides*, *Sisymbrium brassiciforme*, *Stellaria uliginosa*, *Taraxacum officinale*, *Triglochin maritimum*, *Thylacospermum caespitosum*, *Trigonella emodi*, *Viola biflora*. Some of the common grasses and sedges are *Bromus oxyodon*, *B. tectorum*, *Calamagrostis emodensis*, *Poa alpina*

and *Carex maritima*, *C. orbicularis*, *Juncus thomsonii*, *Kobresia pamiroalaica*, *Kobresia royleana*, etc.

2. Affinities with North-Temperate and Arctic regions of Eurasia: Many genera and species occurring in Himachal Pradesh are common to those found in these regions. Some of them are *Arabidopsis thalina*, *Arenaria serpyllifolia*, *Barbarea intermedia*, *Carum carvi*, *Bupleurum falcatum*, *Epilobium* spp., *Galium* spp., *Geranium pratense*, *Medicago sativa*, *Melilotus alba*, *Polygonum* spp., *Potentilla* spp., *Rumex acetosa*, *Sagina saginoides*, *Saxifraga* spp., *Silene* spp., *Thalictrum* spp., *Thlaspi arvense*, *Turritis glabra*, *Verbascum thapsus*, *Viola biflora*.

3. Affinities with Siberian-Mongolian flora: Some of the common taxa which occur in Himachal are *Arabidopsis mollissima*, *Draba setosa*, *Lepidium apetalum*, *Astragalus* spp., *Caragana*, *Chorispora* spp., *Artemisia* spp., *Eremurus himaliacus*, *Thermopsis inflata*, *Thylacospermum*, *Saussurea* spp., *Silene* spp., *Taraxacum* spp., *Scorzonera* spp., *Pleurospermum* spp., and grasses like *Poa*, *Bromus*, *Elymus*, *Stipa*, *Calamagrostis* spp.

4. Affinities with Chinese flora : Several species which occur in Himachal have their distribution extended upto China. Some of such species are *Acer oblongum*, *Allium prattii*, *Alnus nepalensis*, *Anemone rupicola*, *Arisaema tortuosum*, *Astilbe rivularis*, *Clematis connata*, *Coriaria nepalensis*, *Cornus oblonga*, *Cotoneaster microphyllus*, *Cyananthus lobatus*, *Elsholtzia fruticosa*, *Gaultheria trichophylla*, *Hedera nepalensis*, *Hydrangea anomala*, *Ilex dipyrena*, *Iris decora*, *Juniperus recurva*, *Myrsine semiserrata*, *Neolitsea umbrosa*, *Paris polyphylla*, *Piptanthus nepalensis*, *Pleurospermum benthamii*, *Pleurospermum hookeri*, *Podophyllum hexandrum*, *Prinsepia utilis*, *Prunus cerasoides*, *Pyrus pashia*, *Quercus semicarpifolia*, *Rhamnus virgatus*, *Rhus succedanea*, *Rosa brunonii*, *Rosa sericea*, *Rubus biflorus*, *Sabia campanulata*, *Saurauia napaulensis*, *Spiraea bella*, etc.

There are certain taxa in the Himachal flora which are distributed upto Japan also e.g. *Cornus macrophylla*, *Houttuynia cordata*, *Hovenia acerba*, *Hypoxis aurea*, *Malus baccata*, *Quercus glauca*, *Symplocos paniculata*, etc.

5. Affinities with Eastern Himalayan flora : Despite having major difference between the Western and Eastern Himalayan flora

several species are common in both the regions but these do not occur in Japan or China. Some of these species are *Arisaema intermedium*, *Astragalus chlorostachys*, *Clematis tortuosa*, *Delphinium brunonianum*, *Deutzia staminea*, *Gyposphila cerastioides*, *Lespedeza gerardiana*, *Lonicera obovata*, *Meliosma dilleniifolia*, *Parnassia nubicola*, *Philadelphus tomentosus*, *Picrorhiza kurroa*, *Pinus roxburghii*, *P. wallichiana*, *Potentilla atrosanguinea*, *Rhododendron anthopogon*, *R. campanulatum*, *Rhus wallichii*, *R. paniculatas*, *Rosa macrophylla*, *Sorbus foliolosa*, *S. macrophylla*, *Spiraea canescens*, *Thalictrum chelidonii*, *Thermopsis barbata*, *Tsuga dumosa*, etc.

6. Affinities with Tibetan flora : Himachal is bordered by Tibet in the east and two of its districts- Kinnaur and Lahul and Spiti which lie on this border have direct links with Tibetan flora. A large number of species are common between the 2 flora, some of the important taxa are *Anaphalis*, *Aconitum*, *Aquilegia*, *Anemone*, *Arenaria*, *Arabidopsis*, *Acantholemon*, *Astragalus*, *Artemisia*, *Bupleurum*, *Barbarea*, *Caragana*, *Corydalis*, *Christolea*, *Cicer*, *Delphinium*, *Draba*, *Epilobium*, *Geranium*, *Impatiens*, *Juniperus*, *Lamium*, *Lonicera*, *Melilotus*, *Oxytropis*, *Paraaquilegia*, *Pedicularis*, *Pleurospermum*, *Podophyllum*, *Potentilla*, *Polygonum*, *Primula*, *Rosa*, *Ribes*, *Rhododendron*, *Rhodiola*, *Silene*, *Thylacospermum*, *Thlaspi*, *Torularia*, *Triglochin*, *Viola*, etc.

While the common grasses are species of *Aphragmus*, *Festuca*, *Poa*, *Stipa*, *Bothriochloa*, *Festuca*, etc., and sedges like species of *Carex*, *Kobresia*, etc.

7. Affinity with the flora of Afghanistan : Many elements in Himachal flora are common with that of Afghanistan. Some of them are the species of *Anemone*, *Arabis*, *Aconitum*, *Aquilegia*, *Actaea*, *Arabidopsis*, *Artemisia*, *Astragalus*, *Caragana*, *Cicer*, *Draba*, *Delphinium*, *Ephedra*, *Geranium*, *Lespedeza*, *Lamium*, *Lonicera*, *Podophyllum*, *Potentilla*, *Prunus*, *Rheum*, *Ranunculus*, *Salix*, *Silene*, *Sibbaldia*, *Sisymbrium*, *Spiraea*, *Sorbus*, *Trigonella*, *Valerina*, *Viola*, *Stellaria*, *Juniperus*, etc.

The common grasses are the species of *Arthraxon*, *Elymus*, *Festuca*, *Melica*, *Pennisetum*, etc.

Apart from the above categories of plant species there are certain species available which have a very wide distribution range viz., *Capparis*

spinosa occurs from Afghanistan to Nepal, West Asia and Europe; *Viola biflora* is known from Europe, Siberia, Central Asia, North Korea, Japan, North America and in the Central and Eastern Himalayan region; *Poa alpina* distributed in India, Pakistan, Europe, Mediterranean region, middle East to Central Asia and North America.

GYMNOSPERMS

The Gymnosperms which occur throughout the Himalayan region although have maximum number of species in the Eastern Himalaya but are less dominant from their population point of view whereas, the Western Himalaya with lesser species of Gymnosperms has wide spread coniferous forest. *Pinus gerardiana*, *Juniperus macropoda*, *Picea smithiana* are some of the taxa restricted to Western Himalaya only. *Ephedra* an important medicinal gymnospermous herb is represented by 6 species in Western Himalaya but there is only one species in the Eastern Himalaya.

ENDEMIC PLANTS

A large number of species which are endemic to Western Himalaya also occur in Himachal Pradesh and several of them are known only from Himachal Pradesh. The family Poaceae, Fabaceae, Brassicaceae, Ranunculaceae, Caryophyllaceae, Scrophulariaceae, Apiaceae have shown the maximum degree of endemism. Some of the endemic taxa found in Himachal Pradesh are *Agropyron dentatum* (Poaceae), *A. repens* (Poaceae), *A. schugnanicum* (Poaceae), *Anaphalis himachalensis* (Asteraceae), *Anemone coronaria* var. *biflora* (Ranunculaceae), *Anemone narcissifolia* (Ranunculaceae), *A. tetrasepala* (Ranunculaceae), *Anoplocaryum brandissii* (Boraginaceae), *Aquilegia nivalis* (Ranunculaceae), *Arabidopsis russelliana* (Brassicaceae), *Arabis nova* (Brassicaceae), *A. tenuirostris* (Brassicaceae), *Aster molliusculus* var. *minor* (Asteraceae), *Astragalus grahamianus* (Fabaceae), *Carex borii* (Cyperaceae), *Ceratosepalus falcatus* (Ranunculaceae), *Christolea stewartii* (Brassicaceae), *Delphinium koelzii* (Ranunculaceae), *D. roylei* (Ranunculaceae), *Deyeuxia simlensis* (Poaceae), *Dianthus orientalis* (Caryophyllaceae), *D. seguieri* (Caryophyllaceae), *Dicranostigma lactucoides* (Papaveraceae), *Draba cachemirica* (Brassicaceae), *D. lasiophylla* (Brassicaceae), *Epilobium semiamplexicaule* (Onagraceae), *E. spitianum* (Onagraceae), *Eriocycla thomsonii* (Apiaceae), *Erophila verna* (Brassicaceae), *Euclidium syriacum* (Brassicaceae), *Euphrasia jaeschkei*

(Scrophulariaceae), *E. pauciflora* (Scrophulariaceae), *E. platyphylla* (Scrophulariaceae), *Ferula jaeschkeana* (Apiaceae), *Galium serpylloides* (Ranunculaceae), *Halerpestes salsuginosa* (Ranunculaceae), *Hedysarum astragaloides* (Fabaceae), *H. microcalyx* (Fabaceae), *Heracleum thomsonii* (Apiaceae), *Heteropappus holohermaphroditus* (Asteraceae), *Juncus rohtangensis* (Juncaceae), *Lagotis kunawurensis* (Scrophulariaceae), *Lancea tibetica* (Scrophulariaceae), *Meconopsis bikramii* (Papaveraceae), *Microgynoecium tibeticum* (Chenopodiaceae), *Microsisymbrium axillare* ssp. (Brassicaceae), *Oryzopsis stewartiana* (Poaceae), *Paraqailegia uniflora* (Ranunculaceae), *Pedicularis albida* (Scrophulariaceae), *P. purpurea* (Scrophulariaceae), *P. pycnantha* ssp. *cuspidata* (Scrophulariaceae), *Phyllostachys bambusoides* (Poaceae), *Poa falconeri* (Poaceae), *P. koelzii* (Poaceae), *P. lahulensis* (Poaceae), *P. nephelophila* (Poaceae), *P. sikkimensis* (Poaceae), *Potentilla curviseta* (Rosaceae), *Pseudomertensia lahulensis* (Boraginaceae), *Ranunculus arvensis* (Ranunculaceae), *R. bikramii* (Ranunculaceae), *R. lingua* (Ranunculaceae), *Saussurea atkinsonii* (Asteraceae), *Scrophularia kowlzii* (Scrophulariaceae), *S. suffruticosa* (Scrophulariaceae), *Sedum jaeschkei* (Crassulaceae), *Seseli trilobum* (Apiaceae), *Silene cancellata* (Caryophyllaceae), *S. edoardi* (Caryophyllaceae), *S. kunawurensis* (Caryophyllaceae), *S. stewartii* (Caryophyllaceae), *S. viridiflora* forma *webbiana* (Caryophyllaceae), *Sisymbrium loeselii* (Brassicaceae), *Tanacetum himachalensis* (Asteraceae), *Thalictrum reniforme* (Ranunculaceae), *T. rostellatum* (Ranunculaceae), *T. saniculaeforme* (Ranunculaceae), *Veronica biloba* var. *minima* (Asteraceae), *V. hirta* (Asteraceae), *Viola jangiensis* (Violaceae), *Waldheimia stoliczkei* (Asteraceae), *Puccinella himalaica* (Poaceae), *P. kashmiriana* (Poaceae), and *Trigonella upendrae* (Fabaceae).

RARE AND THREATENED PLANTS

A large number of species have been threatened and became rare or vulnerable to extinction due to various biotic and abiotic causes of which deforestation and overexploitation of plant species are the most important factors. Unfortunately this process of destruction is still continuing with more vigorous pace.

Following are some of the threatened and rare plant species which occur in Himachal Pradesh. Majority of them are commercially exploited or excessively used for fuel, fodder and other domestic purposes.

Aconitum heterophyllum, *Allium stracheyi*, *Anemone tetrasepala*, *Angelica glauca*, *Arnebia euchroma*, *Astragalus munori*, *Balanophora involucrata*, *Betula utilis*, *Bunium persicum*, *Cardus edelbergi*, *Ceropegia longifolia*, *Cortusa mattioli*, *Cypripedium* spp., *Dactylorhiza hatagirea*, *Dioscorea deltoidea*, *Ephedra gerardiana*, *Eremurus himalaicus*, *Eriocycla thomsonii*, *Falconeria himalaica*, *Ferula jaeschkeana*, *Holboelia latifolia*, *Hyoscymus niger*, *Juniperus communis*, *J. recurva*, *Jurinella macrocephala*, *Limosella aquatica*, *Litsea longifolia*, *Mahonia jaunsarensis*, *Malus baccata*, *Nardostachys jatamansi*, *Orobanche hansii*, *Physochlaina praealta*, *Picrorhiza kurroa*, *Podophyllum hexandrum*, *Primula schlagintweitiana*, *Rheum australe*, *R. spiciforme*, *R. webbianum*, *Saussurea gnaphaloides*, *S. bracteata*, *S. obvallata*, *Sedum jaeschkei*, *Senecio jacquemontianus*, *Seseli trilobum*, *Thylacospermum caespitosum*, *Valeriana jaeschkei*, *Viola biflora* and *Waldheimia stoliczkei*.

Cultivated Crops

Agricultural practices in Himachal vary from place to place depending upon the altitude, soil, rainfall and irrigation potential. Cultivation is common on hill-slopes, river valleys upto the height of 3500 m. The people in higher regions have great agricultural skills to grow crops with very scanty rainfall and snow cover lasting for a long time. The important crops are maize, paddy, wheat, barley, potato, buck-wheat, millets, pulses, amaranths, pea, lentils etc., besides a large number of seasonal vegetables are also grown, of which tomatoes specially from Solan district are worth mentioning. Himachal is also famous for a variety of fruits particularly apples and plums, in addition to pear, peach, apricot, cherry, walnut etc. In drier areas of Kinnaur grapes are also grown in plenty. Almonds are extensively grown for fresh and dried fruits whereas, 'Chilgoza' (seed of *Pinus gerardiana*) is found in Chamba and Kinnaur districts (H.P.) in India.

PLANT RESOURCES

The Himalayan region which harbours more than 8000 plant species serves as a store house of a variety of economically important plants used for food, fodder, fibre, fuel, timber, medicinal and horticultural purposes. The enormous diversity of these economic plants have sustained the local population throughout the Himalayan region since time immemorial. The cultivation of wild plants by the local population has

resulted in the domestication of several such plants like paddy, maize, pulses, various vegetables and other useful plants.

The local population consumes a large number of wild plants as edible fruits, vegetables, medicines etc., which are directly collected from the forest. Some of the important groups of wild useful plants are as follows—

1. Wild Edible Plants

A wide variety of non-traditional food plants are used by inhabitants. The cultivation of such plants is not practiced and they rely on the forest around them for their supply. Some of these wild edible plant are *Allium corolintanum* (Leaves, bulbs), *A. humile* (Leaves, bulbs), *A. rubellum* (Leaves, bulbs), *A. stracheyi*, (Leaves, bulbs), *A. victorialis* (Leaves, bulbs), *Alternanthera sessilis* (Leaves), *Amaranthus tricolor*, (Leaves, seeds), *Angelica glauca* (Roots spice), *Asparagus racemosus* (Tubers), *Barleria cristata* (Buds), *Bauhinia vahlii* (Seeds), *B. variegata* (Buds), *Begonia picta* (Leaves), *Berberis aristata* (Fruits), *B. asiatica* (Fruits), *B. lycium* (Fruits), *Bombax ceiba* (Buds), *Bunium persicum* (Seeds), *Cannabis sativa* (Seeds), *Capsella bursa-pastoris* (Young roots, leaves), *Cardamine hirsuta* (Leaves), *Carissa carandas* (Fruits), *Cassia obtusifolia* (Seeds), *Castanea sativa* (Fruits), *Chaerophyllum aromaticum* (Whole plant) *C. villosum* (Whole plant) *Chenopodium album* (Leaves), *C. botrys* (Leaves), *C. foliosum* (Leaves), *C. murale* (Leaves) *Chlorophytum arundinaceum* (Tubers) *Cicer microphyllum* (Young shoots and pods), *Codonopsis ovata* (Roots), *Cornus capitata* (Fruits), *Corylus jacquemontii* Seeds (nut), *Cotoneaster microphylla* (Fruits), *Cousinia thomsonii* (Young shoots), *Curculigo orchioides* (Tubers), *Dactylorhiza hatagirea* (Tubers), *Dendrocalamus strictus* (Young shoots), *Dioscorea bulbifera* (Tubers), *D. melanophyma* (Tubers), *D. pentaphylla* (Tubers), *Diplazium esculentum* (Young shoots), *D. polypodioides* (Young shoots), *Diploknema butyracea* (Fruits), *Dipsacus inermis* (Leaves), *Drimia indica* (Leaves), *Elaeagnus parviflora* (Fruits), *E. umbellata* (Fruits), *Elsholtzia densa* (Leaves), *Eremurus himalaicus* (Leaves), *Ficus auriculata* (Fruits), *F. hispida* (Fruits), *F. palmata* (Fruits), *Fragaria nubicola* (Fruits), *F. vesca* (Fruits), *Heracleum lanatum* (Seeds), *Grewia elastica* (Fruits), *G. hirsuta* (Fruits), *Hippophae rhamnoides* (Fruits), *H. salicifolia* (Fruits), *Impatiens balsamina* (Seeds), *Juglans regia* (Fruits), *Lactuca dolichophylla* (Leaves), *Mahonia borealis* (Fruits), *Malus baccata* (Fruits), *Mentha longifolia* (Leaves), *Morus australis* (Fruits), *Mukia maderaspatana* (Fruits), *Myrica*

esculenta (Fruits), *Nepeta longibracteata* (Leaves), *Nasturtium officinale* (Leaves), *Olea ferruginea* (Fruits), *Opuntia monocantha* (Fruits), *Oxalis acetosella* (Leaves), *O. corniculata* (Leaves), *Oxyria digyna* (Leaves), *Podophyllum hexandrum* (Fruits), *Phytolacca acinosa* (Leaves), *Pimpinella diversifolia* (Leaves), *Pinus gerardiana* (Seeds) *Polygonum fagopyrum* (Leaves) *P. alpinum* (Leaves), *Polygonatum verticillatum* (Leaves) *Prunus cornuta* (Fruits), *P. prostrata* (Fruits). *Punica granatum* (Fruits), *Pyrus pashia* (Fruits), *Ranunculus scleratus* (Leaves), *Rheum webbianum* (Leaves), *Rhodiola imbricata* (Leaves), *Rhus javanica* (Fruits), *R. semialata* (Fruits), *Rosa brunonii* (Fruits), *R. macrophylla* (Fruits), *Rubus biflorus* (Fruits), *R. ellipticus* (Fruits) *Rumex acetosa* (Leaves), *R. hastatus* (Leaves), *R. napalensis*, (Leaves), *Silene vulgaris* (Leaves), *Solanum erianthum* (Fruits), *S. melongena* var. *incanum* (Fruits), *S. surattense* (Fruits), *Sonchus brachyotus* (Leaves), *Sorbus lanata* (Fruits), *Taraxacum officinale* (Leaves), *Thymus linearis* (Leaves and flowers), *Tragopogon pratense* (Roots and tender shoots), *Urtica dioica* (Leaves) and *Ziziphus* spp. (Fruits).

2. Medicinal and Aromatic Plants

The forest of Himachal Pradesh are also a potential source of many important medicinal plants which are in use for centuries as folk medicines and even today these are very commonly used for treating various diseases of human beings as well as domestic cattles. The local population uses these medicinal plants in a crude form but the advancement of pharmaceutical researches have made possible to extract the active principal from such plants in pure form for the manufacture of modern medicines. As a result, in order to extract active principal in sufficient quantities, the pharmaceutical industry requires the crude drug plants in bulk. The ever increasing demand of the pharmaceutical industry for medicinal and aromatic plants has rendered many such species rare and threatened in their natural habitats. Some of the important medicinal and aromatic plant of this state are *Abies pindrow* (Leaves), *Achyranthes aspera* (Whole plant), *Aconitum chasmanthum* (Rhizome), *Aconitum deinorrhizum* (Rhizome), *Aconitum ferox* (Rhizome), *Aconitum heterophyllum* (Rhizome), *Aesculus indica* (Leaves and fruits), *Ajuga bracteosa* (Leaves), *Ainsliaea aptera* (Roots), *Arnebia benthamii* (Roots), *Artemisia brevifolia* (Leaves), *A. japonica* (Leaves), *A. nilagirica* (Leaves and stem), *Atropa acuminata* (Roots and leaves) *Berberis asiatica* (Roots), *B. aristata* (Roots), *B. lycium* (Roots), *Boehmeria rugulosa* (Leaves),

Cissampelos pariera (Roots), *Corydalis govaniiana* (Roots), *Dactylorhiza hatagirea* (Roots), *Doronicum roylei* (Roots), *Ephedra gerardiana* (Stem, whole plant), *Equisetum arvense* (Whole plant), *Eupatorium odoratum*, (Leaves), *Ferula jaeschkeana* (Roots), *Fritillaria cirrhosa* (Corms), *F. roylei* (Corms), *Gentiana kurrooa* (Roots), *G. stipitata* (Roots), *Geranium wallichianum* (Roots), *Hedychium spicatum* (Rhizomes), *Holarrhena antidysenterica* (Stem bark), *Hyoscyamus niger* (Seeds and leaves), *Jurinea dolomiaea* (Roots), *Mallotus philippensis* (Seed powder), *Nardostachys grandiflora* (Rhizomes), *Nordostachys jatamansi* (Rhizomes), *Picrorhiza kurrooa* (Roots), *Plectranthus rugosus* (Leaves), *Physochlaina praealta* (Leaves), *Podophyllum hexandrum* (Rhizomes and fruits), *Pyrus pashia* (Whole plant), *Roylea cinerea* (Leaves), *Rubia manjith* (Leaves), *Saussurea costus* (Roots), *Solanum indicum* (Leaves), *Skimmia laureola* (Leaves), *Viola pilosa* (Whole plant), *Zanthoxylum alatum* (Seeds, roots and bark), *Dioscorea deltoidea* (Tubers), *Arcticum lappa* (Whole plant) and *Colchicum luteum* (Corms and seeds).

3. Oil Yielding Plants

A number of species occurring in the area yield oil which is used for cooking, burning and medicinal purposes. Some commonly used species for oil extraction are *Actaea acuminata* (Seeds), *Cedrus deodara* (Hard wood.), *Prinsepia utilis* (Seeds oil edible), *Prunus armeniaca* (Seeds), *Prunus cornuta* (Seeds), *P. persica* (Seeds), *Sorbus aucuparia* (Seeds) and *Zanthoxylum alatum* (Fruits).

4. Gum and Resin yielding Plants

Certain plant species yield resin or gum in the form of exudates from their stem/ bark which is used in dye, paint and pharmaceutical industry. Some of the commonly exploited species are *Cupressus torulosa*, *Bauhinia* spp, *Ferula* spp., *Hedera nepalensis*, *Juniperus communis*, *Pinus roxburghii*, *Pistacia khinjuk*, *Prunus armeniaca*, *P. persica*, and *Rhus wallichii*, etc.

5. Dye yielding Plants

Several species are used to extract dye from their roots, flowers or other plant parts which is used for colouring food material, fabrics etc. Some commonly used species are *Arnebia euchroma*, *Onosma hispida*,

Impatiens glanduligera, *Berberis pachycantha*, *Geranium* spp, *Nyctanthus arbor-tristis*, *Butea monosperma*, *Mallotus philippensis* etc.

6. Timber yielding Plants

The timber yielding species in Himachal Pradesh (Western Himalaya) are few as compared to Eastern Himalaya and mostly belong to Gymnosperms. However, there are certain species which are widely used for various construction purposes like building, furniture, domestic implements, packing boxes for horticulture industry (fruits etc.). The commonly used species are *Betula utilis*, *Cedrus deodara*, *Pinus* spp., *Picea smithiana*, *Dalbergia sisso*, *Juglans regia*, *Salix* spp, *Populus* spp, *Juniperus recurva*, *Albizia* spp., *Anogeissus latifolia*, *Boehmeria* spp, *Terminalia* spp, *Toona ciliata*, *Pyrus pashia*, *Quercus* spp, *Shorea robusta*, *Rhododendron arboreum*, *Fraxinus xanthoxyloides*, *Cotoneaster gilgitensis*, *Hippophae rhamnoides* ssp. *turkestanica*, *Lanea coromandelica*, *Grewia* spp. These species alongwith many other woody species are also used as fuel wood.

7. Fodder Plants

The local population rear a large number of domestic cattles like goats, sheeps, cows, muel etc., for their day to day requirement of milk, meat, transport etc. For feeding these cattles the inhabitants of this area use several species for fodder and forage. Some of the important species used are *Albizia lebbeck*, *Astragalus* spp., *Medicago* spp., *Trigonella* spp, *Cicer microphyllum*, *Polygonum alpinum*, *Flacourtia indica*, *Grewia* spp., *Indigofera cassioides*, *Quercus* spp., *Mallotus philippensis*, *Pyrus pashia*, *Desmodium oojeinensis*, *Morus* spp., *Ficus* spp., *Terminalia* spp., *Urtica dioica*, *Woodfordia fruticosa*, *Rhus* spp., *Populus ciliata*, *Salix denticulata* etc., in addition to several species of grasses like *Apluda*, *Bothriochloa*, *Avena*, *Poa*, *Calamagrostis*, *Pennisetum*, *Phleum*, *Festuca*, *Setaria*, *Phragmites*, *Echinochloa*, *Stipa*, etc.

8. Incense and Perfume yielding Plants

There are several species which are used in incense and perfumes. Many species are collected, dried and burnt as incense in Buddhist monastries, temples and on various religious occassions and ceremonies. Some important ones are *Artemisia* spp., *Chrysanthemum pyrethroides*, *Tanacetum himachalensis*, *Waldhemia* spp., *Rhododendron anthopogon*,

Waldheimia spp, *Saussurea costus*, *Juniperus communis*, *Lonicera obovata*, and *Jurinella macrocephala*, etc.

9. Plants of Religious belief

India has a long tradition of worshipping trees and there are several trees which are worshipped throughout the country like, Peepal, Tulsi, Brahma kamal etc. while many are used in various religious rituals. In Himachal Pradesh, several plant species are worshipped on various religious occasions or considered the abode of their deities or are attached with superstition by the inhabitants, some such plants are *Ficus religiosa*, *Urtica dioica*, *Cedrus deodara*, *Butea monosperma*, *Cynodon dactylon*, *Asparagus racemosus*, *Rosa macrophylla*, *R. webbiana*, *Berberis* spp, *Pyrus pashia*, *Prinsepia utilis*, *Cannabis sativa*, *Verbascum thapsus*, *Lonicera discolor*, *Artemisia maritima*, *Datisca cannabina*, *Pinus roxburghii*, and *Pleurospermum stylosum*, etc.

10. Wild Ornamental Plants

A large number of plant species including herbs, shrubs and trees have enormous ornamental potential which can be directly used as garden plants while some of them can be used for improving the already grown ornamental species genetically for colour, size, longevity and disease resistance. Some of the important ornamentals occurring in the wild are the species of *Anemone*, *Aster*, *Arisema*, *Berberis*, *Mahonia*, *Begonia*, *Capparis*, *Cardiocrinum*, *Erigeron*, *Cremanthodium*, *Hedera*, *Chrysanthemum*, *Hedychium*, *Hypericum*, *Inula*, *Impatiens*, *Iris*, *Dainthus*, *Meconopsis*, *Primula*, *Rhododendron*, *Sophora*, *Trillidium govanianum*, *Potentilla*, *Rosa* etc. In addition to these, species of ferns can be used as foliage plants, certain orchids which occur in this area like *Cymbidium*, *Coelogyne*, *Dendrobium*, *Calanthe*, *Cypripedium*, *Rhynchostylis*, *Aerides* etc. can also be grown for their colourful, attractive flowers.

11. Plants of Botanical curiosities

The flora of Himachal Pradesh harbours a number of species which are botanically curious. These include many saprophytic, parasitic and insectivorous plants. In addition to such plants in the cold desert regions of Kinnaur, Lahul and Spiti where the vegetation is subjected to several drastic climatic conditions (snow, temperature, moisture, solar radiation

etc.), the plant species existing here exhibit a variety of physiological and morphological adaptations to combat the harsh and hostile climate. Some of the curious morphological adaptations are cushion forming/mat forming and woolly habit which imparts the plant body a curious looking shape. Some such characteristic habits of cold desert plants found in Himachal Pradesh.

MAJOR THREATS

The causes of threat to the nature and its resources are almost similar all over the world in the form of 1- natural and 2- man-made causes.

Floods, soil erosion, land slides, earthquakes, natural competition between the species, biology of species mainly the pollination in the absence of a suitable pollinator, natural regeneration, diseases and extension of the alien weedy elements etc., are some of the major natural causes responsible for the destruction of the natural vegetation.

The major man-made causes are

Population explosion : It is one of the most significant factors for the depletion of natural resource diversity.

Timber for building purposes, furniture, etc.: The indiscriminate extraction of timber has severely damaged the floristic diversity.

Fuel wood : It is the major source of energy in the house holds of the rural areas. According to an estimate about 80% of India's wood production is used as fuelwood which is extracted from the forest.

Grazing and Fodder : Excessive grazing of forest under growth, grass lands and alpine meadows and fodder collection.

Forest Fires : Excessive and extensive damage is caused due to the annual forest fire which some times continues for several weeks devouring large forest areas.

Exploitation of Economically Important Plant Species : Selective removal of certain groups of plants viz., medicinal, edible and various other commercially valuable plant species in large quantities from the forest.

Developmental Activities : Various such activities like the development of large urban areas for human settlement on the forest land, construction of hydroelectric projects, buildings, construction of roads on hills and forested areas, mining and development of industries near forested areas.

Agriculture : It is another major threat to the vegetational cover. In order to feed the growing population more and more forested areas are being cleared for cultivation of crops, etc.

The above stated causes have alarmingly reduced the forest cover resulting in severe loss of natural living and non-living resources. Therefore it is necessary to conserve the available natural resources through various effective conservational programmes.

CONSERVATION MEASURES

The conservation programmes can be developed based on *in-situ* or *ex-situ* conservation methods, environmental education and awareness. Greater emphasis has been laid on the *in-situ* conservation of the flora and fauna (Biodiversity) as it provides ample opportunity to the individual species to interact, compete, evolve and survive with other species in nature. Keeping in view the rich biodiversity following 30 protected areas (National Parks and Sanctuaries) covering an area of about 4533 sq. km have been established in different parts of Himachal Pradesh which is 8.1% of the total geographical area of the state (56000 sq.km). Efforts should be made to establish more and more protected areas in the rich biodiversity regions of the state. In addition to these government declared protected areas, peoples of villages, cities should be motivated and encouraged to establish their own small forest like the 'Sacred forest' of Meghalaya. Such small forested areas can be developed without much spending and man-power and will be easy to maintain. School children will be the most suitable task force for such programmes. These small or mini-forest when developed in the vicinity of human settlement will greatly improve the quality of environment so badly polluted by the industries, automobiles and the same time will enrich the biodiversity and act as a repository of plants and animal species for posterity.

Proper forest management is urgently required to effectively combat the menace of forest fires.

Cultivation of fuel wood and fodder for domestic use through social forestry.

Cultivation and sustained exploitation of medicinal and aromatic plants should be encouraged at village level.

Grazing of pastures and alpine meadows by sheeps and goats should be banned or restricted as these areas harbours a significant number of herbs of great medicinal value or other botanical importance.

Massive afforestation programme should be undertaken involving local inhabitants, students and NGO's so that the barren hill slopes, fallow lands are once again become forested.

Rare, endemic and endangered plant species should be introduced in the botanical gardens and multiplied for reintroduction in their natural habitat.

Research on the ecology and reproduction biology of the rare, endangered and endemic species should be intensified.

Public awareness programmes for the better understanding of the environment protection. Environmental education at primary level in the schools should be made compulsory.

REFERENCES

- Aitchison, J.E.T. 1868. Lahul, its flora and vegetable products etc. *J. Linn. Soc. Bot.* **10**: 69-101.
- Aswal, B.S. and B.N. Mehrotra. 1983. New records of plants from Himachal Pradesh, India - III. *J. Econ. Tax. Bot.* **4**(3): 991-994.
- Aswal, B.S. and B.N. Mehrotra. 1985. Flora of Himachal Pradesh- Some additional notes. *Indian J. For.* **8**(4): 310-317.
- Burkill, I.H.. 1908. Spring flora in the Simla Hills. *Asiat. Soc. Bengal.* **4**: 197-231.
- Champion, H.G. and Seth, S.K. 1968. *A revised survey of the forest types of India. Delhi.*
- Chatterjee, D. 1940. Studies on the endemic flora of India and Burma. *J. Roy. Asiat. Soc. Bengal (N.S.)* **5**: 19-67.
- Chatterjee, D. 1962. Floristic patterns of Indian vegetation. Proc. Summer School in Botany, Darjeeling, (eds.) Maheswari *et al.* pp. 32-42.
- Chowdhery, H.J. and B.M. Wadhwa. 1984. Flora of Himachal Pradesh - Analysis. vols. 1-3. Howrah.
- Clarke, C.B. 1898. Sub-areas of British India illustrated by the detailed distribution of the Cyperaceae in that empire. *J. Linn. Soc. (Bot.) London* **34**: 1-146.
- Collett, H. 1902. *Flora simlensis*. Calcutta.
- Good, R. 1964. *The Geography of the flowering Plants*. New York (3rd ed.).
- Hajra, P. K. and R.R. Rao. 1990. Distribution of vegetation types in northwestern Himalaya with brief remarks on phytogeography and floral resource conservation. *Proc. Indian Acad. Sci.* **100** (4) : 263-277.

- Hara, H. 1966. *Flora of Eastern Himalaya*. Osaka, Japan.
- Hooker, J.D. 1854. *Himalayan Journals*. 2 vols. London.
- Hooker, J.D. 1906. *A sketch of the flora of British India*. Oxford.
- Jain, S.K. and R.C. Bharadwaja. 1951. On a Botanical trip to the Parbatti Valley. *Indian For.* 75: 302-315.
- Joshi, A.C. 1952. Aquatic vegetation of Lahul. *The Palaeobotanist* 1:277-280.
- Kachroo, P. 1993. Plant diversity in northwest Himalaya- A preliminary survey. In *Himalayan Biodiversity - Conservation strategies*, U. Dhar, (ed.) Almora. pp. 111-132.
- Kapahi, B.K. and Y.K. Sarin. 1979. Contribution to the botany of Lahul. *J. Bombay nat. Hist. Soc.* 74 (Suppl.) : 627-639.
- Mani, M.S. 1974. *Ecology and Biogeography in India*. W. Junk b.v. Publishers. The Hague.
- Nair, N.C. 1964. On a botanical tour to Lahul and Spiti - *Bull. Bot. Surv. India* 6: 219-235.
- Nair, N.C. 1977. *Flora of Bashahr Himalayas*. Hissar and Madras.
- Parker, R.N. 1918. *A forest flora for the Punjab with Hazara and Delhi*. Lahore.
- Paulsen, O. 1920. *The studies in the vegetation of Pamir*. Copenhagen.
- Popov, M.B. 1926* *Ecologicheskie typi pustyn Srednei Asii. Izv. Glav. Bot. Sada.* 25.
- Puri, G.S. 1952. The distribution of conifers in Kullu Himalayas with special reference to Geology. *Indian For.* 76: 144-153.
- Puri, G.S. 1960. *Indian forest ecology*. vol. 1-2. New Delhi.
- Razi, B.A. 1955. Some observations on plants of the South Indian hill tops and their distribution. *Proc. Nat. Inst. Sci. India* 21, B: 79-89.

- Rao, A.S. 1978. Inventory of the Western Himalayan Flora. In "Proceedings National Seminar on Resources Development and Environment in the Himalayan Region." Department of Science and Technology, New Delhi.
- Rau, M.A. 1960. On a collection of plants from Lahul. *Bull. Bot. Surv. India* 2: 45-56.
- Rau, M.A. 1972. Recent finds of some rare Angiosperms in Western Himalaya and their phytogeographic significance. Proc. In Adv. Morph. V. Puri Comm. Vol.: 133-136. Meerut.
- Rau., M.A. 1974. Vegetation and phytogeography of West Himalaya. In: M.S. Mani (ed.), "Ecology and Bio-geography in India" The Hague, pp. 247-280. W. Junk b.v. Publisher
- Rodgers, W.A. 1985. Biogeography and protected area planning in India. In: J. Thorsell (ed.) "Conserving Asia's Natural Heritage" IUCN, Glad.
- Rodgers, W.A. and H.S. Panwar. 1988. Planning a Wildlife Protected Areas Network in India. Vol. I-II. Wildlife Institute of India, Dehradun.
- Stanylikovitch, K.V. 1948. Botaniko- geographic - heskoe - raionirovanie vostochnovo Pamira, Soobshena Tadj. F.A. Nauk SSR D 55.
- Takhtajan, A. 1969. *Flowering Plants, origin and dispersal*. (Tr. Jeffery) Edinburgh.
- Trivedi, B.S., B.S. Aswal and B.N. Mehrotra. 1981. New records of plants from Himachal Pradesh, India - II. *Indian J. For.* 4(4) : 324-325.
- Uniyal, M.R., A.V. Bhat and P.N. Chaturvedi, 1973. Preliminary observations on Medicinal plants of Lahul Spiti forest division in Himachal Pradesh. *Bull. Med. Eth. Bot. Res.* 3(1): 1-26.
- Wadia, D.N. 1957. *Geology of India*. London.
- Watt, G. 1881. Notes on the vegetation of Chamba state and British Lahul. *J. Linn. Soc. Bot.* 18 : 368-382.



Cedrus deodara



Pine forest



Rosa moschata



Meconopsis aculeata : Himalayan blue poppy



Potentilla atrosanguinea



Juglans regia



Heracleum lanatum



Corydalis govianiana



Pedicularis oederi



Anemone obtusiloba



Anemone tetrasepala



Arisaema jacquemontii



Lancea tibetica



Osmunda claytoniana



Physochlaina praealta



Digitalis purpurea : ornamental and medicinal



Rhodiola wallichiana



Rhodiola himalense



Saussurea gnaphalodes



Saussurea bracteata



Waldheimia glabra



Lactuca orientalis



Delphinium brunonianum



Gentiana algida



Saxifraga stenophylla



Acantholimon lycopodioides



Abies pindrow : in the degraded areas (foreground)
being occupied by weedy elements



Adventives colonizing the deforested areas of Coniferous forest
(*Abies*, *Cedrus*, *Juniperus*, etc.)



Degraded Coniferous forest



Rich harvest of timber : destruction of forest



Degradation of vegetation and land as a result of developmental activities (construction of dam and canal for Pandoh hydroelectric project, Sundarnagar, Kullu)



Urtica hyperborea : a cold desert element from Ladakh
(Courtesy : Dev Raj Agarwal)

JAMMU AND KASHMIR

D.K. Singh
B.P. Uniyal
R. Mathur

Perched like a majestic crown in the extreme North of the Indian Union, the state of Jammu and Kashmir, lies between the coordinates 32°17' to 37°20' North Latitude and 73°25' to 80°30' East longitude. The entire territory extends to over 640 km from North to South and 480 km from East to West, covering a total area of about 2,22,797 sq km in the North Western Himalaya. The state comprising 14 districts largely covers rugged mountainous terrain, except for the small tracks adjoining the Punjab plains and the valley of Kashmir, with a number of peaks rising above 5500 m, including Mt. K2, the second highest peak in the world, situated in the Karakoram range. Some other prominent peaks in the state are Nanga Parbat (8136 m), Disteghilsar (7885 m), Rakaposhi (7788 m), Kanjut Sai (7760 m), Haramosh (7379 m), Nunkun (7055m), etc. Wedged between Afghanistan and Pakistan on the West and the Northwest, Turkmenistan (a constituent of Commonwealth of Independent States the C.I.S) and China on the North and Tibet in the East, as it is, the state is strategically located from the phytogeographical point of view representing the Floristic Gateway to the West Asian, Mediterranean and Eurasian elements in the Flora of India.

The entire state is broadly divided into three main structural groups resulting from the stratified rock formations. These are the Panjal, the Zaskar and the Tertiary groups. The Panjal comprises the outer hills, outer plains and the middle mountains of the Lesser Himalaya, the Zaskar, the entire tract from Lahul and Spiti in the East to Karakoram in the North, and the Tertiary group is represented by the valley of Kashmir and other river valleys. The three geological constituents have resulted into considerable physiographic as well as climatic variations with direct bearing on the seasons, soil and vegetation in the state. In fact the state forms a transitional region of diverse physical and phyto-climatic features.

Biogeographically the state falls under Boreal zone with two subzones, viz. Sino-Siberian or the Trans-Himalayan, and Sino-Himalayan or the North Western Himalaya, and four Biomes, viz. Tundra zone, Alpine zone, Temperate zone and Subtropical zone (Rodgers 1985;

Khoshoo, 1993). The relief features of the state are comparable with a three storeyed structure, each representing a distinct geomorphological and climatological regime.

The province of Jammu with the Siwaliks, the undulating ravinous plains and the outer hills on the South of Pir Panjal represents the first storey. The Siwalik hills in the region are largely anticlinal and on an average rise to an elevation of 600-1200 m overlooking a series of 'Duns'. The area receives an average annual precipitation of about 170 cm through South-West monsoon. The tectonic valley of Kashmir, originally a synclinal valley, with its lacustrine deposits called "Karewas" covering more than half the area and some "Duns" between the Pir Panjal range on the South and South-east, and the Great Himalayan range in the North and the North-east represents the second storey. The valley of Kashmir, with an average height of about 1600 m, experiences a submediterranean climate with average annual precipitation of about 105 cm, which is mostly in the form of snow during winter months. And the Trans-Himalayan region comprising the territories of Gilgit, Baltistan and Ladakh, North of the Great Himalayan ranges, forms the third storey with some of the loftiest inhabited tracts of the world. Ladakh, including the territories of Rupshu, Nubra and Zaskar is the largest tract of the state, covering almost half its area. The region presents a Holarctic climate with extreme cold arid condition and receives average annual precipitation of less than 10 cm at Leh.

The Pir Panjal and the great Himalayan ranges almost divide the state into three distinct physiographic divisions, which are isolated from one and other by lofty mountain barriers. The passage from one region to another is usually facilitated through high altitude passes. Some of the important passes in these ranges are as follows. THE PIR PANJAL RANGE : Pir Panjal (3494 m), Bundil (4200 m), Pirgali (3800 m), Banihal (2832 m); THE GREAT HIMALAYAN RANGE : Zojila (3529 m), Chilung La (4401 m), Umsai La (3294 m), Sarsank (5716 m), Poat La (5716 m), Singo La (5097 m), Barlacha La (4891 m), Kunzam La (4551 m) Chang La (5200 m), Khardung La (5500 m), etc.

The Hindukush and the Karakoram ranges in the Northwest and the North, with perpetual snow cover and a large number of world renowned glaciers, like Siachen, Baltoro, etc. form the watershed of the Central Asian drainage. An important feature of the river system in the state is its antiquity as compared to the mountains they traverse through. The major

rivers in the three divisions of the state are Ravi, Ujh, Tawi and Chenab in Jammu; Jhelum, Liddar, Vishav, Rambhara, Sukhnag, Dudganga, Indus, etc. in Kashmir; and the Indus, Shyok, Zaskar, etc. in Ladakh. Besides, there are about 18 natural lakes in the state covering a total area of over 700 sq km, the prominent among them being the Mansar, Surinsar, Sanasar (Jammu); Dal, Anchar, Hokarsar, Manasbal, Wular, Kaunsarnag, Gangabal, Tarsar Marsar, Sheshnag, Anantnag, etc. (Kashmir); and Pangong, Tso Morari, etc. (Ladakh).

The botanical explorations and the floristic studies in Jammu and Kashmir date back to the early nineteenth century with William Moorcroft making the first botanical foray in the state in 1822. Gerard brothers (1821), Victor Jacquemont (1831), Godfrey Vigne (1836), Von Huegel (1835), H. Falconer (1839), J.E. Winterbottom (1846), T. Thomson (1878), C.B. Clarke (1876), J.F. Duthie (1892-93), H.W. Botting (1892), J.L. Stewart (1868), Atkinson (1878-79), Henderson, and Hume (1873), Meebold (1905) and R.R. Stewart (1925-1947) had been other notable collectors in the preindependence period. In the recent past scientists from the Regional Research Laboratory, Jammu and the Universities at Srinagar and Jammu have also made significant contribution towards the plant explorations in the state. With the reorganisation of the Botanical Survey of India and the establishment of its Northern Regional Circle at Dehra Dun in 1956, the exploration activities in Jammu and Kashmir have gained appreciable momentum. Among the major collectors from this premier organisation, mention may be made of M.A. Rau, T.A. Rao, N.C. Nair, U.C. Bhattacharyya, M.V. Viswanathan, J.N. Vohra, B.D. Naithani, P.C. Pant, B.P. Uniyal, B.M. Wadhwa, P.K. Hajra, S.K. Murti, R.R. Rao, etc. In spite of such efforts made in the past considerable area of the state, particularly Nubra valley, Rupshu, etc., still remain to be thoroughly explored.

The first floristic account of the state of Jammu and Kashmir comes through John Forbes Royle's (1833-39) publication "Illustrations of Botany of Himalayan Mountains and of Flora of Cashmere". Subsequently, Duthie (1893-94), Meebold (1909), Coventry (1923-30), Blatter (1927-29), Lambert (1933), Bamber (1916), Mukherjee (1940), Pennell (1943), Rao (1960), Singh (1970), Stewart (1972), Rau (1975), Kachroo (1993) and many others made notable contribution to our knowledge about floristic diversity of Kashmir. Besides, a number of regional floras covering different physiographic, administrative or ecological units of the state (Singh and Kachroo, 1976; Kachroo, Saproo and Dhar 1977; Sharma and Kachroo,

1981; Dhar and Kachroo, 1983; Kaul, 1986; Sharma and Jamwal, 1988; Kapur and Sarin, 1990; Sharma and Kachroo 1992; Singh, J.B. and Kachroo, 1994); and the revisions and monographs by Raven (1962), van Soest (1961, 1963), Grierson (1964), Kazmi (1970-71), etc. have significantly contributed to our knowledge of the floristics of Jammu and Kashmir. Interestingly Flora of Pakistan, currently being edited by Nasir and Ali, also provides significant insight into the flora of the state. Nevertheless, the "*Flora of British India*" by Sir J.D. Hooker (1872-97) is the only comprehensive treatise, dealing with the floristic diversity of the entire state of Jammu and Kashmir, available till date. As such our knowledge about the flora of Jammu and Kashmir state is not only incomplete but remains largely abridged as well. In the present state of our knowledge approximately 4,300 species of Angiosperms (excluding infra-specific taxa), 19 Gymnosperms and 168 Pteridophytes are known to occur in Jammu and Kashmir. This accounts for *ca* 25 per cent of Angiosperms, 30 per cent of Gymnosperms and 16 percent of the Pteridophytic flora of the country in less than 7 per cent of its total landmass. Floristically, therefore, Jammu and Kashmir represents a megadiversity state comparable only with the Eastern Himalayan states of Arunachal Pradesh and Sikkim (Singh and Hajra 1996; Chauhan, *in lit.*).

VEGETATION

The wide range of physiography and phytoclimatic conditions met within the state of Jammu and Kashmir have adequately expressed itself by supporting a vast and luxuriant vegetation ranging from Tropical dry deciduous in the South-west to Alpine scrubs of Cold desert in the North-east, with rich gene-pool of both wild and agri-horticultural plant species. About 20,443 sq km, or 9.2 per cent of its total geographical area is under forest cover, of which 10,953 sq km of forest have crown density above 40 percent and the remaining with crown density ranging from 10-40 per cent. Besides, about 3,108 sq km area is under scrub forest. Phytogeographically, the state is divisible into three distinct provinces, viz. the Jammu with more of tropical, subtropical and temperate elements; the Kashmir with its characteristic temperate and alpine flora; and the cold arid region of Ladakh showing predominance of alpine mesophytes, cold-desertic and oasis elements, characteristic of Tibetan plateau and Siberia.

The vegetation of Jammu and Kashmir is fairly well known through the contributions of Duthie (1893, 1894), Troll (1967), Rao (1960), Cham-

pion and Seth (1968), Rau (1974), Singh, J.B. and Kachroo (1983, 1983a), etc. Accordingly, the vegetation of the state is broadly grouped under tropical, temperate and alpine, each with numerous subtypes, based largely on the altitude, rainfall, humidity and species composition.

At the lower heights (up to 1000 m), especially around Jammu, the tree species are represented by *Acacia modesta*, *Bauhinia variegata*, *Phyllanthus emblica*, *Trema politoria*, *Bombax ceiba*, *Desmodium oojienensis*, *Dalbergia sissoo*, *Cassia fistula*, *Albizia lebbeck*, *Mitragyna parvifolia*, *Moringa oleifera*, *Milusa velutina*, *Butea monosperma*, *Aegle marmelos*, *Ehretia aspera*, *Terminalia bellirica*, *Ficus* spp., *Lannea coromandelica*, etc. *Naringi crenulata*, *Engelhardtia colebrookeana*, and *Oroxylum indicum* are also seen occasionally. *Pinus roxburghii* is the only gymnosperm in these heights. This species is seen mixed up with *Mallotus philippensis*, *Glochidion velutinum* and *Wendlandia heynei* a little before Sunderbani. Pure strands of *Butea monosperma* can be seen at few places in district Kathua. This species is common around Palian also.

The shrubby vegetation includes *Mimosa rubicaulis*, *Adhatoda zeylanica*, *Murraya koenigii*, *Aechmanthera tomentosa*, *Indigofera cassioides*, *Colebrookea oppositifolia*, *Capparis sepiaria*, *Maytenus royleanus*, *Myrsine* sp., *Ziziphus mauritiana*, *Callicarpa macrophylla*, etc. Association of *Carissa opaca*, *Dodonaea viscosa*, *Adhatoda zeylanica* and *Woodfordia fruticosa* is a common feature in this region. *Berberis lycium*, *Rubus ellipticus*, *Pogostemon benghalense* and *Zanthoxylum armatum* are also met with at certain places.

Among the herbaceous elements *Argemone mexicana*, *Cirsium arvense*, *Silybum marianum*, *Coronopus didymus*, *Oxalis corniculata*, *Tephrosia hamiltonii*, *Anisomeles indica*, *Tribulus terrestris*, *Indigofera linifolia*, *Gomphrena celosiioides*, *Tridax procumbens*, *Zornia gibbosa*, *Heliotropium strigosum*, *Alternanthera pungens*, *Achyranthes aspera*, *Pupalia lappacea*, *Malvastrum coromandelianum*, *Leucas* spp., *Sida* spp., *Solanum* spp., etc. are commonly met with. *Gloriosa superba*, *Withania somnifera*, *Eclipta alba*, *Soliva anthemifolia*, etc. are frequently seen. *Zeuxine strateumatica*, ground orchid grows amidst grasses by the river-side.

On the dry river bed species of *Saccharum* grow in abundance. Other common species of grasses are *Dichanthium annulatum*,

Chrysopogon serrulatus, *Hackelochloa granularis*, *Heteropogon contortus*, *Apluda mutica*, *Pogonatherum paniceum*, *Themeda anathera*, *Phragmites karka*, *Brachiaria ramosa*, *Arthraxon lancifolius*, *Hemarthria compressa*, *Setaria glauca*, *Oplismenus compositus*, *Panicum antidotale*, *Desmostachya bipinnata*, *Imperata cylindrica*, *Aristida adscencionis*, etc.

The climbers, twiners and creepers in this zone are represented by *Abrus precatorius*, *Bauhinia vahlii*, *Clematis gouriana*, *Cardiospermum halicacabum*, *Cryptolepis buchanani*, *Cayratia trifolia*, *Helinus lanceolatus*, *Rhynchosia minima*, *R. capitata*, *Vallaris solanacea*, *Atylosia crassa*, *Diplocyclos palmatus*, *Trichosanthes* spp., *Ipomoea* spp., *Porana paniculata*, *Cissampelos pareira*, *Tinospora cordifolia*, etc.

In the low lying areas, irrigated fields, ponds, puddles and marshy habitats *Hydrilla verticillata*, *Ceratophyllum demersum*, *Nymphoides cristatum*, *Juncus bufonius*, *Ranunculus sceleratus*, *Rotala mexicana*, *Ammannia multiflora*, *Bacopa monnieri*, *Limnophila indica*, *Ludwigia adscendens*, *Typha angustata*, *Veronica anagallis-aquatica*, *Cyperus* spp., *Fimbristylis* spp., *Pycreus* spp., *Scirpus* spp., etc. are of common occurrence.

Calotis hispidula, *Eremostachys superba*, *Soliva anthemifolia*, *Taverniera nummularia*, *Vicia bithynica*, etc. are some of the interesting plant species growing within this height.

Higher up the vegetation shows a change as in other parts of the Himalaya. Temperate species like *Rhododendron arboreum*, *Lyonia ovalifolia*, *Quercus leucotrichophora*, *Ilex dipyrena*, *Litsea umbrosa* var. *consimilis*, etc. are first to make appearance. This association is more common in the erstwhile Jammu province particularly the Trikuta hills and higher reaches of Kathua District. At other places *Alnus nitida*, *Diospyros lotus*, *Aesculus indica*, *Platanus orientalis*, *Acer caesium*, *A. pictum*, *Robinia pseudoacacia*, *Juglans regia*, *Picrasma quassioides*, *Corylus colurna*, *Populus ciliata*, etc. are frequently met with. The coniferous species appearing at this altitude are *Pinus wallichiana* and *Cedrus deodara*.

The shrubby vegetation in this zone mainly consists of *Viburnum cotinifolium*, *Sarcococca pruniformis*, *Syringa emodi*, *Daphne oleoides*, *Skimmia laureola*, *Pyracantha crenulata*, *Buddleja paniculata*, *Ribes orientale*, *Philadelphus tomentosus*, *Spiraea* spp., *Cotoneaster* spp., etc.

The ground floor in this region is adorned by species of *Anemone*, *Aconitum*, *Polygonum*, *Impatiens*, *Delphinium*, *Geranium*, *Potentilla*, *Primula*, *Valeriana*, *Pedicularis*, *Galium*, *Silene*, *Iris*, *Lloydia serotina*, *Notholirion thomsonianum*, *Colchicum luteum*, *Erodium cicutarium*, *Dipsacus inermis*, *Morina longifolia*, *Rostraria cristata*, etc.

Among the more common climbers and twiners mention may be made of *Galium verum*, *Codonopsis rotundifolia*, *Hedera nepalensis*, *Polygonum dumetorum*, *Cassytha filiformis*, *Rosa* spp., *Clematis* spp., *Cuscuta* spp., *Dioscorea* spp., etc.

The aquatic and marshy vegetation includes *Nymphaea alba*, *Nelumbo nucifera*, *Euryale ferox*, *Ranunculus trichophyllus*, *Caltha palustris*, *Myriophyllum spicatum*, *M. verticillatum*, *Menyanthes trifoliata*, *Spirodela polyrhiza*, *Butomus umbellatus*, *Potamogeton* spp., etc.

Within this altitudinal range are found the grassy meadows called "Margs" that resemble the "Bugyals" of Garhwal and Kumaon Himalaya. Among these Gulmarg, Sonamarg, Tangmarg, Khillanmarg, etc. are more famous.

The tree species in these margs include *Acer caesium*, *Prunus cornuta*, *Pinus wallichiana*, *Cedrus deodara*, etc. in the lower heights, *Abies pindrow* and *Picea smithiana* in the upper reaches that ultimately culminating in to *Betula utilis* forming the tree limit. *Taxus wallichiana* is also seen growing here. *Indigofera heterantha*, *Plectranthus rugosus*, *Berberis lycium*, *Parrotiopsis jacquemontiana*, *Syringa emodi*, etc. are some of the shrubby species here. *Anemone obtusiloba*, *Gentiana carinata*, *Adonis chrysocyathus*, *Ranunculus laetus*, *Caltha palustris*, *Corydalis falconeri*, *Cardamine macrophylla*, *Draba glacialis*, *Dianthus crinitus*, *Geranium wallichianaum*, *Dictamnus albus*, *Lavatera kashmiriana*, *Phlomis bracteosa*, *Salvia hians*, *Polygonum viviparum*, etc. constitute the ground floor vegetation in these "Margs".

Berberis huegeliana, *B. royleana*, *Cotoneaster lambertii*, *Delphinium uncinatum*, *Onopordum acanthium*, *Tricholepis kavensium*, *Senecio vulgaris*, *Cousinia minuta*, *Xanthium spinosum*, *Lavatera kashmiriana*, *Polygonum pacificum*, *Potamogeton filifolius*, *Listera ovata*, *Galium parsiense* subsp. *anglicum*, etc. are some of the interesting or rare species found within this altitude. Like Garhwal and Kumaon Himalaya, *Betula utilis* forms the tree limit in Kashmir Himalaya also. Singh and Kachroo

(1976) have reported a solitary tree of *Sorbus* growing above the *Betula* line. Interestingly similar observations have also been made in Uttar Pradesh in the Nanda Devi Biosphere Reserve (Balodi, *pers. com.*) but the species in the latter case happens to be *Pinus wallichiana*.

The Trans-Himalayan region, better known as the "Cold Desert" has a peculiar flora owing to extremes of temperature and almost rainless conditions. The plants develop special adaptive characters to thrive in such harsh conditions which make the flora peculiar. The most common plants met with are *Nepeta floccosa*, *Physochlaina praealta*, *Bieberteinia odora*, *Hyoscyamus niger*, *Cicer microphyllum*, *Acantholimon lycopodioides*, *Thylacospermum caespitosum*, *Inula rhizocephala*, *Saussurea gnaphalodes*, *Corydalis flabellata*, *Papaver nudicaule*, *Gentiana algida*, *Arenaria bryophylla*, *Chesneya cuneata*, *Dracocephalum* spp., *Draba* spp., *Chorispora* sp., *Stipa* spp., *Astragalus* spp., etc. The large sandy stretch of Pang that extends to miles together and dominated by *Caragana pygmaea* is also a peculiarity of this region.

Tricholepis tibetica, *Lancea tibetica*, *Stachys tibetica*, *Stracheya tibetica*, *Euphorbia tibetica*, *Nepeta tibetica*, *Hedinia tibetica*, *Rheum tibeticum*, *Tanacetum tibeticum*, *Actinocarya tibetica*, etc. perhaps point out towards the affinity of the flora with Tibet. Plants like *Capsella bursa-pastoris*, *Stellaria media*, *Capparis spinosa*, *Peganum harmala*, *Tribulus terrestris*, *Verbascum thapsus*, *Ceratophyllum demersum*, *Zannichellia palustris*, etc. are common with the lower regions. Some of the species like *Macrotomia benthami*, *Aconitum heterophyllum*, *Oxyria digyna*, *Hippophae tibetana*, *Caltha palustris*, *Podophyllum hexandrum*, etc. are common with the temperate regions.

The aquatic and marshy vegetation is represented by *Ranunculus trichophyllus*, *Hippuris vulgaris*, *Limosella aquatica*, *Ranunculus hyperboreus*, *Ceratophyllum demersum*, etc. *Glaux maritima*, a plant generally found in Salt water lakes elsewhere, has interestingly been reported from the fresh water lakes of Ladakh.

Astragalus zanskerensis, *Trachometum venetum*, *Poa suruana*, *P. markgrafii*, *Thermopsis inflata*, *Saussurea bracteata*, *Kengia mutica*, *Milula spicata*, etc., are some of the other interesting species found in cold deserts.

The gymnosperms in this region are represented by 6 species of bushy *Juniperus* and medicinally important *Ephedra gerardiana*.

FLORISTIC DIVERSITY

The topographical divisions of Jammu and Kashmir, each with distinct phytoclimatic conditions together with the confluence of floristic elements from not only neighbouring Central Asian mountains of Pamir, Hindukush and Karakoram, but also the Mediterranean regions and far off countries as well have together contributed to the richness of floristic diversity in the state which comprise approximately 4252 species of flowering plants, excluding the infraspecific taxa, belonging to 189 families and about 1220 genera out of about 17,500 species in 247 families and 2984 genera in India (Karthikeyan, *in lit.*). Besides, there are 19 species of gymnosperms spreading over to eight genera and four families and 168 species of Pteridophytes in 54 genera and 31 families amongst the other vascular plants occurring in the state (Table I).

Table I
Status of various groups of vascular plants

Plant groups	Family	Genera*	Species*
ANGIOSPERMS	189	1220	4252
DICOTS	158	960	3395
MONOCOTS	31	260	857
GYMNOSPERMS	4	8	19
PTERIDOPHYTES	31	54	168

*Approximate

The proportion of Dicotyledons to Monocotyledons in the state is approximately 5:1 at family level, 3.7:1 at generic level and 4:1 at species level which compares well with that in India, viz. 4.6:1, 3.3:1 and 3:1 respectively. The over all genus to species ratio in the flowering plants of the state is 1:3.5 as against 1:5.6 in India.

A conspectus of families of flowering plants in Jammu and Kashmir with approximate number of genera and species is presented in Table II.

Table II
A conspectus of flowering plants

Name of the family	Number of genera (appr.)	Number of species (appr.)	Remarks
1.	2.	3.	4.
DICOTYLEDONS			
Acanthaceae	16	24	
Aceraceae	1	8	
Adoxaceae	1	1	Monotypic. Found in N. America, Europe, N. and C. Asia.
Aizoaceae	2	3	
Alangiaceae	1	1	
Amaranthaceae	10	22	
Anacardiaceae	8	11	
Annonaceae	3	3	
Apiaceae	50	125	
Apocynaceae	10	10	
Aquifoliaceae	1	2	
Araliaceae	2	3	
Aristolochiaceae	1	2	
Asclepiadaceae	15	25	
Asteraceae	109	481	
Basellaceae	1	1	
Balanophoraceae	1	1	
Balsaminaceae	1	16	
Begoniaceae	1	1	
Berberidaceae	2	23	
Betulaceae	2	2	
Biebersteiniaceae	1	1	Monogeneric

1.	2.	3.	4.
Bignoniaceae	4	4	
Bombacaceae	1	1	
Boraginaceae	33	106	
Brassicaceae	62	177	
Buxaceae	2	2	
Cactaceae	1	1	
Callitrichaceae	1	4	Monogeneric. Cosmopolitan, chiefly in temperate zones.
Campanulaceae	7	18	
Cannabaceae	2	2	
Capparaceae	5	10	
Caprifoliaceae	6	34	
Caricaceae	1	1	
Caryophyllaceae	22	86	
Casuarinaceae	1	1	Monogeneric. Found in S.E. Asia and S.W. Pacific.
Celastraceae	4	9	
Ceratophyllaceae	1	1	Monogeneric. Cosmopolitan.
Chenopodiaceae	16	50	
Combretaceae	3	6	
Convolvulaceae	6	18	
Coriariaceae	1	1	Monogeneric. Found in warm temperate zones.
Cornaceae	2	4	
Corylaceae	1	1	
Crassulaceae	9	36	
Cucurbitaceae	12	16	
Cuscutaceae	1	1	Monogeneric. Cosmopolitan.
Datiscaceae	1	1	
Dipsacaceae	4	9	

1.	2.	3.	4.
Dipterocarpaceae	1	1	
Droseraceae	1	1	
Ebenaceae	1	3	
Ehretiaceae	2	6	
Elaeagnaceae	2	6	
Elatinaceae	1	1	
Ericaceae	4	8	
Euphorbiaceae	17	52	
Fagaceae	2	8	
Flacourtiaceae	3	4	
Fumariaceae	2	34	
Gentianaceae	10	76	
Geraniaceae	2	31	
Grossulariaceae	1	10	
Haloragaceae	1	3	
Hamamelidaceae	1	1	
Hippocastanaceae	1	1	
Hippuridaceae	1	1	Monotypic. Found in temperate and cold wetlands of N. Hemisphere.
Hydrophyllaceae	1	1	
Hypericaceae	1	9	
Illecebraceae	1	3	
Iteaceae	1	1	
Juglandaceae	2	2	
Lamiaceae	51	175	
Lardizabalaceae	1	1	
Lauraceae	2	2	
Leeaceae	1	3	
Leguminosae	68	289	
Lentibulariaceae	1	4	
Linaceae	2	5	
Loganiaceae	2	4	
Loranthaceae	3	6	
Lythraceae	5	12	
Magnoliaceae	1	1	

1.	2.	3.	4.
Malpighiaceae	2	2	
Malvaceae	14	42	
Martyniaceae	1	1	
Meliaceae	3	5	
Menispermaceae	3	5	
Menyanthaceae	2	3	
Molluginaceae	2	3	
Monotropaceae	1	2	
Moraceae	3	23	
Morinaceae	1	3	
Moringaceae	1	1	Monogeneric. Found in Mediter- ranean regions and N. Africa.
Myrsinaceae	3	3	
Myrtaceae	4	4	
Nelumbonaceae	1	1	Monogeneric.
Nyctaginaceae	3	3	
Nymphaeaceae	1	7	
Olacaceae	1	1	
Oleaceae	6	22	
Onagraceae	5	35	
Orobanchaceae	3	16	
Oxalidaceae	1	5	
Paeoniaceae	1	1	Monogeneric. Found in S. and C. Europe, China and N.E. America.
Papaveraceae	4	16	
Parnassiaceae	1	3	
Passifloraceae	1	1	
Pedaliaceae	1	1	
Philadelphaceae	2	3	
Phrymaceae	1	1	
Phytolaccaceae	1	2	
Pittosporaceae	1	2	
Plantaginaceae	1	11	

1.	2.	3.	4.
Platanaceae	1	1	Monogeneric. Found in N. America, Balcan Peninsula and Himalayas.
Plumbaginaceae	4	11	
Podophyllaceae	2	3	
Polemoniaceae	1	1	
Polygalaceae	2	11	
Polygonaceae	12	110	
Portulacaceae	1	4	
Primulaceae	7	66	
Proteaceae	1	1	
Punicaceae	1	1	
Pyrolaceae	2	3	
Ranunculaceae	22	106	
Resedaceae	1	1	
Rhamnaceae	8	28	
Rosaceae	27	223	
Rubiaceae	15	50	
Rutaceae	10	10	
Sabiaceae	2	2	
Salicaceae	2	41	
Santalaceae	1	2	
Sapindaceae	3	3	
Sapotaceae	1	1	
Saxifragaceae	4	35	
Scrophulariaceae	31	139	
Selaginaceae	1	3	
Simaroubaceae	2	2	
Solanaceae	13	33	
Sphenocleaceae	1	1	Monotypic. Found in C. and S. E. Asia.
Staphyleaceae	1	1	
Sterculiaceae	3	3	

1.	2.	3.	4.
Styracaceae	1	1	
Tamaricaceae	2	8	
Ternstroemeaceae	1	1	
Thymelaeaceae	3	4	
Tiliaceae	3	9	
Trapaceae	1	1	Monogeneric.
Ulmaceae	4	10	
Urticaceae	11	22	
Valerianaceae	3	18	
Verbenaceae	13	17	
Violaceae	1	19	
Viscaceae	2	2	
Vitaceae	5	12	
Zygophyllaceae	4	4	
MONOCOTYLEDONS			
Alismataceae	3	8	
Amaryllidaceae	8	9	
Aponogetonaceae	1	1	Monogeneric.
Araceae	5	9	
Arecaceae	2	4	
Bambusaceae	3	3	
Butomaceae	1	1	Monotypic. Found in Europe and Temperate Asia.
Cannaceae	1	1	
Commelinaceae	3	6	
Cyperaceae	20	169	
Dioscoreaceae	1	4	
Eriocaulaceae	1	1	
Haemodoraceae	3	4	
Hydrocharitaceae	4	4	
Hypoxidaceae	1	1	
Iridaceae	3	17	
Juncaceae	2	20	

1.	2.	3.	4.
Lemnaceae	3	9	
Liliaceae	24	78	
Najadaceae	1	3	Monogeneric.
Orchidaceae	27	51	
Pandanaceae	1	1	
Poaceae	129	415	
Pontederiaceae	2	3	
Potamogetonaceae	1	15	
Scheuchzeriaceae	1	2	Monogeneric.
Smilacaceae	1	6	
Sparganiaceae	1	2	Monogeneric. Found in N. temperate and Arctic regions.
Typhaceae	1	2	Monogeneric.
Zannichelliaceae	1	1	
Zingiberaceae	5	7	

A perusal of Table II and the analysis of the species in each family presents an interesting data as presented below ;

Families with	1 species	50
Families with	2-10 species	83
Families with	11-25 species	26
Families with	26-50 species	12
Families with	51-75 species	3
Families with	76-100 species	3
Families with	101-150 species	5
Families with	151-250 species	4
Families with	251-500 species	3

An equally interesting data emerge for the diversity at generic level in the state :

Families with	1 genus	82
Families with	2-10 genera	82

Families with	11-25	genera	15
Families with	26-50	genera	5
Families with	51-100	genera	3
Families with more than	100	genera	2

It is deduced from the data presented above that while only 12 families of the flowering plants in Jammu and Kashmir have 100 or more species, 133 families in the state are represented by up to 10 species only. Similarly only 2 families in the state are reported to have 100 or above genera while 164 of them are represented by up to 10 genera only.

An interesting aspect of the floristic diversity is that apart from the families represented by just a single species in India as well as the Jammu and Kashmir a number of families are represented in the state by 40 per cent or more of their total species hitherto recorded from India, viz. Alismataceae (57%), Apiaceae (43%), Asteraceae (53%), Basellaceae (100%), Boraginaceae (50.7%), Brassicaceae (85.5%), Callitrichaceae (67%), Caprifoliaceae (50%), Casuarinaceae (50%), Caryophyllaceae (92.6%), Chenopodiaceae (70%), Coriariaceae (50%), Crassulaceae (50%), Datisceae (50%), Fumariaceae (52%), Gentianaceae (40%), Geraniaceae (70%), Illecebraceae (75%), Iridaceae (81%), Juglandaceae (100%), Malvaceae (45%), Menyanthaceae (100%), Nymphaeaceae (100%), Onagraceae (71%), Orobanchaceae (50%), Papaveraceae (59%), Plantaginaceae (92%), Polygonaceae (67%), Pontederiaceae (100%), Potamogetonaceae (83%), Ranunculaceae (55%), Salicaceae (64%), Tamaricaceae (50%), Valerianaceae (67%), etc.

Similarly apart from the monotypic genera or the ones represented in India and the Jammu and Kashmir by just a single species, a number of genera, such as *Allium* (34 species), *Potentilla* (50 species), *Waldheimia* (5 species), *Tragopogon* (5 species), etc. have their cent per cent representation in the state (see also Singh and Hajra, 1996).

Apart from the above, the state of Jammu and Kashmir also abounds in rich genetic diversity of agri-horticultural crops like *Pyrus*, *Prunus*, *Sorbus*, *Rubus*, *Ribes*, *Hordeum*, *Elymus*, *Eremopyrum*, *Avena*, *Aegilops*, *Allium*, *Lepidium*, *Carum*, *Linum*, *Cicer*, *Cucumis*, etc. The strong linkages and contiguity of Indian gene centre with other rich locii of crop diversity, such as central and western Asia, coupled with the influx of

germplasm in the past from the Mediterranean region has enormously augmented the crop genetic diversity in the state including the locally selected variability (Arora, 1994).

Asteraceae with 109 genera and 481 species (excluding the infraspecific taxa) is the largest flowering plant family in the state, whereas 50 families, including monotypics like Adoxaceae, Hippuridaceae, Sphenocleaceae, Butomaceae, are represented by just a single genus and species. Similarly, while Poaceae with 129 genera is the largest family by virtue of number of genera, 83 families including monogenerics, like Aponogetonaceae, Biebersteiniaceae, Callitrichaceae, Casuarinaceae, Coriariaceae, Ceratophyllaceae, Cuscutaceae, Moringaceae, Najadaceae, Nelumbonaceae, Platanaceae, Leeaceae, Paeoniaceae, Typhaceae, Scheuchzeriaceae, Sparganiaceae, etc., are represented in the state by a single genus only. At a lower taxonomic level, *Taraxacum* with 72 species is the largest genus in Jammu and Kashmir, whereas ca 653 genera, including ca 27 monotypics, viz. *Apluda mutica*, *Boenninghausenia albiflora*, *Butomus umbellatus*, *Caesulia axillaris*, *Colebrookea oppositifolia*, *Craniotome versicolor*, *Cydonia vulgaris*, *Desmostachya bipinnata*, *Gontscharovia popovii*, *Hemiphragma heterophyllum*, *Hygroszya aristata*, *Lawsonia inermis*, *Lygeum spartum*, *Milula spicata*, *Naringi crenulata*, *Nicandra physaloides*, *Ochthochloa compressa*, *Parochetus communis*, *Pseudaechmanthera tomentosa*, *Pycnophilanthus uniflorus*, *Roylea elegans*, *Stracheya tibetica*, *Thylacospermum caespitosum*, *Thysanolaena maxima*, *Zataria multiflora* (Uniyal and Mathur, *in lit.*), have their representation in the state by a single species only. The dominant families and genera in the state and their comparative position in Indian context is given in Table III and IV respectively.

Table III
Dominant families of flowering plants

Family	Jammu and Kashmir	India
Asteraceae	(109) 481	(166) 803
Poaceae	(129) 415	(264) 1291
Leguminosae	(68) 289	(167) 1141
Brassicaceae	(62) 177	(64) 207
Lamiaceae	(51) 175	(72) 435
Cyperaceae	(20) 169	(38) 545

Family	Jammu and Kashmir	India
Rosaceae	(26) 147	(40) 432
Scrophulariaceae	(31) 139	(62) 368
Apiaceae	(50) 125	(72) 288
Polygonaceae	(12) 110	(17) 163
Boraginaceae	(33) 106	(43) 209
Ranunculaceae	(22) 106	(28) 193

The figures in parenthesis represent the number of genera.

Table IV
Dominant genera of flowering plants

Genus	No. of Species in	
	Jammu and Kashmir	India
<i>Taraxacum</i>	72	82
<i>Carex</i>	70	160
<i>Astragalus</i>	59	72
<i>Potentilla</i>	50	50
<i>Poa</i>	45	55
<i>Saussurea</i>	41	61
<i>Nepeta</i>	40	41
<i>Pedicularis</i>	37	98
<i>Gentiana</i>	37	62
<i>Allium</i>	34	34
<i>Corydalis</i>	32	53
<i>Cotoneaster</i>	30	59

The major families of Angiosperms, having more than 100 species in Jammu and Kashmir together account for about 59.2 per cent of the State's flora, whereas the 12 major genera represent about 13 per cent of the floristic diversity of the state.

PHYTOGEOGRAPHICAL AFFINITIES

The territorial contiguity of Jammu and Kashmir with Central and West Asia, having identical geoclimatic past, has resulted into its closer floristic affinity with that of several countries of the region. While the flora of Jammu and Kashmir shows greater affinity with that of Central and West Asia and Mediterranean region, Indo-Malayan and Indo-Chinese elements are also present here in good proportion. Apart from that, the flora of the state is also characterised by the presence of a number of disjunct species representing floristic elements of New Zealand, Australia, Africa and America, a phenomenon indicative of "... different episodes in geological and climatological history which have influenced the migration and even survival of floras" (Steere and Inone, 1972; Singh 1995).

According to Meher-Homji (1971) five principal floristic elements are discernible in North-Western part of the Indian subcontinent, which together with its phytogeographic position accounts for diverse floristic composition of the region. These are Mediterranean; Mediterranean and Temperate; Tropical; Arid and General. While discussing the affinities of Alpine and subalpine flora of Kashmir, Dhar and Kachroo (1983) concluded "..., it appears that our flora (alpine-subalpine) leans heavily towards Afghanistan and Central Asia, South China and Europe. But considering the area in the West together, the affinities are surely to Afghanistan - Central Asia-South China-Axis. Amongst the other adjacent areas Siberia, Caucasus, Eastern Himalaya are more closer".

The floristic affinities with adjoining phytochoria, as exhibited by Kashmir flora in terms of percentage is; Pakistan (80.22 per cent), Afghanistan (44), Iran (21.42), Europe (33.68), USSR (44.15), Tibet (26.45), China (38.17), Western Himalaya (62.22) and Eastern Himalaya (36.69) (Virjee, Dhar and Kachroo, 1989). Kachroo (1992), however, provided the data for floristic affinities with respect to Kashmir flora as follows: Afghanistan (56.37), Central Asia (43.20), Southwest China (38.69), Siberia (31), Caucasus (21.69), Iran (32.81), Europe (32.81), Eastern Himalaya (22.12) (Kachroo, 1993). Similarly, of the 895 species of flowering plants known to be occurring in Ladakh region, 449 are common with Kashmir, 153 with Siberia, 230 with Tadjikstan, 98 with Afghanistan, 78 with Baluchistan and 48 with Rajasthan (Kachroo, 1993). Some of the floristic elements of Jammu and Kashmir, which are common with other biogeographic regions within the country as well as other countries or the biogeographic regions of the world, are enumerated below.

Eastern Himalaya

Gypsophila cerastioides, *Oxygraphis endlicheri*, *Ranunculus diffusus*, *Thalictrum reniforme*, *Rubus niveus*, *Hypericum elodeoides*, *Rhododendron arboreum*, *Verbascum thapsus*, *Lonicera angustifolia*, *Eupatorium adenophorum*, *Sonchus asper*, *Poa annua*, *Artemisia biennis*, *Saussurea obvallata*, *Saussurea simpsoniana*, *Aster diplostephioides*.

Central India

Ranunculus sceleratus, *Berberis lycium*, *Capparis sepiaria*, *Shorea robusta*, *Sida cordifolia*, *Helicteres isora*, *Crotalaria albida*, *Indigofera cassioides*, *Butea monosperma*, *Dalbergia sissoo*, *Cassia fistula*, *Rotala mexicana*, *Woodfordia fruticosa*, *Wendlandia heynei*, *Plumbago zeylanica*.

Peninsular India

Barbarea intermedia, *Potentilla leschenaultiana*, *Cissampelos pareira* var. *hirsuta*, *Clematis gouriana*, *Ranunculus muricatus*, *Cocculus laurifolius*, *malvastrum coromandelianum*, *Bombax ceiba*, *Aegle marmelos*, *Murraya koenigii*, *Rhynchosia capitata*, *Crotalaria medicaginea*, *Desmodium triflorum*, *Withania somnifera*, *Bacopa monnieri*, *Alternanthera pungens*.

Indo-Malayan region

Callicarpa arborea, *Vitex negundo*, *Ficus hispida*, *Oroxylum indicum*, *Phyllanthus embelica*, *Ziziphus mauritiana*, *Cordia dichotoma*, *Dodonaea viscosa*, *Debregeasia longifolia*, *Alangium salvifolium*, *Terminalia bellirica*, *Youngia japonica*, *Cocculus laurifolius*.

China

Fimbristylis podocarpa, *Scirpus maritimus*, *Saccharum spontaneum*, *Ischaemum rugosum*, *Phragmites karka*, *Plantago major*, *Boerhavia repens*, *Mallotus philippensis*, *Solanum nigrum*, *Androsace aizoon*, *Plumbago zeylanica*, *Primula denticulata*, *Thalictrum alpinum*, *Anemone obtusiloba*, *Dianthus chinensis*, *Bauhinia variegata*, *Pimpinella diversifolia*.

Europe

Morus alba, *M. nigra*, *Ficus carica*, *Cannabis sativa*, *Urtica urens*, *Viscum album*, *Portulaca oleracea*, *Stellaria media*, *Nymphaea alba*, *Ceratophyllum demersum*, *Acorus calamus*, *Actaea spicata*, *Adoxa moschatellina*, *Cuscuta europea*, *Arctium lappa*, *Convolvulus arvensis*, *Cynodon dactylon*.

Central Asia

Physalis peruviana, *Phryma leptostachya*, *Plantago asiatica*, *Euphorbia antiquorum*, *Melia azedarach*, *Berchemia lineata*, *Hovenia dulcis*, *Ammannia baccifera*, *Epilobium palustre*, *Punica granatum*.

Australia

Blainvillea acmella, *Picris hieracioides*, *Vittadinia australis*, *Erigeron karvinskianus*, *Arenaria serpyllifolia*, *Capparis sepiaria*, *Lepidium latifolium*, *Calotis hispidula*.

Africa

Sida acuta, *Dalbergia sissoo*, *Cassythia filiformis*, *Centella asiatica*, *Celosia argentea*, *Rotala mexicana*, *Rhynchosia minima*, *Ricinus communis*, *Pupalia lappacea*, *Phyllanthus urinaria*, *Indigofera cordifolia*, *Oxalis corniculata*, *Moringa oleifera*, *Polycarpaea corymbosa*, *Mucuna pruriens*, *Corchorus olitorius*.

America

Bromus catharticus, *Polypogon monspeliensis*, *Phleum alpinum*, *Phalaris minor*, *Echinochloa colona*, *Chenopodium botrys*, *Amaranthus viridis*, *Mirabilis jalapa*, *Ranunculus aquatilis*, *Argemone mexicana*, *Medicago lupulina*, *Lotus corniculatus*, *Melilotus officinalis*.

ENDEMISM

The occurrence of endemics, which is generally determined by biogeographic provinces, unique ecosystems, and topographical as well as climatological interfaces, is suggestive of the biogeography, locii of speciation, vicariance, extinction and adaptive evolution of the biota of a

particular region. The geographical position, physiography and the geological history of Jammu and Kashmir have together contributed to considerably higher endemism in relatively younger mountain system (Kachroo, 1993). Conforming to the general pattern of endemism in India (Chatterjee, 1939; Ahmedullah and Nayar, 1987), the state of Jammu and Kashmir also show higher endemism in Dicotyledons as compared to Monocotyledons (Dhar and Kachroo, 1983; Kachroo, 1993). Some of the families, which show high endemism in Kashmir are: Saxifragaceae (53%), Fumariaceae (52%), Violaceae (50%), Rutaceae (50%), Valerianaceae (50%), Dipsacaceae (50%), Campanulaceae (50%), Gentianaceae (49%), Apiaceae (45%), Scrophulariaceae (44%), Balsaminaceae (43%), Asteraceae (39%), Primulaceae (39%), Fabaceae (39%), Berberidaceae (38%), Aceraceae (33%), Parnassiaceae (31%), etc. However, most of these endemics are either schizoendemics or Pan-Himalayan spreading across the entire length of the mountain ranges from Afghanistan to North Myanmar. Some of the genera, which show very high percentage of endemism in the state are *Alchemilla*, (above 85%), *Taraxacum* (55%), etc. Nayar (1996) puts the figure of total endemics in the state at 224.

Some of the endemic taxa, either exclusively confined to the state or found elsewhere as well within the political boundary of the country are listed in Table V.

Table V
Endemic Angiosperms

Name of the taxa	Distribution	Remarks
ASTERACEAE		
<i>Anaphalis kashmiriana</i>	J and K	
<i>Bidens tetraspinosa</i>	J and K	
<i>Chondrilla setulosa</i>	J and K	
<i>Crepis naniforma</i>	J and K, H.P.	Rare.
<i>Lactuca benthamii</i>	J and K	Known through type only
<i>L. kashmiriana</i>	J and K	
<i>Olgaea thomsonii</i>	J and K	
<i>Saussurea clarkei</i>	J and K	
<i>Tragopogon kashmirianus</i>	J and K	

Name of the taxa	Distribution	Remarks
BALSAMINACEAE		
<i>Impatiens meeboldii</i>	J and K	
<i>I. pahalgamensis</i>	J and K	
BERBERIDACEAE		
<i>Berberis glaucocarpa</i>	J and K, H.P., U.P.	
<i>B. huegeliana</i>	J and K	Rare, known through type only.
<i>B. kashmiriana</i>	J and K	
<i>B. pseudumbellata</i> ssp. - <i>gilgitica</i>	J and K	
<i>B. stewartiana</i>	J and K	
BORAGINACEAE		
<i>Actinocarya acaulis</i>	J and K, Sikkim	
<i>A. tibetica</i>	J and K	
<i>Anoplocaryum brandisii</i>	J and K, N.W. India	
<i>Cynoglossum flexuosum</i>	J and K	
<i>Eritrichium spathulatum</i> var. <i>spathulatum</i>	J and K	
<i>E. spathulatum</i> var. <i>thomsonii</i>	J and K	
<i>Hackelia meeboldii</i>	J and K	
<i>H. stewartii</i>	J and K	
<i>Heliotropium dasycarpum</i> var. <i>gymnostomum</i>	J and K	
<i>Lasiocaryum munroi</i>	J and K, Sikkim	
<i>Pseudomertensia drummondii</i>	J and K	
BRASSICACEAE		
<i>Arabis tenuirostris</i>	J and K	
<i>Draba aubrietoides</i>	J and K	
<i>D. ludlowiana</i>	J and K	

Name of the taxa	Distribution	Remarks
<i>Erophila tenerrima</i>	J and K	
<i>Lignariella duthiei</i>	J and K	
CALLITRICHACEAE		
<i>Callitriche fehmedianii</i>	J and K	
CARYOPHYLLACEAE		
<i>Minuartia ebracteolata</i>	J and K, H.P.	
GENTIANACEAE		
<i>Gentiana harwanensis</i>	J and K	
<i>G. marginata</i> var. <i>hugelii</i>	J and K	
LEGUMINOSAE		
<i>Alysicarpus heyneanus</i>	J and K, M.P.,	
var. <i>meeboldii</i>	U.P.	
<i>Astragalus gilgitensis</i>	J and K	
<i>A. kashmirensis</i>	J and K, H.P.,	
	U.P.	
<i>A. maxwellii</i>	J and K, H.P.	
<i>Hedysarum astragaloides</i>	J and K, H.P.	
<i>H. cachemirianum</i>	J and K	
<i>Oxytropis shivai</i>	J and K	
LILIACEAE		
<i>Allium gilgiticum</i>	J and K	Rare; known through type only.
<i>Eremurus himalaicus</i>	J and K, H.P.	
ORCHIDACEAE		
<i>Neottia kashmiriana</i>	J and K	
POACEAE		
<i>Bromus barobalianus</i>	J and K	
<i>Calamagrostis decora</i>	J and K	

Name of the taxa	Distribution	Remarks
<i>Calamagrostis stoliczkai</i>	J and K	
<i>Digitaria stewartiana</i>	J and K	
<i>Festuca levingei</i>	J and K	Type only
<i>F. simlensis</i>	J and K, H.P.	
<i>Poa koelzii</i>	J and K, H.P., U.P.	
<i>P. ladakhensis</i>	J and K	
<i>P. markgrafii</i>	J and K	
<i>P. suruana</i>	J and K	
<i>Puccinellia thomsonii</i>	J and K	Rare
<i>P. himalaica</i>	J and K, H.P.	
<i>Rostraria clarkeana</i>	J and K	Type only
<i>Schizachyrium impressum</i>	J and K	Type only

PRIMULACEAE

<i>Primula obtusifolia</i>	H.P., J and K E.H.
<i>P. clarkei</i>	J and K
<i>Androsace studiosorum</i>	J and K

RANUNCULACEAE

<i>Aconitum moschatum</i>	J and K
<i>Consolida schlagintweitii</i>	J and K
<i>Ranunculus stewartii</i>	J and K
<i>R. palmatifidus</i>	J and K
<i>R. glacialiformis</i>	J and K
<i>Isopyrum ludlowii</i>	J and K

RHAMNACEAE

<i>Rhamnella gilgitica</i>	J and K
<i>Sageretia kashmirensis</i>	J and K
<i>S. kishwarensis</i>	J and K

ROSACEAE

<i>Alchemilla aksharmae</i>	J and K
<i>A. brummittii</i>	J and K

Name of the taxa	Distribution	Remarks
<i>Alchemilla cecillii</i>	J and K	
<i>A. chthamalea</i>	J and K, U.P.	
<i>A. duthieana</i>	J and K	Type only
<i>A. gilgitensis</i>	J and K	
<i>A. kishengangensis</i>	J and K	
<i>A. kungwatanensis</i>	J and K	
<i>A. mantonii</i>	J and K	
<i>A. nicolsonii</i>	J and K	
<i>A. niltarensis</i>	J and K	
<i>A. plocekii</i>	J and K	
<i>A. rothmaleri</i>	J and K	
<i>A. samantraii</i>	J and K	
<i>A. sarojinii</i>	J and K	
<i>A. sojakii</i>	J and K	
<i>A. waltersii</i>	J and K	
<i>A. ypsilotoma</i>	J and K	
<i>Cotoneaster gilgitensis</i>	J and K, H.P., U.P.	
<i>C. lambertii</i>	J and K	
<i>Spiraea rhamniphylla</i>	J and K, H.P., U.P.	
<i>Prunus bokhariensis</i>	J and K	
RUBIACEAE		
<i>Galium harwanensis</i>	J and K	
<i>G. mahadivensis</i>	J and K	
SAXIFRAGACEAE		
<i>Saxifraga asarifolia</i>	J and K	
<i>S. duthiei</i>	J and K, W. Himal.	
<i>S. flagellaris</i> spp. <i>mucronulata</i>	J and K	
SCROPHULARIACEAE		
<i>Euphrasia alba</i>	J and K	
<i>E. densiflora</i>	J and K, U.P.	
<i>E. flabellata</i>	J and K, H.P.	
<i>E. incisa</i>	J and K	
<i>E. jaeschkei</i>	J and K, H.P.	

Name of the taxa	Distribution	Remarks
<i>Euphrasia kashmiriana</i>	J and K	
<i>E. laxa</i>	J and K, H.P.	
<i>E. pauciflora</i>	J and K, H.P.	
<i>E. platyphylla</i>	J and K, H.P.	
<i>E. remota</i>	J and K, H.P.	
<i>E. secundiflora</i>	J and K	Type only
<i>Pedicularis brevirostris</i>	J and K	
<i>P. canescens</i>	J and K	
<i>Scrophularia dentata</i>	J and K, H.P.	
<i>S. nudata</i>	J and K	
<i>Veronica cachemirica</i>	J and K	
<i>V. koelzii</i>	J and K	
<i>V. nana</i>	J and K	Type only
<i>V. uncinata</i>	J and K	Type only

VIOLACEAE

<i>Viola fedtschenkoana</i>	J and K	
ssp. <i>muzaffarabadensis</i>		
<i>V. jordani</i> var. <i>falconeri</i>	J and K	
<i>V. rupestris</i> var. <i>himalayensis</i>	J and K	

ECONOMIC PLANTS

The Himalayas are an acknowledged "Treasure-House" of enormous physical and biological resources, and the Kashmir Himalaya is no exception. The long historical and geographical isolation of the state coupled with the diverse social and cultural traditions and practices of its people have also helped in the evolution of rich ethnobotanical heritage in Jammu and Kashmir over a period of time. The early Kashmiris used plants like *Desmostachya bipinnata*, *Hordeum*, *Crocus sativus*, *Sesamum*, *Betula*, *Amaranthus tricolor*, *Acorus calamus*, *Morus*, etc., in various, social and religious rites; *Skimmia laureola*, *Morina* spp., *Jurinea macrocephala*, *Peganum harmala*, etc., as incense; *Typha angustata*, *Parrotiopsis jacquemontiana*, *Euonymus*, *Cotoneaster*, *Aesculus indica*, *Abies pindrow*, *Prunus cornuta*, *Carissa spinarum*, *Buxus wallichiana*,

etc., for making crafts including kitchenwares and musical instruments. Besides, a large number of plants were used for variety of purposes such as toiletries (*Juglans regia*, *Corydalis falconeri*, *Cyperus rotundus*, *Origanum vulgare*, etc.), medicines (*Urtica* spp., *Linum usitatissimum*, *Ulmus wallichiana*, *Dolichos biflorus*, *Mallotus philippensis*, *Artemisia* spp., *Limnanthemum nymphaeoides*, *Polygonum* spp., *Euphorbia thomsoniana*, *Podophyllum hexandrum*, etc.), food (*Paspalum scrobiculatum*, *Codonopsis ovata*, *Marsilea quadrifolia*, *Nymphaea alba*, etc.), building materials (*Cedrus deodara*, *Pinus wallichiana*, etc.), culinary preparations (*Onosma hispidum*, *Crocus sativus*, *Origanum vulgare*, *Cymbopogon citratus*), etc.

Apart from that, a number of plants brought and introduced by various invaders and immigrants, that have now become permanent denizens of the state, also add to its economic plant diversity. Saffron or the *Crocus sativus*, an Iranian element most likely introduced by the Mughuls, is one of the many such examples. As such, a considerably large proportion of huge plant diversity met in the state are economically important, yielding both timber as well as a vast array of other products such as medicine, food, fodder, oil, gum, tannins, etc., collectively known as non timber forest products (NTFP) or minor forest products (MFP). Table VI shows some of the important economic plants of the state, majority of which are in active use even today.

In addition, the state abounds in large number of wild ornamental plants of considerable horticultural significance, such as *Fritillaria imperialis*, *Asparagus filicinus*, *Rosa webbiana*, *R. moschata*, *Lavatera kashmiriana*, *Geranium pratense*, *Bergenia ligulata*, *Lychnis coronaria*, *Sorbaria tomentosa*, *Ferula jaeschkeana*, *Aquilegia fragrans*, *Delphinium* spp., *Corydalis* spp., *Rhododendron campanulatum*, *Platanus orientalis*, *Iris* spp., *Pedicularis* spp., *Primula* spp., *Saussurea* spp., *Gentiana algida*, *Aster flaccidus*, *A. thomsonii*, *Caltha palustris*, *Erigeron multiradiatus*, *Inula* spp., etc.

On the other hand certain plants, like *Rhus succedanea*, *Urtica dioica*, *Euphorbia helioscopia*, *E. prolifera*, *E. pilosa*, etc., are harmful and cause miseries to human beings. Besides, a number of parasites such as *Hedera nepalensis*, *Cuscuta reflexa*, *Arceuthobium minutissimum*, etc., cause severe damage to the vegetation.

Table VI
Economic plants and their uses

Name of the species	Agricultural implements	Dye	Filter	Food:	Fuel	Gum	Medicinal	Timber	Wild edible	Other uses	Remarks
	1	2	3	4	5	6	7	8	9	10	11
<i>Abies pindrow</i>	-		-			+		+			
<i>A. precatarius</i>	-	-					+				
<i>Abutilon indicum</i>	-			-	-		+				
<i>A. theophrasti</i>	-	-	-	-			+				
<i>Acacia nilotica</i>	-			-		-	+				
<i>A. modesta</i>	-		-	-			+				
<i>Acantholimon lycopodioides</i>	-				+		+				
<i>Acer pentapomicum</i>						-	+				
<i>Achillea millefolium</i>	-	-	-	-	-		+				Oil used in soap industry
<i>Achyranthes aspera</i>	-	-				-	+				
<i>A. bidentata</i>	-	-	-	-	-	-	+				
<i>Aconitum heterophyllum</i>	-	-	-	-	-	-	+				

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Acaulium deltorrhizum</i>							+				
<i>A. chasmanthum</i>							+				
<i>A. violaceum</i> var. <i>robustum</i>							+				
<i>A. kasimircum</i>							+				
<i>Acorus calamus</i>							+				
<i>Actaea spicata</i>				-			+				
<i>Adhatoda vasica</i>							+				
<i>Adiantum capillus-veneris</i>							+				
<i>Aegle marmelos</i>							+				
<i>Aerva lanata</i>							+				
<i>Aesculus indica</i>							+				
<i>Agave americana</i>	-						+				
<i>Agrimonia eupatoria</i>	-						+				
<i>Agrostis gigantea</i>				1							
<i>Ainsliaea pteropoda</i>							+				
<i>Ajuga parviflora</i>	-						+				
<i>Alisma plantago</i>			-				+				
<i>Allium rubellum</i>							+				Spices
<i>A. consanguineum</i>		-					+		+		
<i>A. wallichii</i>	-	-		-			+				Condiment

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Allium atropurpureum</i>	-	-							+		
<i>A. stoliczkaei</i>									+		
<i>A. tuberosum</i>	-						+				
<i>Albium nitida</i>							+				Tannin
<i>Alternanthera sessilis</i>									+		
<i>Althea rosea</i>			-				+				
<i>Amaranthus gangeticus</i>							+				
<i>A. hybridus</i>							+		+		
<i>A. viridis</i>							+				
<i>Anagallis arvensis</i>							+				
<i>Anaphalis cinnamomea</i>							+				
<i>A. cuneifolia</i>							+				
<i>Andrographis echioides</i>							+				
<i>Androsace rotundifolia</i>							+				
<i>Anemone obtusiloba</i>							+				
<i>A. sarasepala</i>							+			-	
<i>A. vitifolia</i>							+				
<i>Angelica glauca</i>	-	-				-	+				Spices
<i>Apium graveolens</i>	-	-	-	-	-	-		-		-	Condiments
<i>Aquilegia vulgaris</i>	-	-					+				

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Archangelica himalaica</i>											
<i>Arctium lappa</i>		-	-	-			+			+	Petals used in confectionary
<i>Arenaria foliosa</i>		-		+							
<i>Argemone mexicana</i>							+				
<i>Arnebia tibetana</i>			-				+				
<i>Artemisia parviflora</i>							+				
<i>A. absinthium</i>							+				
<i>A. brevifolia</i>							+				
<i>A. dracunculus</i>							+				
<i>A. maritima</i>							+				
<i>A. sieversiana</i>				+			+				
<i>A. vestita</i>							+				
<i>Asplenium adiantum-nigrum</i>							+				
<i>Aster falconeri</i>							+				
<i>Astragalus psilocentrus</i>							+				
<i>A. nivalis</i>							+				
<i>A. rhizanthus</i>				+							
<i>A. zamskarensis</i>				+							
<i>Atropa acuminata</i>				-			+				

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Azadirachta indica</i>							+				
<i>Bacopa monnieri</i>							+				
<i>Barbarea vulgaris</i>							+				
<i>Barleria prionitis</i>							+				
<i>Bauhinia variegata</i>							+				
<i>B. racemosa</i>											Fish poison, Insecticide
<i>Berberis aristata</i>							+			+	
<i>B. asiatica</i>							+				
<i>B. lycium</i>							+			+	
<i>B. pachycantha</i> ssp. <i>zabeliana</i>				+			+		+		
<i>B. ulicina</i>					+						
<i>B. umbellata</i>							+				
<i>Bergenia ligulata</i>							+				
<i>B. stracheyi</i>				+			+				
<i>Blebersteinia odora</i>						-	+				Insect repellent
<i>Boenninghausenia albiflora</i>			-			-	+				Insect repellent
<i>Boerhavia diffusa</i>	-	-	-	-		-	+			-	
<i>Bothriochloa ischaemum</i>	-	-	-	+							

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Branella vulgaris</i>			-				+				
<i>Bunium persicum</i>				-					+		Spices
<i>Bupleurum falcatum</i>				-			+				
<i>B. lanceolatum</i>				-			+				
<i>Butea monosperma</i>					-		+				
<i>Caesalpinia decapetala</i>							+				
<i>Calamintha umbrosa</i>				-			+				
<i>Calotropis procera</i>							+				
<i>Callitha palustris</i>		-					+				
<i>Cannabis sativa</i>							+				
<i>Capparis spinosa</i>				+			+		+		
<i>Capsella bursa-pastoris</i>							+				
<i>Cardiospermum halicacabum</i>							+				
<i>Carduus edelbergii</i>							+				
<i>Carex moorcroftii</i>				+							
<i>C. nivalis</i>							+				
<i>Carissa spinarum</i>		-				-	+		+		
<i>Carthamus tinctorius</i>		+					+				Oil
<i>Cassia fistula</i>							+				
<i>Cassytha filiformis</i>		-	-	-			+				

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Cedrela serrata</i>	-	-	-	-	-	-	+				
<i>Cedrus deodora</i>	-	-	-	-	+		+	+			
<i>Celastrus paniculatus</i>	-	-	-	-			+				
<i>Celtis australis</i>	+	-	-	+			+	+			Oil
<i>Centella asiatica</i>	-	-	-	-			+				
<i>Chenopodium acuminatum</i>	-	-	-	-			+				
<i>C. villosum</i>	-	-	-	-			+	+			
<i>Chenopodium album</i>	-	-	-	-			+	+			
<i>C. blitum</i>	-	-	-	-				+			
<i>C. botrys</i>	-	-	-	-			+				
<i>Christolea crassifolia</i>	-	-	-	-					+		
<i>Cicer microphyllum</i>	-	-	-	+					+		
<i>Cichorium intybus</i>	-	-	-	-			+				
<i>Cimicifuga foetida</i>	-	-	-	-			+				
<i>Cissampelos pareira</i>	-	-	-	-			+				
<i>Clematis connata</i>	-	-	-	-			+				
<i>C. gowriana</i>	-	-	-	-			+				
<i>C. tibetana</i>	-	-	-	+			+				
<i>Colchicum luteum</i>	-	-	-	-			+				
<i>Conium maculatum</i>	-	-	-	-			+				

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Convolvulus arvensis</i>	-	-	-	+	-			-			
<i>Coriaria nepalensis</i>	-		-	-	-	-			+		
<i>Corydalis flabellata</i>	-	-	-	-	-	-	+				
<i>C. govaniana</i>	-	-	-	-	-	-	+	-			
<i>Corylus colurna</i>	-	-	-	-	-		+				
<i>Costus speciosus</i>	-	-	-	-	-	-	+	-			
<i>Cotinus coggygria</i>	-			-	-	-			+		
<i>Cotoneaster nummularia</i>	-	-			-					+	Branches used to make baskets
<i>Crambe cordifolia</i>									+		
<i>Crataegus oxyantha</i>					-		+				
<i>Crematogaster ellisii</i>					-		+				
<i>Cristium arvense</i>				+	-						
<i>Crotalaria cytisoides</i>				+	-						
<i>C. juncea</i>			+	-		-					
<i>C. medeolifolia</i>							+				
<i>Cuscuta reflexa</i>							+				
<i>Cydonia oblonga</i>						-			+		
<i>Cymbopogon jwarancusa</i>	-						+				
<i>Cynodon dactylon</i>	-			+							

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Cynoglossum wallichii</i>							+				
<i>Cyperus rotundus</i>							+				
<i>Dactyloctenium aegyptium</i>							+				
<i>Dalbergia latifolia</i>							+				
<i>Datura cannabina</i>							+				
<i>Datura Stramonium</i>							+				
<i>Debregeasia hypoleuca</i>											
<i>Descurainia amarantoides</i>							+				
<i>Delphinium denudatum</i>							+				
<i>D. cashmerianum</i>											Magico religious
<i>Descurainia sophia</i>				-			+		+		
<i>Demodrum tiliaefolium</i>				-			+				
<i>Desmodium bipinnata</i>											Sacred
<i>Dianthus anatolicus</i>							+				
<i>Dicliptera roxburghiana</i>							+				
<i>Dioscorea bulbifera</i>							+				
<i>D. deltoidea</i>							+	-			
<i>Dipsacus mitis</i>							+	-	+		
<i>Dodonaea viscosa</i>	-	-	-	-	-	-	+	-	-	-	

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Draba setosa</i>											Incense
<i>Echinops cornigerus</i>							+				
<i>Eclipta alba</i>			-		-		+				
<i>Elaeagnus parvifolia</i>			-		-				+		
<i>E. umbellata</i>				-	-		+				
<i>Elsholtzia densa</i>						-			+		
<i>Elymus dahuricus</i>			-	+	-						
<i>Ephedra Gerardiana</i>			-				+				
<i>Epimedium elatum</i>			-	-		-				+	To expel and kill mosquitoes
<i>Equisetum debile</i>			-				+				
<i>Eremurus himalaicus</i>			-	-					+		
<i>Erigeron canadensis</i>	-	-	-		-		+				
<i>Evonymus hamiltonianus</i>		-	-	+							
<i>Euphorbia helioscopia</i>		-	-				+				
<i>E. nerifolia</i>				-			+				
<i>Euryale ferox</i>						-			+		
<i>Evolvulus ulatnioides</i>	-	-	-	-			+				
<i>Fagopyrum esculentum</i>	-	-	-	-	-	-			+		
<i>Ferula faeschkeana</i>	-	-	-	+	-	+	+		-	+	Oil

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Festuca kashmiriana</i>	-	-	-	+	-	-	-	-	-	-	-
<i>Fragaria vesca</i>	-	-	-	-	-	-	-	-	+	-	-
<i>Fritillaria roylei</i>	-	-	-	-	-	-	+	-	-	-	-
<i>Fumaria parviflora</i>	-	-	-	-	-	-	+	-	-	-	-
<i>Gadium rotundifolium</i>	-	-	-	-	-	-	+	-	-	-	-
<i>Gentiana algida</i>	-	-	-	-	-	-	+	-	-	-	-
<i>G. argentea</i>	-	-	-	-	-	-	+	-	-	-	-
<i>G. kurroo</i>	-	-	-	-	-	-	+	-	-	-	-
<i>Gentianella tenella</i>	-	-	-	-	-	-	+	-	-	-	-
<i>Geranium pratense</i>	-	-	-	-	-	-	+	-	-	-	-
<i>G. nepalense</i>	-	-	-	-	-	-	+	-	-	+	Oil
<i>Geum edatum</i>	-	-	-	-	-	-	+	-	-	-	-
<i>Glaux maritima</i>	-	-	-	+	-	-	-	-	-	-	-
<i>Gnaphalium luteo-album</i>	-	-	-	-	-	-	+	-	-	-	-
<i>Goldfussia delhouiana</i>	-	-	-	-	-	-	+	-	-	-	-
<i>Gymnosporia montana</i>	-	-	-	-	-	-	-	-	-	-	Religious belief
<i>Hedera nepalensis</i>	-	-	-	-	-	-	+	-	-	-	-
<i>Helicteres isora</i>	-	-	-	-	-	-	+	-	-	-	-
<i>Heliotropium eichwaldi</i>	-	-	-	-	-	-	+	-	-	-	-
<i>Heracleum candicans</i>	-	-	-	-	-	+	+	-	-	-	-

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Heracleum pinnatum</i>	-	-	-	-	-	-	+	-			
<i>Hippophae rhamnoides</i>		-	-	-	+	-	-	-	+		
<i>Holarrhena anticyantherica</i>	-	-	-	-	-	-	+	-		-	
<i>Humulus lupulus</i>	-	-	+	-	-	-	+	-			
<i>Hyoscyamus niger</i>	-	-	-	-	-	-	+			-	
<i>Hypericum perforatum</i>	-	-	-	-	-	-	+	-			
<i>Ilex diphyrea</i>	-	-	-	-	-	-	+	-			
<i>Impatiens ruylei</i>	-						+		+		
<i>Imperata cylindrica</i>			-	-	-	-	-	-		-	Religious belief
<i>Indigofera gerardiana</i>	-	-	-	-	-	-	-			+	Misc. (branches used to make baskets)
<i>I. hebeptala</i>		-	-	+		-					
<i>Inula cuspidata</i>			-	-		-	+				
<i>I. obnusifolia</i>	-	-	-	-	-		+				
<i>I. racemosa</i>	-	-	-	-			+				
<i>Iris ensata</i>	-		-	+	-		+				
<i>I. hookeriana</i>	-		-	-	-	-				+	
<i>Jasminum officinale</i>	-	-	-	-	-	-	+				
<i>J. frantille</i>	-	-	-	-	-	-	-	-			Ink

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Jasminum pubescens</i>	-	-	-	-	-	-	+				
<i>Jatropha curcas</i>	-	-	-	-	-	-	+	-			
<i>Juglans regia</i>	-	-	-	-	-	-		+	+	+	
<i>Juncus lamprocarpus</i>	-	-	-	-	-	-	+	-			
<i>Juniperus communis</i>	-	-	-	-	-	-	+				
<i>J. recurva</i>	-	-	-	-	-	-	-			+	
<i>Jurinea macrocephala</i>	-	-	-	-	-	-	-	-			Incense
<i>J. himalaica</i>	-	-	-	-	-	-	+				
<i>Kydia calycina</i>	-	-	-	-	-	-	+				
<i>Lactuca tibetica</i>	-	-	-	-	-	-			+		
<i>L. sativa</i>	-	-	-	-	-	-	-	-	+		
<i>Lamium album</i>	-	-	-	-	-	-	+				
<i>Lancea tibetica</i>	-	-	-	-	-	-	+	-	-		
<i>Lavatera kashmiriana</i>	-	-	-	-	-	-	+	-			
<i>Lawsonia inermis</i>	-	-	-	-	-	-	-	-			Religious belief
<i>Leonurus cardiaca</i>	-	-	-	-	-	-	+	-			
<i>Lepidium capitatum</i>	-	-	-	-	-	-	+	-	-		
<i>L. latifolium</i>	-	-	-	-	-	-	+	-	+		
<i>Lepedeza sericea</i>	-	-	-	-	-	-	-	-	-		Oil
<i>Leucos cephalotes</i>	-	-	-	-	-	-	+	-	-		

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Limnanthemum nymphaeoides</i>		-		-					+		
<i>Lolium perenne</i>		-		+							
<i>Lonicera spinosa</i>			-		+		+				
<i>Lychnis apetala</i>	-						+	-			
<i>Macrostomia benthamii</i>							+				
<i>Mallotus philippensis</i>			+				+				
<i>Malva sylvestris</i>			-				+		+		
<i>M. rotundifolia</i>				+			+				
<i>M. neglecta</i>							+		+		
<i>M. verticillata</i>										+	Seeds added to sharbat
<i>Marrubium vulgare</i>							+				
<i>Martynia annua</i>				-			+				
<i>Matthiola flarida</i>							+				
<i>Mecanopsis aculeata</i>					-				+		
<i>Medicago falcata</i>				+							
<i>M. sativa</i>				+			+				
<i>Megacarpaea polyandra</i>				-					+		
<i>Melilotus alba</i>	-	-		-	-				+		
<i>M. officinalis</i>	-	-		+			+				

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Melothria heterophylla</i>	-	-	-	-	-	-	+				
<i>Mentha longifolia</i>	-	-	-	-	-	-	+				
<i>Morha longifolia</i>	-	-	-	-	-	-	+	-			Religious belief
<i>Morus alba</i>	-	-	-	-	-	-	-	-	+		
<i>Mucuna pruriata</i>	-	-	-	-	-	-	+				
<i>Murraya koenigii</i>	-	-	-	-	-	-	+				
<i>Myricaria elegans</i>	-	-	-	+	+	-					
<i>Myrsine africana</i>	-	-	-	-	-	-	+				
<i>Nardostachys jatamansi</i>	-	-	-	-	-	-	+				
<i>Nelumbo nucifera</i>	-	-	-	-	-	-			+		
<i>Nepeta floccosa</i>	-	-	-	-	-	-	+				
<i>N. leucophylla</i>	-	-	-	-	-	-	+				
<i>Nerium indicum</i>	-	-	-	-	-	-	+				
<i>Nyctanthes arborvitatis</i>	-	-	-	-	-	-	+				
<i>Nymphaea alba</i>	-	-	-	-	-	-			+		
<i>Olea cuspidata</i>	-	-	-	-	-	-	+				
<i>Onosma hispidum</i>	-	-	-	-	-	-	+				
<i>Ophioglossum vulgare</i>	-	-	-	-	-	-			+		
<i>Origanum vulgare</i>	-	-	-	-	-	-	+	-			
<i>Orobancha cernua</i>	-	-	-	-	-	-	-	-	+		

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Orthostaphyon rubicundus</i>				-					+		
<i>Oxalis acetosella</i>							+			+	
<i>O. corniculata</i>					-		+				
<i>Paeonia emodi</i>	-				-		+				
<i>Panicum antidotale</i>	-				-				+		
<i>P. miliaceum</i>	-				-				+		
<i>Papaver nudicaule</i>	-						+		+		
<i>Parrotiopsis jacquemontiana</i>	-										
<i>Pedicularis pectinata</i>							+				
<i>Peganoon harmala</i>	-	+					+				
<i>Pennisetum flaccidum</i>				+	-						
<i>Penzancea indicum</i>	-						+				
<i>Perovskia abrotanoides</i>		+			-						
<i>Phlomis bracteosa</i>				+							
<i>Phragmites communis</i>							+		+		
<i>Phyllanthus niruri</i>							+				
<i>Physochlisma praecox</i>							+				
<i>Phytolacca acinosa</i>			+	-			+				Roots used to adulterate Belladonna

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Pterorhiza karrooa</i>		-	+	-	-	-	+	-	-		
<i>Pinus wallichiana</i>		-	-	-	-			+	-	-	
<i>Plantago lanceolata</i>	-	-	-	-			+	-		-	
<i>P. major</i>	-	-	-	+	-		+		-		
<i>Platanus orientalis</i>	-	-	-	-			-	-		+	
<i>Plectranthus rugosus</i>			-	-	-		-	-		+	
<i>Plumbago zeylanica</i>	-				-		+	-			
<i>Podophyllum hexandrum</i>		-	-		-		+		+		
<i>Polygonatum multiflorum</i>			-	-			+		-		
<i>P. verticillatum</i>		-		-			+				
<i>Polygonum affine</i>		-	-				+				
<i>P. alpinum</i>	-			-			+	-	+		
<i>P. amplexicaule</i>		-	-	-	-		+				Substitute for tea
<i>P. aviculare</i>				-	-		+	-	-		
<i>P. convolvulus</i>		-		-				-	-	+	Misc. (Used in making bread)
<i>P. hydropter</i>	-	-					+				
<i>P. paronychioides</i>	-	-	-	-	-	-	-	-	+		
<i>P. plebejum</i>	-	-	-	-	-	-	+	-	-	-	

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Polygonum rumicifolium</i>									+		
<i>P. sibiricum</i>									+		
<i>Pongamia pinnata</i>							+				
<i>Populus ciliata</i>					+						
<i>P. nigra</i>											Match boxes and fruitcases
<i>Portulaca oleracea</i>									+		
<i>Potamogeton crispus</i>									+		
<i>Potamogeton indicus</i>									+		
<i>Potentilla anserina</i>							+				
<i>P. argyrophylla</i>											Oil
<i>P. sericea</i>							+				
<i>P. supina</i>							+				
<i>Prangos pabularia</i>					+		+				
<i>Prinsepia utilis</i>							+				Oil
<i>Psychrogeton andryalioides</i>					+						
<i>Pteris cretica</i>							+		+		
<i>Punica granatum</i>		-	-				+				
<i>Pyrus fallotosa</i>		-	-						+		

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Pyrus pashia</i>									+		
<i>Quercus ilex</i>									+		
<i>Ramanunculus laetus</i>							+				
<i>R. muricatus</i>							+				
<i>R. pulchellus</i>							-				
<i>R. trichophyllus</i>							r				
<i>Rhamnus prostrata</i>							r				
<i>Rheum emodi</i>							+		+		
<i>Rhodiola imbricata</i>				+			+				
<i>Rhododendron campanulatum</i>							+				
<i>Ribes rubrum</i>									+		
<i>Ricinus communis</i>							+				
<i>Rubia pseudoacacia</i>					+		+		+		
<i>Rorippa usquaticum</i>									+		
<i>Rosa macrophylla</i>							+		+		
<i>R. webbiana</i>					+		+		+		
<i>Rubia cordifolia</i>							+		+		
<i>R. fruticosus</i>	-	-	-	-					+		
<i>R. niveus</i>	-	-	-	-	-	-	-		+	-	

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Rubus saxatilis</i>									+		
<i>R. ulmifolius</i>									!		
<i>Rumex hastatus</i>					-		+		+		
<i>R. nepalensis</i>					-		+		+		
<i>R. orientalis</i>			-				+				
<i>Saccharum spontaneum</i>							+				
<i>Salix alba</i>											Sports items
<i>S. babylonica</i>					-						Sports items
<i>Salvia hlars</i>							+				
<i>Sambucus wightiana</i>		-			-		+				
<i>Surcococca pruniformis</i>											Making baskets
<i>Saussurea albescens</i>									!		
<i>S. cosnes</i>							+				
<i>S. obvallata</i>											Sacred
<i>S. sacra</i>							+				
<i>Scirpus articulatus</i>	-		-				+				
<i>Sedum ewersii</i>				-					!		
<i>S. rhodiola</i>		-	-						+		
<i>S. tibeticum</i>		-	-						+		

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Setivum tenuifolium</i>							+				
<i>S. vaginatum</i>							+				
<i>Senecio chrysanthemoides</i>							+				
<i>S. jacquemontianus</i>				-			+				
<i>Sesbania sesban</i>							+				
<i>Situnmia laureola</i>											Ess. oil
<i>Solanum erianthum</i>							+				
<i>S. surattense</i>							+				
<i>Sonchus oleraceus</i>							+				
<i>Stachys floccosa</i>							+				
<i>Swerita chtraylta</i>							+				
<i>Tamarix indica</i>					+						
<i>Toraxacum officinale</i>					-		+				
<i>Terminalia arjuna</i>							+				
<i>T. balfirica</i>							+				
<i>T. chebala</i>							+				
<i>Thalictrum foliolosum</i>					-		+				
<i>T. minus</i>					-		+				
<i>T. platycarpum</i>			-	+	-			-			

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Thlaspi kotschyianum</i>		-		-	-		+				
<i>Thymus serpyllum</i>				-	-		+				
<i>Tinospora cordifolia</i>		-	-	-			+				
<i>Tragopogon pratense</i>					-		+				
<i>Tropa natans</i>		-			-				1		
<i>Tribulus terrestris</i>				-	-		+				
<i>Trichodezma indicum</i>				-	-		+				
<i>Trichosanthes palmata</i>							+				
<i>Tridax procumbens</i>				-	-		+				Dog bite
<i>Triglochin maritimum</i>			-						+		
<i>T. palustre</i>		-		-			+				
<i>Trigonella foenum-graecum</i>				-		-	+	+	+		
<i>Tulipa stellata</i>				-	-	-	+				
<i>Tylophora indica</i>			-	-	-	-	+				
<i>Typha angustata</i>				-			-		+		
<i>Ulmus laevigata</i>		-	-	+	-		-				
<i>U. waltichiana</i>		+		-	-	-	+		+		
<i>Urena lobata</i>	-	-	-	-	-	-	+	-			
<i>Urginea indica</i>	-	+	-	-	-		+				
<i>Urtica dioica</i>		-	-	-			+		+		

Name of the species	1	2	3	4	5	6	7	8	9	10	11
<i>Urtica hyperborea</i>					-				+		
<i>Valeriana hardwickii</i>							+				
<i>V. jatamansi</i>							+				
<i>V. officinalis</i>							+				
<i>Verbascum thapsus</i>							+				
<i>Vernonia crinita</i>							+				
<i>Vernonia cineraria</i>							+				
<i>Viburnum foetens</i>				+					+		
<i>V. nervosum</i>							+				
<i>V. stellulatum</i>							+		+		
<i>Viola odorata</i>							+				
<i>Viscum album</i>							+				
<i>Vitex negundo</i>							+				
<i>Waltheimia tomentosa</i>							+				
<i>Withania somnifera</i>							+				
<i>Woodfordia fruticosa</i>							+				
<i>Zanthoxylum armatum</i>							+				
<i>Ziziphus jujuba</i>											Sharbat
<i>Z. mauritiana</i>									+		
<i>Z. vulgaris</i>									+		

CONSERVATION STRATEGIES

The rich floristic diversity met in Jammu and Kashmir notwithstanding, a number of species in the state are getting depleted and their populations considerably depauperised either because of over exploitation or loss of habitat. The economically important species, including the ornamental ones in particular are facing the brunt of widespread biotic activities in the state. Certain plants, like *Aconitum* spp., *Podophyllum hexandrum*, *Colchicum luteum*, *Atropa acuminata*, *Saussurea costus*, etc. have now come under different kinds of threat due to over exploitation. Dhar and Kachroo (1983a) reported about 40 endemic species of Kashmir Himalaya, such as *Aconitum kashmiricum*, *Acquilegia nivalis*, *Trollius acaulis*, *Meconopsis aculeata*, *Corydalis cashmeriana*, *Megacarpaea bifida*, *Saxifraga jaquemontiana*, *Cremanthodium arnicoides*, *Saussurea sacra*, *Primula minutissima*, *Gentiana cachemirica*, etc., as endangered, majority of which are highly exploited for their medicinal or ornamental virtues. Similarly Hajra (1983) listed a number of endemic and threatened taxa from the state, viz. *Berberis kashmiriana*, *Papaver himalaicum*, *Draba dasyastra*, *Erophila tenerrima*, *Viola himalayensis*, *Dianthus minimus*, *Impatiens meeboldi*, *I. pahalgamensis*, *Rhannella gilgitica*, *Amphicarpaea anomalus*, *Astragalus anomalus*, *A. bakeri*, *Alysicarpus meeboldii*, *Indigofera cedrorum*, *Thermopsis inflata*, *Vicia benthamiana*, *Alchimella cashmiriana*, *Cotoneaster cashmirensis*, *Potentilla kashmirica*, *Saussurea bracteata*, *S. clarkei*, *Androsace aizoon*, *A. moorcroftiana*, *Primula clarkei*, *Gastrodia orobanchoides*, *Neottia kashmiriana*, *Allium loratum*, *Calamogrostris stoliczkai*, *Lophocloa clarkeana*, etc. The recent surveys by the scientists of Botanical Survey of India have further identified the species like *Kengia mutica*, *Milula spicata* and *Taverniera numularia* as rare in Jammu and Kashmir. Once commonly occurring plants, like *Dioscorea deltoidea* and *Ulmus wallichiana* are now vulnerable. Some of the plants like *Berberis huegeliana*, *Festuca levingei*, *Euphrasia secundiflora*, *Rostraria clarkeana*, *Schizachyrium impressum*, *Veronica uncinata*, *Lactuca benthamii*, *L. undulata*, etc. are known through their types only. Even species like *Pedicularis brevirostris*, *P. stewartii*, etc. have not been collected for over six decades now since their last collection from wild.

Proper identification and documentation of species belonging to different categories of threat, is therefore, imperative for evolving any effective conservation strategy. A determined effort is required to complete the

explorations in the state and inventorise the flora including the threatened taxa. The surveys should be especially intensified for locating the species which could not be collected since long, both in their known places of occurrence as well as in other locations with more or less similar eco-climatic conditions. The rediscovery of *Allium auriculatum*, *Carex borii*, *C. pamirensis*, *Delphinium uncinatum*, *Cotoneaster lambertii*, etc. after a long interval, either from their known localities or other areas clearly underlines the necessity of such exploratory surveys. The Botanical Survey of India, through critical evaluation of various taxa, reported to be threatened, has already compiled Red Data Sheets on 24 taxa (Nayer and Sastry, 1987, 1988, 1990), from Jammu and Kashmir (Table VII). The effort needs to be further intensified.

Table VII
Taxa included in Red Data Book of Indian plants

Name of the taxa	Status	Distribution	Remarks
ALLIACEAE			
<i>Allium stracheyi</i>	V	Kashmir, H.P., Garhwal, Kumaon and Nepal	Endemic to Himalaya
ASTERACEAE			
<i>Chondrilla setulosa</i>	R	J and K	Endemic
<i>Inula racemosa</i>	V	J. and K.	Endemic
<i>Lactuca undulata</i>	E	Kashmir	Endemic
<i>Saussurea bracteata</i>	R	J. and K., H.P., Garhwal, Kumaon, Pakistan, C. Asia	
<i>S. clarkei</i>	R	Kashmir	Endemic
<i>S. costus</i>	E	J. and K., H.P., Pakistan	
BERBERIDACEAE			
<i>Berberis huegeliana</i>	I	Kashmir	Endemic
<i>B. kashmiriana</i>	R	J. and K. (Mantar valley)	Endemic

Name of the taxa	Status	Distribution	Remarks
CARYOPHYLLACEAE			
<i>Silene kunawarensis</i>	R	Kashmir, H.P., Pakistan	
DIOSCOREACEE			
<i>Dioscorea deltoidea</i>	V	Himalaya, Pakistan, Afghanistan, Indo- China, W. China	
FABACEAE			
<i>Hedysarum astragaloides</i>	R	Kishtwar, Chenab valley, J.andK., Lahul, H.P., Pakistan (?)	
<i>H. cashemirianum</i>	R	Kashmir, Pakistan (?)	
<i>H. microcalyx</i>	V	Chenab valley, J and K, Lahul, Simla, Kulu, H.P., Garhwal, Pakistan(?)	
LILIACEAE			
<i>Eremurus himalaicus</i>	R	J.andK., H.P.	Endemic
<i>Lloydia himalayensis</i>	R	J.andK., H.P., Sikkim, Bhutan, Nepal	
ORCHIDACEAE			
<i>Cypripedium cordigerum</i>	R	J and K, H.P., Garhwal, Nepal, Bhutan, Pakistan	
<i>Neottia inayatii</i>	R	Kashmir, Pakistan	
PAPAVARACEAE			
<i>Meconopsis latifolia</i>	V	Kashmir	

Name of the taxa	Status	Distribution	Remarks
POACEAE			
<i>Puccinellea kashmiriana</i>	R	Kamiri Valley, J and K, Lahul, H.P.	
RANUNCULACEAE			
<i>Aconitum deindrhizum</i>	V	J and K, H.P., Nepal, Bhutan	Endemic to Himalays
<i>Delphinium uncinatum</i>	V	Kashmir, H.P. Pakistan, Presently known Afghanistan only from Kishtwar in Jammu region and Chamba in H.P.	
RUBIACEAE			
<i>Rubia himalayensis</i>	V	Kashmir, Pakistan, Afghanistan	
SCROPHULARACEAE			
<i>Picrorhiza kurrooa</i>	V	J and K, Sikkim	

E = Endangered; I = Indeterminate; R = Rare; V = Vulnerable

It may be recalled that conservation of plants was well in the minds of people of the state. Maharaja of Kashmir is said to have not only passed an ordinance to check the export of KUTH (*Saussurea costus*) to save it from extinction but also facilitated its large scale introduction in adjoining Himachal Pradesh as a measure of safety against war and aggression (Sarin, *pers. comm.*).

A large number of species, including those belonging to different Red Data category, are already getting *in situ* protection in the 4 National Parks and 15 Wildlife Sanctuaries in Jammu and Kashmir (Table VIII) covering a total area of about 14,057.74 sq km (Mudgal and Hajra, 1995) or about 6% of the total geographical area of the state. This should be further complemented by creating *ex situ* conservation facilities in three

different physiographic regions of the state and augmenting the existing ones. Special attention may be given to the protection of unique ecosystems of cold desert of Ladkahn and the floral diversity it contain. As the region is known for having a large number of endemic and other species characteristic of this area alone in Indian flora, setting up of a Biosphere reserve may be considered for effective long term conservation and perpetuation of its biological resources.

Table VIII
Protected Areas

Name of N.P./WS	Area (sq km)
City Forest NP	9.07
Dachigam NP	141.00
Hemis NP	3350.00
Kistwar NP	400.00
Baltal-Thajwas WS	203.00
Changthang WS	4000.00
Gulmarg WS	180.00
Hirapora WS	110.00
Hokersar WS	10.00
Jasrota WS	4.00
Karakoram WS	5000.00
Lachipora WS	80.00
Limber WS	26.00
Nandini WS	33.34
Overa WS	32.00
Overa-Aru WS	425.00
Ramnagar Rakha WS	12.20
Surinsar Mansar WS	39.13
Trikuta WS	3.00
Total Area	14057.74

NP = National Park; WS = Wildlife Sanctuary

Apart from that, the National Committee on Wetlands, Mangrooves and Coral Reefs, under the National Wetlands Programme of the Ministry of Environment and Forest has already identified the Wular lake of the state for formulation and implementation of the management action plans for intensive conservation and management. The lake, covering an area of about 18,900 ha, represents one of the six "Ramsar Sites" under Ramsar Convention. As the proper assessment, documentation and the conservation of biota of wetlands in the state is a major gap, other major lakes in different regions of Jammu and Kashmir, like Mansar, Dal, Anchar, Hokarsar, Pangong, Tso Morari, etc., could also be brought under the purview of the above programme.

Expansion of Protected Area Network (PAN) in the state and augmentation of monitoring mechanism and management; banning of commercial trade of economic plants of wild origin and domestication of highly exploited NTFP or MFP component of plant diversity to ward off stress on their natural populations in the state; and appropriate incentive for local biodiversity conservation efforts, like joint management practices and benefit sharing are some of the strategies for ensuring sustainable utilisation of plant resources of Jammu and Kashmir and its conservation for posterity.

REFERENCES

- Ahmedullah, M. and M.P. Nayar 1987. *Endemic plants of Indian region*. Calcutta.
- Arora, R.K. 1994. The Indian gene centre : Diversity in crop plants and their wild relatives. In: Rana, R.S., R.K. Saxena, R.K. Tyagi, S. Saxena and V. Mitter (eds.) *Ex-situ Conservation of Plant Genetic Resources*. New Delhi. 29-37.
- Bamber, C.J. 1916. *Plants of the Punjab. A descriptive key to the flora of the Punjab, North West Frontier province and Kashmir*. Lahore.
- Blatter, E. 1927-29. *Beautiful flowers of Kashmir*. Series I-III. London.
- Champion, H.G. and A.K. Seth 1968. *A revised survey of the forest types of India*. Delhi.
- Chatterjee, D. 1939. Studies on the endemic flora of India and Burma. *J. Asiat. Soc. Bengal*. 5: 19-97.
- Coventry, B.O. 1923-1930. *Wild flowers of Kashmir*. Series I-III. London.
- Dhar, U. and P. Kachroo 1983. *Alpine Flora of Kashmir Himalaya*. Jodhpur.
- Dhar, U. and P. Kachroo 1983a. Some remarkable features of endemism in Kashmir Himalayas. In: Jain, S.K. and A.R.K. Sastry (eds.) *An Assessment of Threatened Plants of India*. Howrah. 18-22.
- Duthie, J.F. 1893-94. Report on a botanical tour to Kashmir. *Rec. Bot. Surv. India* 1(1): 1-18; 25-47.
- Grierson, A.J.C. 1964. A revision of the Asters of the Himalayan Area. *Notes Roy. Bot. Gard. Edinb.* 26: 67-163.
- Hajra, P.K. 1983. Western Himalayas. In: Jain, S.K. and A.R.K. Sastry (eds.) *Materials for a catalogue of Threatened Plants of India*. Howrah. 49-61.
- Kachroo, P., B.L. Saproo and U. Dhar 1977. *Flora of Ladakh*. Dehra Dun.

- Kachroo, P. 1992. *Central Asia and Kashmir. Archeobotany and Floristics*. Jodhpur.
- Kachroo, P. 1993. Plant diversity in Northwest Himalaya - a preliminary survey. In : U. Dhar (ed.) *Himalayan Biodiversity : Conservation strategies*. Nainital. 111-132.
- Kashyap, S.R. 1934. Dominant flower colour in the alpine Himalaya and Tibet. *Proc. Ind. Sci. Cong. (Abst.)* 324: 325.
- Kapoor, S.K. and Y.K. Sarin 1990. *Flora of Trikuta Hills*. Dehra Dun.
- Kaul, M.K. 1986. *Weed flora of Kashmir Valley*. Jodhpur.
- Kazmi, S.M.A. 1970-71. A revision of the Boraginaceae of west Pakistan and Kashmir. *J. Arnold Arbor.* 51: 133-184; 52: 110-136; 666-690.
- Khoshoo, T.N. 1993. Himalayan Biodiversity Conservation - An overview. In: U. Dhar (ed.) *Himalayan Biodiversity Conservation Strategies*. Nainital. 5-35.
- Lambert, W.J. 1933. List of trees and shrubs from Kashmir and Jammu forest circles, Jammu and Kashmir state. *Forest Bull.* no. 80. ser. Calcutta.
- Meebold, A. 1909. Eine botanische Reise durch Kaschmir. *Bot. Jahrb.* 43(Beibl.) : 63-90.
- Meher-Homji, V.M. 1971a. The climate of Srinagar and its variability. *Geogr. Res. India* 33(1): 1-14.
- Mudgal, V. and P.K. Hajra 1995. *Bharat ki Vanaspati Vividhita*. Dehra Dun.
- Mukherjee, S.K. 1940. A revision of Labiatae of Indian empire. *Rec. bot. Surv. India* 14: 1-128.
- Nayar, M.P. 1996. *Hot spots of endemic plants of India, Nepal and Bhutan*. Thiruvananthapuram.
- Nayar, M.P. and A.R.K. Sastry 1987-1990. *Red Data Book of Indian Plants*. I-III Calcutta.

- Pennell, F.W. 1943. The Scrophulariaceae of western Himalaya. *Acad. Nat. Sci. Phil. Mongr.* 5: 1-163.
- Rao, T.A. 1960. Further contribution to the flora of Jammu and Kashmir. *Bull. Bot. Surv. India* 2: 387-423.
- Rau, M.A. 1974. Vegetation and phytogeography of the Himalaya. In : M.S. Mani (ed.) *Ecology and biogeography in India*. Hague. 247-280.
- Rau, M.A. 1975. *High altitude flowering plants of West Himalaya*. Howrah.
- Raven, P.H. 1962. The genus *Epilobium* in the Himalayan region. *Bull. Brit. Mus. (Nat. Hist.)* 2: 323-382.
- Rogers, W.A. 1985. Biogeography and Protected Area Planning in India. In : J. Thorsal (ed.), *Conserving Asia's Natural Heritage*. IUCN, Glad.
- Royle, J.F. 1839. *Illustrations of the Botany and other branches of the Natural History of the Himalayan mountains and of the flora of Cashmere*. London.
- Sharma, B.M. and P. Kachroo 1981. *Flora of Jammu*. Dehra Dun.
- Sharma, B.M. and P. Kachroo 1992. *Forest Flora of Pir Panjal Range*. Dehra Dun.
- Sharma, B.M. and P.S. Jamwal 1988. *Flora of Upper Liddar valleys of Kashmir Himalaya*. Jodhpur.
- Singh, D.K. 1995. Distribution of family Notothylaceae in India and its phytogeographical significance. *Adv. Pl. Sci. Res.* 2: 28-43.
- Singh, D.K. and P.K. Hajra 1996. Floristic Diversity. In : Gujral, G.S. and V. Sharma (eds.) *Changing perspectives of Biodiversity status in the Himalaya*. New Delhi : 23-38.
- Singh, G. 1970. Botany along Senmarg to Trunkhal. *Kashmir Science* 7 (1-2): 82-88.
- Singh, G. and P. Kachroo 1976. *Forest Flora of Srinagar*. Dehra Dun.

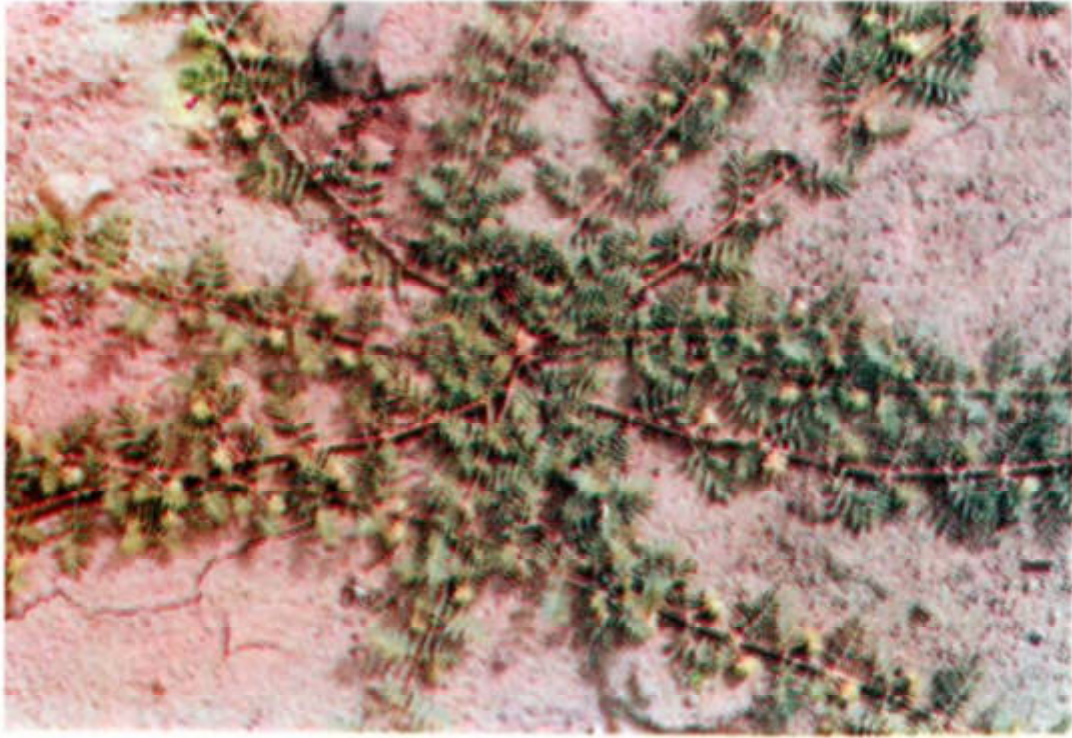
- Singh, J.B. and P. Kachroo 1983. Vegetation analysis of some special habitat in Pir Panjal Forest Range (Kashmir, India) *J. Econ. Tax. Bot.* 42(3): 659-666.
- Singh, J.B. and P. Kachroo 1983a. Plant Community characteristics in Pir Panjal Forest Range *J. Econ. Tax. Bot.* 4(3): 911-937.
- Singh, J.B. and P. Kachroo 1994. *Forest Flora of Pir Panjal Range*. Dehra Dun.
- van Soest, J.L. 1961. New species of *Taraxacum* from the Himalayan region. *Bull. Brit. Mus. (Nat. Hist.) Bot.* 2(10): 261-273.
- van Soest, J.L. 1963. *Taraxacum* species from India, Pakistan and neighbouring countries. *Wentia* 10: 1-91.
- Steere, W.C. and H. Inoue 1972. Distribution patterns and speciation of bryophytes in the circum pacific regions : Introduction. *J. Hattori Bot. Lab.* 35: 1-2.
- Stewart, R.R. 1967. The Cyperaceae of Kashmir - A Check-List. *Bull. Bot. Surv. India* 9: 152-162.
- Stewart, R.R. 1972. *Flora of West Pakistan. An annotated catalogue of the vascular plants of west Pakistan and Kashmir*. Karachi.
- Troll, C. 1967. Die Klimatische und vegetations-geographische Gliederung des Himalaya-systems. *Khumbu Himal. Bol.* 1: 355-448.
- Virjee, U. Dhar and P. Kachroo 1989. Cytogeography of some endemic taxa of Kashmir Himalaya. *Proc. Indian Nat. Sci. Acad. B* 55: 177-184.



A view of typical marshy habitat in cold desert, Nubra Valley, Ladakh
(Courtesy : Dev Raj Agarwal)



A view of temperate, herbaceous vegetation comprising species
of *Ranunculus*, *Anemone*, *Polygonum*, etc.
(Courtesy : Dev Raj Agarwal)



Tribulus terrestris
(Courtesy : Dev Raj Agarwal)



Verbascum thapsus
(Courtesy : Dev Raj Agarwal)



Bergenia stracheyi and *Fritillaria royolei* : temperate elements
(Courtesy : Dev Raj Agarwal)



Rhododendron anthopogon
(Courtesy : Dev Raj Agarwal)



Capparis spinosa
(Courtesy : Dev Raj Agarwal)



Arceuthobium minutissimum : parasitic on *Pinus gerardiana*
(Courtesy : Dev Raj Agarwal)



Gentiana algida : a cold desert element from Ladakh
(Courtesy : Dev Raj Agarwal)



Saxifraga lychnitis : a rare, cold desert element from Ladakh
(Courtesy : Dev Raj Agarwal)



Saussurea gnaphalodes : a cold desert element from Ladakh
(Courtesy : Dev Raj Agarwal)



Physochlaina praealta : a cold desert element from Ladakh
(Courtesy : Dev Raj Agarwal)



Stachys tibetica : a cold desert element from Ladakh
(Courtesy : Dev Raj Agarwal)



Dracocephalum heterophyllum : a cold desert element from Ladakh
(Courtesy : Dev Raj Agarwal)



Oxytropis microphylla : a cold desert element from Ladakh
(Courtesy : Dev Raj Agarwal)



Urtica hyperborea

KARNATAKA

N.P. Singh
P.V. Prasanna
B.G. Kulkarni

The state of Karnataka is situated on the lower west-coast and on the Western edge of Deccan Plateau with an area of 1,92,204 sq km. Etymologically the name 'Karnataka' derives its origin as 'Karu nadu' which implies lofty land. The state lies between 11° 40' and 18° 27' North latitude and 74° 5' and 78° 33' east longitude which forms the centre of Western peninsular India. The North-South distance is about 750 km and East West width is about 400 km. The Karnataka state was formed on 1st November, 1956. The neighbouring states are Maharashtra on the North, Andhra Pradesh on the east and Tamil nadu and Kerala on the South. The State has got nearly 320 km of coast line and the coastal belt is interspersed with many coconut palm and Arecanut orchards. Just next to the coastal land lie the western ghats.

There are 19 districts in the state. The Karnataka state can be divided into two different regions viz., **Malnad** and **Maidan**. The **Malnad** is hilly region comprising mostly the districts like Belgaum, Chikmagalur, Dakshina Kannada, Hassan, Kodagu, Shimoga and Uttara Kannada. Part of Dharwad district also comes under this. The elevation varies from coast i.e. sea level to 2105 m (Mulaingiri in Chikmagalur district). Remaining districts make up the **Maidan** or the plain area which is mainly an inland plateau of varying heights.

A few notable peaks in the state are Mulaingiri in the Bababudan range (2150 m), Bababudangiri (2071 m), Kalhattigiri (2052 m) and Kudremukh (1827 m) all in Chikmagalur district and Tadiandamol (1744 m), Pushpagiri (1713 m) and Brahmagiri (1608 m), all in Kodagu District.

Rivers originating in the Western ghats flow westwards to Arabian sea like Kalinadi, Gangavali, Agnashani, Sharavathi, Gurupur and Netravathi and the rivers which flow towards east are Ghataprabha, Malaprabha (tributaries to the Krishna), Tungabhadra, Hemavathi and Kavery which join the Bay of Bengal through the states of Andhra and Tamilnadu.

There are four main kinds of rock types found in the state *viz.*, Dharwar schists and granite gneisses, Sedimentary rocks, Deccan trap and Laterite alluvial deposits. There are 8 different types of soils, *viz.*, Coastal alluvium, Lateritic soils, Dark brown clay, Red soils, Red loams, Red and black soils, Deep black soils and Trap soils.

The Karnataka state has tropical monsoon climate. The year can be divided into three seasons *viz.* cold season (from December to February), summer season (March-May) and rainy or monsoon season (June to September). The north-east, post or retreating monsoon period is from October to November. The total annual rainfall in the state ranges from 45-95 cm in the **maidan** region which roughly constitutes the eastern half to as high as 150 - 750 cm in heavy rainfall zone of **Malnad** extending from Uttara Kannada to Kodagu. Agumbe in Shimoga district is the wettest place in the state with an annual rainfall of 827 cm. The mean daily maximum temperature in April (34.5°C) starts decreasing in monsoon months upto July-August (27.2°C). Then there is slight rise in temperature during September-October (28.3°C), which again decreases in December (26.7°C).

The temperature in the northern interior Karnataka have a greater amplitude than the coast e.g. Bidar (45.6°C), Bellary (39°C) and Chitradurga (39°C) etc. There is appreciable drop in the temperature on the ghats at Madikere (1152 m), where maximum daily temperature is 28.6°C.

VEGETATION

The vegetation of Karnataka is of diverse type due to topography, soils and bio-climate ranging from tropical wet evergreen to thorny scrub jungles. Out of 1,92,204 sq km of total area, the forest cover is about 38,724 sq km (about 18% of the total area). The wet evergreen forest are seen at an altitude ranging from 600-1000 m on the wind ward side of the western ghats. The moist deciduous, dry deciduous and scrub jungles are seen from the leeward side and at the lower slopes to the intermediate areas to the east of western ghats and further north-east areas of the state.

Tropical wet evergreen forest

This kind is met with in the districts of Chikmagalur, Dakshina Kannada, Hassan, Kodagu, Shimoga and Uttara Kannada, in the valleys

and lower slopes of Western ghats. The rainfall ranges from 250-600 cm. The main components are *Artocarpus hirsutus*, *Calophyllum elatum*, *Canarium strictum*, *Dipterocarpus indicus*, *Holigarna grahamii*, *Hopea wightiana*, *Kingiodendron pinnatum*, *Palaquium ellipticum* and *Poeciloneuron indicum*, etc. The ground flora is meagre because of insufficient sunlight. The under growth is chiefly composed of *Aglaiia anamallayana*, *Chasalia ophioxooides*, *Euonymus indicus*, *Gomphandra tetrandra*, *Helicia nilagirica*, *Humboldtia brunonis* and *Psychotria nigra*, etc. In this forest type the common woody climbers are *Artabotrys zeylanicus*, *Beaumontia jerdoniana*, *Chonemorpha fragrans*, *Desmos lawii*, *Grewia umbellifera*, *Gnetum ula*, *Hugonia belli*, *Phanera phoenicea*, *Thunbergia mysorensis* and species of *Connarus*, *Tetrastigma* and *Uvaria*, etc. The trunks of trees here are covered with mosses, *Impatiens* spp., *Peperomia* spp., *Utricularia* spp., and ferns like *Microsorium punctatum*, etc.

Moist deciduous forest

These are situated in the intermediate rainfall region having 75-150 cm in the western part of Dakshina Kannada and Uttara Kannada districts and eastern parts of Belgaum, Chikmagalur, Hassan, Kodagu, Mandya, Mysore and Shimoga districts. These forest are characterized by brief leaf fall and non stratified canopy. The dominant trees seen are *Bombax ceiba*, *Dalbergia latifolia*, *Dillenia pentagyna*, *Grewia tiliaefolia*, *Haldina cordifolia*, *Kydia calycina*, *Lagerstroemia microcarpa*, *Olea dioica*, *Pterocarpus marsupium*, *Schleichera oleosa*, *Tectona grandis*, *Terminalia bellirica*, *T. crenulata*, *T. paniculata* and *Xylia xylocarpa*, etc.

Climbers like *Adenia hondala*, *Aspidopterys canarensis*, *Erythropalum populifolium*, *Erycibe paniculata*, *Luvunga sarmentosa*, *Moullava spicata* and species of *Connarus*, *Derris*, *Diploclisia*, *Gouania* and *Schefflera* are also seen.

Dry deciduous forest

This type of forest are seen towards the east of moist-deciduous forest occupying major remaining areas of the state like Bellary, Bidar, Bijapur, Chitradurga, Gulbarga, Kolar, Raichur, Tumkur and eastern section of Chikmagalur and Dharwad. The dry deciduous forest are found in small blocks almost throughout the above districts. The rainfall in these

areas ranges from 35-75 cm. The canopy of the forest is open. The trees are leafless during the dry months.

The common trees are *Acacia chundra*, *Anogeissus latifolia*, *Buchanania lanzan*, *Boswellia serrata*, *Cochlospermum religiosum*, *Gmelina arborea*, *Hardwickia binata*, *Lannea coromandelica*, *Shorea roxburghii*, *Sterculia urens* and *Tectona grandis*, etc. A few climbers like *Celastrus paniculatus*, *Combretum ovalifolium*, *Cryptolepis buchmanii*, *Sarcostigma acidum* and *Ventilago denticulata*, etc. are present.

Scrub forest

These are very open and are composed of widely scattered trees generally varying from 5-7 m and have thorny and hard wood predominant species of which *Acacia* spp. are very characteristic. Trees are short boled, stunted and branched low. The forest are mixed of few species and do not form marked plant communities. Shrubs and climbers are more in number. The main components are *Acacia chundra*, *A. latronum*, *A. leucophloea*, *A. nilotica* ssp. *indica*, *Albizia amara*, *Chloroxylon swietenia*, *Dichrostachys cinerea*, *Diospyros melanoxylon*, *Euphorbia nivulia*, *Givotia rottleriformis*, *Prosopis cineraria*, *Soymida febrifuga*, *Zizyphus oenoplia* and *Z. xylopyrus*, etc. and climbers like *Cardiospermum halicacabum*, *Coccinia grandis*, *Cocculus hirsutus*, *Corallocarpus epigaeus*, *Hemidesmus indicus*, *Leptadenia reticulata*, *Rivea hypocrateriformis* and *Wattakaka volubilis*, etc. are generally seen.

Dry grass land

This is the last stage of degradation in barren, shallow lands. The trees, if any are distant and are visible here and there, otherwise vast stretches of grasses mixed with a few thorny or prickly herbs and rarely shrubs can be seen. Scanty rainfall, high temperature and dry, shallow soils allow the development of poor grasslands. No proper grasslands or pasture lands are demarcated as such. The common components are *Apluda mutica*, *Chrysopogon fulvus*, *Cymbopogon caesius*, *C. coloratus*, *C. martinii*, *Dichanthium pertusum*, *Heteropogon contortus*, *Lophopogon tridentatus* and *Themeda triandra*, etc.

Meadows

The vegetation in upper reaches of the Western ghats at this altitude (over 1400 m) consists of grassy mountain meadows interspersed with compact patches of forest known locally as 'Sholas'. The grassy mountain meadows present a quick succession of herbs that appear in short-leaved profusion. The main components met with are grasses like *Arundinella nepalensis*, *Chrysopogon asper*, *Isachne lisboae*, *Polypogon monspeliensis*, and other plants like *Chlorophytum malabaricum*, *Habenaria* spp., *Satyrium nepalense*, *Gentiana quadrifaria*, *Swertia corymbosa*, *Exacum bicolor*, *Drosera peltata*, *Hypericum mysurense* (on slopes), *Parnassia mysorensis*, *Viola betonicifolia* and *Teucrium tomentosum*, etc. and ferns like *Botrychium lanuginosum* and *Cripsinus montanus*, etc.

The Sholas

The shola vegetation includes both tropical and subtemperate genera mixed together may be considered as climax type. These are isolated, compact, comprising mostly stunted, evergreen trees. They are seen characteristically along elevations of 1500 m and above. Sholas in Karnataka occur in Kudremukh, Gangamula, Kemmangudi (Chikmagalur Dt.), Brahmagiri (Madikeri), Pushpagiri, Tadiandamol and Talacauvery (Kodagu Dt.). A few representative elements are *Acronychia pedunculata*, *Atalantia wightii*, *Euonymus angulatus*, *Eurya nitida*, *Gordonia obtusa*, *Michelia nilagirica* and *Pittosporum neelgherrense*, etc.

The sholas are the relict evergreen type of vegetation which might have covered wider areas in the past, are now confined to the sheltered folds of the mountains. This is because of the continuous adverse effect of climatic and edaphic factors which have influenced greatly the present status of Sholas. This is often termed as living fossil community.

Mangrove Vegetation

Karnataka has about 320 km of coast line. The mangrove vegetation occurs along the coast of Dakshina Kannada and Uttara Kannada. This vegetation occurs more where salinity is more and near estuaries like mouth of Kalinadi, Honavar and Kumpta in Uttara Kannada and Kundapur, Basrur, Malpe etc. in Dakshina Kannada. The plants occurring in this kind

of vegetation are *Acanthus ilicifolius*, *Aegiceras corniculatum*, *Avicennia marina*, *A. officinalis*, *Bruguiera gymnorhiza*, *Ceriops tagal*, *Kandelia candel*, *Rhizophora mucronata*, *Sonneratia apetala* and *S. caseolaris*, etc.

The sandy vegetation along the coast comprises of *Caesalpinia crista*, *Ipomoea pes-caprae*, *Scaevola frutescens*, and *Spinifex littoreus*, etc. The fern *Acrostichum aureum* occurs in the back water areas along with Cyperaceae members.

Areas for study and conservation

Of the total area in the state 75-80% have been thoroughly explored. Out of 19 districts in the state, a few areas in Mysore (Nugu Valley) and eastern part of Shimoga has not been thoroughly explored. Hence these areas should be explored to get the complete picture of the floristic richness of the area. Though a few ghat areas in the districts like Belgaum, Dakshina Kannada, Kodagu and Uttara Kannada have been floristically explored still the areas need further explorations to have complete knowledge about the flora of the area.

FLORISTIC DIVERSITY

In the Karnataka State approximately 3849 species under 1328 genera belonging to 199 families are reported. Out of these 2838 species and 94 infraspecific taxa are under 1025 genera and 161 families of dicots, while 1009 species and 60 infraspecific taxa are under 301 genera and 36 families of monocots. The gymnosperms of two families viz. Cycadaceae and Gnetaceae are represented by the genera *Cycas* and *Gnetum* with one species each respectively.

Under Pteridophytes, ferns in Karnataka are represented by 152 species belonging to 67 genera under 29 families besides, 21 species belonging to 5 genera under 5 families of fern allies (P.K. Rajagopal, 1996).

It can further be analysed that 47% of families are monogeneric and 31.61% genera are monotypic. The three large genera are *Cyperus* (42 spp.) *Eriocaulon* (37 spp.) and *Impatiens* (34 spp.).

The ten largest families in the state are as follows

Sl. No.	Family	Number of		
		Genera	Species	Infraspecific taxa
1.	Poaceae	119	386	26
2.	Fabaceae	66	274	14
3.	Asteraceae	80	177	05
4.	Orchidaceae	52	175	03
5.	Euphorbiaceae	50	169	03
6.	Acanthaceae	48	166	09
7.	Cyperaceae	22	157	15
8.	Rubiaceae	43	137	03
9.	Lamiaceae	23	96	—
10.	Convolvulaceae	16	75	02

The following table shows comparison of number of genera and species in Karnataka State and in India.

Sl. No.	Family	Number of Genera**/ Species in	
		Karnataka	India*
1.	Leguminosae (Fabaceae)	(103) 387	(167) 1141
2.	Poaceae	(119) 386	(264) 1291
3.	Asteraceae	(80) 177	(166) 803
4.	Orchidaceae	(52) 175	(184) 1229
5.	Euphorbiaceae	(50) 169	(84) 523
6.	Acanthaceae	(48) 166	(92) 500
7.	Cyperaceae	(22) 157	(38) 545
8.	Rubiaceae	(43) 137	(113) 616
9.	Lamiaceae	(23) 96	(72) 435
10.	Convolvulaceae	(16) 75	(28) 184

*Latest figures based on S. Karthikeyan, Personal communication.

**No. of genera is given in parenthesis.

The floristic analysis reveals that the following families are monogeneric Alangiaceae, Aponogetonaceae, Aquifoliaceae, Asparagaceae, Balanophoraceae, Balsaminaceae, Barringtoniaceae, Begoniaceae, Buddlejaceae, Cassythaceae, Cleomaceae, Cordiaceae, Crassulaceae, Cuscutaceae, Dilleniaceae, Dioscoreaceae, Droseraceae, Ebenaceae, Elaeagnaceae, Elaeocarpaceae, Erythroxylaceae, Haloragaceae, Heliotropaceae, Leeaceae, Lentibulariaceae, Lobeliaceae, Menyanthaceae, Najadaceae, Nymphaeaceae, Ochnaceae, Pittosporaceae, Plumbaginaceae, Portulacaceae, Potamogetonaceae, Primulaceae, Sabiaceae, Smilacaceae, Sonneratiaceae, Staphyleaceae, Symplocaceae and Xyridaceae - Total 43 families. 31.61%

PHYTOGEOGRAPHY

The most distinct feature is the development of the 'Tropical wet evergreen forest' prominent along the windward side of the Western ghats. The typical composition of these forest is the presence of abundant trees, shrubs, herbs, lianas, stragglers and epiphytes. Forest in this region are characterised by the multistoried structure with emergent species raising their crowns above the general canopy layer due to which it imparts undulating look to the canopy. The light coloured bark in a number of tree species is less than 3 mm thick. The boles of the trees are clear and slender, often buttressed at the base. Lichens, mosses, ferns, hemiparasites, orchids and other epiphytes find suitable niches on the trees and flourish in the microclimate of the trees.

The origin of the flora of the penninsular India especially that of Western ghats owes its complexity and diversity to pre-historic connection of land mass with Madagascar, Africa and South America (Thorne, 1978). The genera like *Pittosporum* (Pittosporaceae), *Apodytes*, *Gomphandra*, *Nothapodytes*, *Sarcostigma* and *Hydnocarpus* show the past connection of Peninsular India with separated parts like Africa and South America (Nayar, 1982). The occurrence of the genus *Poeciloneuron* in Western ghats has many allied genera in South America (Nayar, 1979), which further adds to the above statement.

The close resemblance of flora of Western ghats and East Africa is shown by presence of genera of Orchidaceae viz. *Acampe*, *Bulbophyllum*, *Eulophia*, *Habenaria*, *Nervilia*, *Oberonia* and *Satyrium*, etc. The species belonging to tribe Andropogoneae of Poaceae indicate phyto-geographical affinity of Indian Flora with Africa. The flora of Western ghats has

much affinity with that of Malesian region (Subramanyam and Nayar, 1974). Out of total woody dicots in Assam (110 families) and Western ghats (103 families) 98 are common to both the areas (Arora, 1964). All these amply testify that the floristic diversity of the Western ghats is of ancient lineage.

ENDEMIC PLANTS

Name of the species	Family
<i>Acanthopale jogensis</i>	Acanthaceae
<i>Amomum ghaticum</i>	Zingiberaceae
<i>A. masticatorium</i>	Zingiberaceae
<i>Amorphophallus mysorensis</i>	Araceae
<i>Ardisia parviflora</i>	Myrsinaceae
<i>Brachiaria eruciformis</i> var. <i>dtvaricata</i>	Poaceae
<i>B. hybrida</i>	Poaceae
<i>B. reptans</i> var. <i>hispida</i>	Poaceae
<i>B. semiundulata</i> var. <i>intermedia</i>	Poaceae
<i>B. semiundulata</i> var. <i>lanata</i>	Poaceae
<i>B. stapfiana</i>	Poaceae
<i>Brachystelma ciliatum</i>	Asclepiadaceae
<i>B. elenaduensis</i>	Asclepiacaceae
<i>B. kolarensis</i>	Asclepiadaceae
<i>B. volubile</i>	Asclepiadaceae
<i>Bulbophyllum mysorensis</i>	Orchidaceae
<i>Calamus nagbettai</i>	Arecaceae
<i>Christisonia flammea</i>	Orobanchaceae
<i>Chrysopogon pseudo-zeylanicus</i>	Poaceae
<i>Crotalaria sandoorensis</i>	Fabaceae
<i>Croton lawianus</i>	Euphorbiaceae
<i>Cryptocarya procera</i>	Lauraceae
<i>Cryptolepis elegans</i>	Periplocaceae
<i>C. grandiflora</i>	Periplocaceae

Name of the species	Family
<i>Cynoglossum ritchiei</i>	Boraginaceae
<i>Cyperus astroglumosa</i>	Cyperaceae
<i>C. plurinodosa</i>	Cyperaceae
<i>Dalechampia stenoloba</i>	Euphorbiaceae
<i>Dichanthium magdalenii</i>	Poaceae
<i>Dimeria ornithopoda</i> var. <i>megalantha</i>	Poaceae
<i>Diospyros saldanhae</i>	Ebenaceae
<i>Eragrostis santapaui</i>	Poaceae
<i>Eugenia macrosepala</i>	Myrtaceae
<i>Eulophia emiliana</i>	Orchidaceae
<i>Gastrochilus flabelliformis</i>	Orchidaceae
<i>Glyphochloa divergens</i> var. <i>divergens</i>	Poaceae
<i>G. divergens</i> var. <i>hirsuta</i>	Poaceae
<i>Hopea canarensis</i>	Dipterocarpaceae
<i>H. ponga</i> var. <i>cauveriana</i>	Dipterocarpaceae
<i>Hubbardia heptaneuron</i>	Poaceae
<i>Ilex tadiandamolense</i>	Aquifoliaceae
<i>Impatiens acaulis</i> var. <i>granulata</i>	Balsaminaceae
<i>I. agumbeana</i>	Balsaminaceae
<i>I. barberi</i>	Balsaminaceae
<i>I. talbotii</i>	Balsaminaceae
<i>Iphigenia mysorensis</i>	Liliaceae
<i>Isachne kunthiana</i> var. <i>elatior</i>	Poaceae
<i>I. meeboldii</i>	Poaceae
<i>I. mysorensis</i>	Poaceae
<i>I. veldkampii</i>	Poaceae
<i>Ischaemum ritchiei</i>	Poaceae
<i>Karnataka benthamii</i>	Apiaceae
<i>Lepturus radicans</i>	Poaceae
<i>Leuca angustissima</i>	Lamiaceae
<i>Litsea lakshammiana</i>	Lauraceae
<i>Luisia macrantha</i>	Orchidaceae
<i>Memecylon terminale</i>	Melastomataceae

Name of the species	Family
<i>Nervilia hispida</i>	Orchidaceae
<i>Nilgirianthus meeboldii</i>	Acanthaceae
<i>Oberonia josephii</i>	Orchidaceae
<i>O. rangannaiana</i>	Orchidaceae
<i>Ochlandra talbotii</i>	Poaceae
<i>Ophiorrhiza codyensis</i>	Rubiaceae
<i>Panicum garadei</i>	Poaceae
<i>Paracautleya bhatti</i>	Zingiberaceae
<i>Peperomia meeboldii</i>	Piperaceae
<i>Phalaenopsis mysorensis</i>	Orchidaceae
<i>Phyllanthus talbotii</i>	Euphorbiaceae
<i>Phyllocephalum mayurii</i>	Asteraceae
<i>Piper crenulatifolium</i>	Piperaceae
<i>Pittosporum karnatakense</i>	Pittosporaceae
<i>Psychotria canarensis</i>	Rubiaceae
<i>Salacia gambleana</i>	Hippocrateaceae
<i>Schizachyrium sudhanshui</i>	Poaceae
<i>Senecio mayurii</i>	Asteraceae
<i>Strobilanthes minor</i>	Acanthaceae
<i>Tarenna agumbensis</i>	Rubiaceae
<i>Terminalia gella</i>	Combretaceae
<i>Utricularia cecilia</i>	Lentibulariaceae
<i>U. sampathii</i>	Lentibulariaceae
<i>U. santapauii</i>	Lentibulariaceae
<i>Viscum mysorensis</i>	Viscaceae

Recently reported as new record for India *Cassia sericea* (Singh, 1981), earlier confined to Muddebihal, Bijapur district has now become naturalized as a weed and has already started occupying larger areas and is acting as a biological control of *Parthenium hysterophorus* as reported by Singh (1983) and also large scale experiments were carried out by Karnataka University, Dharwar among others and it has been proved as such.

ECONOMIC USES

The topography and the diverse climatic conditions of the state support a good number of plants which are useful for the mankind. The following categories reveal the various kinds of plant species for different purposes (Raghavan, 1969 and Singh, 1988).

Plants used in wood industries

Timber : *Calophyllum apetalum*, *C. elatum*, *Carallia brachiata*, *Chukrassia tabularis*, *Hopea parviflora*, *H. wightiana*, *Lagerstroemia microcarpa*, *Schleichera oleosa*, *Toona ciliata* and *Vateria indica*, etc.

Railway Sleepers : *Calophyllum elatum*, *Dipterocarpus indicus*, *Lagerstroemia microcarpa*, *Mesua ferrea*, *Palaquium ellipticum*, *Poeciloneuron indicum*, *Terminalia bellirica* and *T. paniculata*, etc.

Walking Sticks : *Calamus pseudo-tenuis*, *Diospyros ebenum*, *D. paniculata*, *Dimocarpus longan*, *Dysoxylum malabaricum*, *Poeciloneuron indicum* and *Schleichera oleosa*, etc.

Hard Board : *Canarium strictum*, *Dipterocarpus indicus*, *Dysoxylum malabaricum* and *Hopea* spp., etc.

Plywood Industry : *Mastixia arborea*, *Myristica dactyloides*, *Palaquium ellipticum* and *Vateria indica*, etc.

Match Industry : *Canarium strictum*, *Elaeocarpus tuberculatus*, *Homalium zeylanicum*, *Litsea wightiana*, *Mangifera indica*, *Persea macrantha* and *Trewia polycarpa*, etc.

Tea Chests : *Allianthus triphysa*, *Artocarpus gomezianus*, *A. heterophyllus*, *A. hirsutus* and *Myristica dactyloides*, etc.

Plants used in Cane Industry : *Calamus* spp. are used in making different kinds of cane furnitures.

Other minor uses of wood

Tennis and Badminton rackets : *Humboldtia brunonis*.

Pencil Industry : *Holigarna arnottiana*.

Bobbin manufacture : *Lophopetalum wightianum*.

Fodder Plants

Albizia chinensis, Alloteropsis cimicina, Arthraxon lancifolius, Axonopus compressus, Bothriochloa bladhii, Butea monosperma, Cassia tora, Centotheca lappacea, Cyrtococcum longipes, Desmodium triflorum, Echinochloa colona, Eragrostis gangetica, E. unioloides, Indigofera glandulosa, I. spicata, Paspalidium flavidum, Setaria pumila, Themeda tremula, T. triandra, Urochloa panicoides and Vigna radiata, etc.

Other less commonly used fodder plants are *Anogeissus latifolia, Capparis zeylanica, Grewia tiliaefolia, Kydia calycina, Mitragyna parvifolia* and *Ziziphus glaberrima*, etc.

Fibre yielding plants

The fibre yielding plant species are *Acacia leucophloea, Bombax ceiba, Calotropis gigantea, Gyrocarpus americanus, Hardwickia binata, Helicteres isora, Hibiscus cannabinus, Marsdenia tenacissima, Pergularia daemia* and *Wattakaka volubilis*, etc.

Gum yielding plants

Acacia nilotica ssp. indica, Anogeissus latifolia, Boswellia serrata, Butea monosperma, Lagerstroemia parviflora, Pterocarpus marsupium, and Sterculia urens, etc.

Cultivated plants

Besides cultivation of important cereals and pulses, cash crops like **Areca nut, Coconut, Coffee, Cocoa, Tea, and Rubber** are also grown on large scales.

VULNERABILITY AND MAJOR THREATS

The natural ecosystems are being increasingly affected by various factors, viz., demographic pressures, environmental degradation, deforestation, land degradation, floods, pollution of water, air etc. The habitats which are rich in vegetation are also being affected by the intense mining activity. The common threats to the flora are Natural and Man made. The natural causes are: floods, diseases, pressure from alien plants, landslides, soil erosion and forest fires, etc. A few man made threats which adversely affect the vegetation are over exploitation of natural resources, destruction of the habitats through urbanisation, pollution of environment, etc. All these factors create inhospitable climate for the vegetation.

Some of the threats in Karnataka which significantly affect the floristic diversity are construction of dams e.g. Varahi dam, a hydroelectric project at Hulical, Sharavathi river dam in Shimoga; Bhadra dam in Chikmagalur District and Dam on Kavery river in Mysore Dist. are some examples besides, the presently hotly disputed Cogentrix hydroelectric project off Mangalore coast. These dams are flooding large areas of Natural forest. The intense mining activity at Kudremukh iron ore project in Chikmagalur district has adversely affected the vegetation of the area (previously Kemmangundi in Chikmagalur District was site for iron ore mining area). Sandur hills in Bellary district are likewise greatly affected.

The important cash crops like Cardamom, coffee, rubber, tea, cocoa, sugar cane, etc. are widely cultivated in the Southern Karnataka districts. The areas of cultivation of these crops are expanded at faster rate resulting on the erosion of native species. The West coast paper mill at Dandeli in Uttara Kannada has also added to destruction of vegetation.

Cane industries and the coal industries which depend on the plant species are also the chief causes for the depletion of forest. The road construction like National Highway No. 17 along the coast and road from Kudremukh iron ore mine (Malleshwara) in Chikmagalur District to Panambur Port in Dakshin Kannada Dist. also affect vegetation. The Railway line between Mangalore to Hassan which is complete and Konkan railway line being laid from Mumbai to Mangalore have also added major share towards reduction of forest areas futher. A few glaring examples of the Plant species which are not found to occur (probably extinct)

since its original collection are *Hubbardia heptaneuron* from Sharavathi (Gersoppa) water falls and *Dalechampia stenoloba* from Bhadra dam area in Chikmagalur district.

CONSERVATION MEASURES

To conserve Plant Diversity, the threats affecting the flora have to be averted. Dam construction, mining activities, deforestation etc. have to be contained. *In situ* and *ex situ* conservation of threatened plant species have to be adopted. Besides the present national parks and wild life sanctuaries some other areas which need protection have to be earmarked. The following plant species have been banned from export under the Convention on International Trade in Endangered Species of Wild fauna and flora.

Ferns and Fern allies : *Angiopteris evecta*, *Cyathea* spp., *Osmunda regalis* and *Psilotum triquetrum*, etc.

Flowering plants : *Ceropegia* spp., *Drosera* spp. *Garcinia rubro-echinata* (*G. echinocarpa*), *Hippocratea* spp., *Lobelia nicotianaefolia*, *Orthosiphon stramineus*, *Pterospermum obtusifolium*, *Rauvolfia densiflora* and *R. serpentina*, etc.

Rich fauna depends on rich flora and vegetation and floristic diversity presents faunistic diversity i.e. conservation of adequate habitat can protect biological diversity. The habitat is conserved if sufficient and representative samples of relatively undisturbed forest be set aside as nature reserves particularly biosphere reserves. Such reserves with adequate populations of plants and animals will enable them to maintain genetic diversity especially, those which are rare or occur in low density. National parks also help to a great extent in conserving the rare plant species. Existence of National Park and equivalent reserve cannot in any way guarantee the survival of the plant species growing in it, unless such reserves are efficiently guarded and managed.

Known threat prone and extinct prone species should be conserved in Botanical gardens (*ex-situ* conservation) and re-introduced in their natural habitats. The number of Botanical gardens to shoulder such responsibilities is too meagre. More Botanical gardens with necessary infrastructure must be established on priority basis. Developmental projects like

river valley projects, clearing of less disturbed forest for alternative land use, mining and plant based industries need to be strictly monitored by well informed competent authority so that further damage to these ecosystems is minimized. There must be clear understanding between conservation and development so that Biological diversity remain undisturbed and sustainable and ecological balance is maintained.

Sacred groves should be studied thoroughly and protected as they represent relict type of vegetation and many rare and threatened plant species are protected due to age old religious beliefs in the deity and fear for ill effects due to disturbing or cutting any tree. As the religious feeling about deity is diminishing and with the result the inherent fear for punishment is also decreasing. Besides educating people about sacred groves and their importance, certain legal measures have to be enforced to conserve the sacred groves.

Emphasis on the environmental education and the necessity of protecting our rich Biological diversity must be made clear to the public in order to conserve our precious Biodiversity from depletion.

REFERENCES

- Arora, R.K. 1964. *Phytogeographic notes on the humid tropics flora of India - world distribution and analysis of the woody dicotyledonous flora of Western Ghats and Assam* J. Indian Bot. Soc. **43** : 220-228.
- Nayar, M.P. 1979. Changing patterns of the Indian Flora ; *Bull. Bot. Surv. India* **19** : 145-154.
- Nayar, M.P. 1982. Endemic flora of Peninsular India and its significance; *Bull. Bot. Surv. India* **22** 12-23.
- Raghavan, R.S. 1969. *The flora of Agumbe and Tirthahalli ranges in Shimoga district, Mysore State* (Vols. 1 and 2) (Thesis).
- Rajagopal, P.K. 1996. *Ferns and Fern Allies of Karnataka* (Thesis).
- Singh, N.P. 1979 (1981). *Cassia sericea* a new record for India. *Bull. Bot. Surv. India* **21** (1-4) : 203.
- Singh, N.P. 1983. Potential biological control of *Parthenium hysterophorus*; *Curr. Sci.* **52** (13) : 644.
- Singh, N.P. 1988 *Flora of Eastern Karnataka*, Mittal Publications, Delhi.
- Subramanyam, K and M.P. Nayar, 1974. *Vegetation and Phytogeography of the Western Ghats in Ecology and Biogeography in India* (ed. M.S. Mani) Dr. W. Junk Publishers, The Hague P. 178-196.
- Thorne, R.F. 1978. Plate tectonics and angiosperm distribution. *Notes R. Bot. Gard. Edinburgh* **36** : 297-316.



A view of moist deciduous forest at Makut, Kodagu dist.



A view of dry deciduous forest at Kushalnagar, Kodagu dist.



Nelumbo nucifera at Mettikuppe, Mysore dist.



Fruits of *Sapindus laurifolius*



Kandelia candel showing vivipary

KERALA

M. Mohanan

V.J. Nair

Kerala, called so because of the abundance of coconut palms (*Cocos nucifera*) throughout the state is one of the smallest Indian states. It lies on the southwest corner of the peninsula between latitudes 8° 04" and 12° 44" N and longitudes 74° 54' and 77° 12' E. It is bounded on the north by Karnataka, south by Tamil Nadu, east by Western Ghats and the west by the Arabian sea. The total area is 38,863 sq km which is only about 1.8% of the total area of India. The state is divided into 14 districts. The greatest length of the state is 550 km and greatest breadth is 121 km.

There are several legends on the origin of Kerala. The most common one is that it has been created by Lord Parasurama by throwing his axe which uplifted a landmass from the Arabian sea where it fell. Although there is no evidence to prove the authenticity of this legend, many ancient works like "*Keralolpathi*", "*Keralappazhama*", "*Kerala mahatmyam*", etc., contain references supporting this view. Epics like *Bhrahmadapuram*, *Devibhagavatham*, *Valmiki Ramayanam*, *Agnipuranam*, *Matsyapuranam*, *Mahabharatham*, *Raghuvamsam*, etc., have references about the existence of Kerala.

The state of Kerala as we know today was non-existent when India became independent. It was then under the administrative set up of the princely states of Travancore and Cochin; Malabar which was a part of the Madras Presidency was under the direct rule of the British. Although the states of Travancore and Cochin were integrated into one (Travancore-Cochin) on 1st July 1949, the Malabar still remained to be a part of the Madras Province. The state came into being on 1st November 1956 when the states of Travancore-Cochin (except Thovala, Agastheeswaram, Kalkulam, Velavancode and parts of Chenkottai) and Malabar were united along with the taluk of Kasaragode.

On a physiographic basis the state can be divided into three zones, The Highlands or mountainous zone (*Malanadu*) above 600 m, the Midlands (*Idanadu*) between 300 and 600 m and the Lowlands or coastal zone (*Theerabhoomi*) below 300 m. The lowlands can be again divided into plains between 30 and 300 m and coastal zone below 30 m.

The lowlands (Theerabhoomi)

The lowlands includes the plains and the coastal zone. The coastal zone consists of chiefly flat, undulating lands except for a few hills at places like Veli, Varkala, etc. The average elevation of this region is below 30 m. The unique feature of this zone is the presence of an unusual strip of land called "*Vembanad*" which is 1 m below the sea level. One of the many natural advantages of Kerala is the presence of an extensive system of backwaters and canals for navigation. All the coastal lagoons extending from Thiruvananthapuram to Trissur are connected by a navigable canal about 370 km long. Kerala has a 560 km long coastal area with very extensive sand beaches often intercepted by rivers or backwaters. The major backwaters are: *Kumpala, Kalnad, Beccal, Chittari, Kavvayi, Velliyancode, Chavakkad, Kodungaloor, Varappuzha, Vembanad, Kayamkulam, Ashtamudi, Paraur, Idava, Nadayara, Anjengu, Kadinamkulam* and *Veli*. *Sasthancotta, Vellayani* and *Pookkod* are the three major natural fresh water lakes in Kerala.

The midlands (Idanadu)

This is a stretch of undulating land with small hills and valleys lying between the Lowlands and the Highlands. The average elevation of this strip of land is about 200 m. The area is now thickly populated and is under extensive cultivation of crops like coconut, arecanut, cashew, tapioca, paddy etc. Despite the tremendous population pressure and aggressive farming, a few pockets of forested areas still remain in some places of this region which represent the original features of the midlands. These are called 'Kavus' (sacred groves).

The highlands (Malanadu)

The highlands or the mountainous zone is essentially a part of the southern Western Ghats that stretch along the eastern border of the state and consists of a series of hills which rises up to an average height of about 900 m with a number of peaks of over 1500 m high. The top and upper reaches of these peaks are often rocky and inaccessible and are generally barren or with scanty vegetation; while the slopes and valleys are covered with very luxuriant vegetation. These mountain ranges are unbroken for most of the part and forms a barrier between Kerala and Tamil Nadu except at a few places where the continuity of these ghats is broken

by depressions. These depressions are generally termed as 'gaps' or 'passes'. The 'Palakkad gap' which is 30 km wide and 80 km long is the largest pass in Western Ghats from Kerala to Tamil Nadu separating the Anaimudis from the Nilgiris. The other smaller passes are the 'Aryanad pass' at Thiruvananthapuram, which is closed now, and 'Ariyankavu pass' at Kollam. There are many other 'paths' passing through the Western Ghats from Kerala to Tamil Nadu. They are the Kumili-Kambam route, Udumpanchola-Munnar-Bodinayikkannur, Boneccord-Kannikkatti, etc. According to Legris and Meher-Homji (1977) the Palakkad gap is a prepleistocene river. On the southwestern side of the Nilgiris lies Wynaad Plateau and the verdant Silent Valley. There are fourteen peaks in these ranges having altitudes over 1000 m. Some of them are Devarmala (1992 m), Thenmala (1525 m), Banasuramala (1912 m), Brahmagiri (1608 m), Vavalmala (2339 m), Anginad (2386 m), Karimala (1998 m), Padagiri (1585 m), Sivagiri (1774 m), Meenmala (1784 m), Muthiramala (1041 m) and Agastyamudi (1869 m). The highest peak is the Anaimudis (2817 m).

Kerala is often described as a land of rivers and backwaters (*Kayal*). Over 44 rivers originate from the Western Ghats of Kerala. Out of these 41 cut across the state with their innumerable tributeries and branches and empties themselves into the Arabian Sea directly or indirectly through the back-waters. *Kabani*, *Bhavani* and *Pampar* are east flowing rivers. Among the west flowing rivers "*Bharathappuzha*" (250 km) is the longest that originates from the Anamala and joins the Arabian sea. *Pamba* (196 km) is often known as the 'gift of Kuttanad'. Both these are sacred rivers for the Hindus of Kerala. The second largest river in Kerala is the '*Periyar*' (227 km) which arises from the famous pilgrimage centre of Hindus the Sabarimala. The other important rivers in the state are *Meenachalaru* (78 km), *Manimalayaru* (90 km), *Achencoilaru* (128 km), *Kalladayaru* (121 km), *Karamanayaru* (65 km), *Neyyar* (66 km), *Chandragirippuzha* (106 km), *Valarpatanampuzha* (110 km), *Ramapuramaru* (19 km), *Mayyazhippuzha* (54 km), *Kuttiyadi* (74 km), *Kallayippuzha* (22 km), *Chalyar* (169 km), etc.

The state is geologically divisible into four minor belts: a coastal belt of recent deposits, a narrow belt of pleistocene or late tertiary (Varkalai beds), another narrow belt of laterite and a high mountain belt formed from precambrian-archean chrystalline hard rocks consisting of granites, schists, gneisses, quartzites, etc.

Igneous rock bound shores often with overhanging cliffs composed of topmost laterite, sand-stones, sandy clay, alum clay and a bottom belt of black carbonaceous clay with broken pieces of wood and lignite are common in some areas along the shore wherever the Western Ghats generally extends southwards. Such cliffs with fossiliferous miocene beds edging out from the seashore can be clearly seen at Varkala. Certain significant plant indicators are present along the sand beaches of Kerala which are lithologically either calcareous or non-calcareous. These areas are also rich in Ilmenite, Monasite, Lignite, etc. The coast of Kerala is also rich in deposits of clay, Bauxite and Iron. A small outcrop of middle tertiary lime stone occurs in Kollam.

Laterite extending to about 160 m below the surface is of common occurrence in the midlands.

The mountainous region is with crystalline rocks consisting of leptynites and charnokites, horn-blende and gneisses, schists and granulites. Building stones (vettukal) are charnokites and leptynites and occur generally in the interior midlands and in some areas of the coastal belt. Gem stones (quartz) banded agatejaspar (Vaiduryam) are common in Nedumangad and Chirayinkil taluks of Thiruvananthapuram District. Glass and mica, graphite, etc., also occur in Kerala.

The main soil types met with in Kerala are Alluvial soil, peaty soil, red soil, laterite soil, lateritic soil and forest soil. Alluvial soil is usually formed on marshy and submergible areas. Mixed red and black alluvia are also met with. A major portion of the state is covered with red loamy soils which is well drained and poor in nutrient. Laterite and lateritic soils are found in midlands and low hilly regions. The highlands are characteristic with forest soil or hill soil which is undifferentiated and rich in humus.

Soils of Chavara and Neendakara contain many rare minerals like Ilmenite, monasite, silicon etc. Cherthala (Shertallay) is rich in sand from which glass is manufactured. More recently Bauxite reserves (in Kumbala) Iron-ore (in Cherupa, Eliottumala, Nanminda and Naduvannannur) and graphite (in Thodupuzha and Idukki) are discovered.

Kerala enjoys a moderately warm-humid tropical climate with very little variation in temperature. The four main seasons are winter (Jan. -

Feb.), summer (March - May), South-West monsoon (June - Sept.) and North-East monsoon (Aug. - Dec.).

The maximum mean daily temperature in the coastal region is 32° C (April - May) and minimum mean daily temperature is 22° C (Dec. Jan.). The maximum temperature rises to about 37° C in some areas of the plains. The minimum temperature also drops down to 7° C in hilly areas varying slightly with altitude.

The state is in the threshold of the South-West monsoon during June to September and receives the maximum rainfall from this; it is less in the southern part of Kerala (about 70 cm) and more in the northern part (up to 250 cm). Idukki and Wynaad Districts receive the highest rainfall from the S.W. monsoon (over 350 cm). The situation is just the reverse in North-East monsoon season when the southern part of Kerala receives more rain compared to the northern part. When the state is taken as a whole, Kozhikode receives the highest rainfall (375 cm) and Thiruvananthapuram the lowest (181 cm). The average annual rainfall in the state varies from 1016 mm to 7620 mm (Table I).

Table I
Average rainfall (in mm) from 1969-1979

1969-	1970-	1971-	1972-	1973-	1974-	1975-	1976-	1977-	1978
1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2695	3046	2600	2704	2184	3301	2729	2737	3581	2788

The average districtwise distribution of rainfall (in cm) is as follows Thiruvananthapuram (181), Pathanamthitta (313), Kottayam (313), Ernakulam (327), Kozhikode (375), Kannur (374), Kollam (256), Alappuzha (301), Idukki (337), Trissur (313), Malappuram (291), Wynaad (359), Kasaragode (358), Palakkad (233).

The atmosphere is humid throughout the year. The relative humidity varies from 70 - 90 percent. (Climatological data from Meteorological Centre, Thiruvananthapuram).

VEGETATION

Vegetation of the state is discussed here with reference to the three physiographic zones :

- I. Vegetation in the coastal zone and lowlands
- II. Vegetation in the midlands
- III. Vegetation in the highlands

I. VEGETATION IN THE COASTAL ZONE AND LOWLANDS

Kerala state has a very long and extensive coastal zone (560 km) harbouring a very characteristic vegetation. The two major types of vegetation met with in the coastal zone are Strand and Estuarine vegetation (Rao and Sastry, 1972, 1974).

1. Strand vegetation

Strand vegetation is characterised by 'open mat-forming pioneers in varying proportions closely followed by herbs, shrubs and trees disbursed on a relief beyond the high tide limit designated as supra-littoral zone of back shore. This consists of three types the strand sand and the strand rock. Strand coral does not occur in Kerala coast.

(a) **Strand-sand** : The strand sand habitat running parallel to the sea coast of Kerala is not very wide, but lengthy (560 km). This habitat is often intercepted by downward flowing rivers, hyper-saline estuaries, lagoons and cliffs. The formation of this habitat is highly influenced by the interaction of wind and waves. Another remarkable feature is the presence of a few plant indicators in this region. This region is often divisible morphologically into three zones reflecting a graded sequence of different floristic composition. These zones are the outer open pioneer zone, a closed herbaceous zone following it, the middle mixed or bushy zone and the inner woodland zone.

A large portion of the coastline of Kerala is bordered by coconut plantations. Sand-binders are *Gisekia pharnaceoides*, *Heliotropium marifolium*, *Indigofera spicata*, *Ipomoea pes-capre*, *Justicia tranquebariensis*, *Launaea sarmentosa*, *Pedaliium murex*, *Polycarpaea corymbosa*, *Polycarpon prostratum*, *Rothia indica*, *Spermacoce hispida*, *Zoysia matrella*, *Cyperus arenarius*, *imbristylis cymosa*, *Spinifex*

littoreus, *Hydrophylax maritima*. The common shrubs in the mixed bushy zone are *Calotropis gigantea*, *Capparis brevispina*, *Cassia auriculata*, *Erythroxylum monogynum*, *Gmelina asiatica*, *Ipomea vitifolia*, *Hugonia mystax*, *Hygrophila auriculata*, *H. erecta*, *Ixora coccinea*, *Premna serratifolia*, *Solanum surratense*, *Sida cordifolia*, *Sphaeranthus indicus*, *Tephrosia* spp., *Turnera ulmifolia*, *Vitex trifolia*, etc. The inner woodland region is characterised by the presence of *Calophyllum inophyllum*, *Coffea travancorensis*, *Derris indica*, *Hopea ponga*, *Morinda citrifolia*, *M. pubescens*, *Manilkara hexandra*, *Thespesia populnea*, *Uvaria zeylanica* and *Wrightia arborea*. *Anacardium occidentale*, *Cocos nucifera* and *Casuarina equisetifolia* are the main cultivated species besides recently introduced species of *Acacia*. *Cassytha filiformis* is a common parasite in this region. In the northern part, tobacco is also cultivated extensively (Ansari, 1985).

(b) **Strand-rock** : This is common in the southward extension of the Western Ghats in Kerala where igneous rock bound back shore, sometimes with over hanging cliffs are found. This type is best manifested at Varkala in Thiruvananthapuram District and Beccal in Kasaragode District. This habitat has three distinct aspects 1. Steep rising rocky slopes with pot-holes, 2. Solution cups and crannies, 3. Wave cut rocky shore with undulating upper surface and crevices. Presence of a group of plants showing complete fidelity to this habitat is a unique feature. They are *Polycarpaea corymbosa*, *Indoneesiella echioides*, *Portulaca quadrifida*, *Pavonia odorata*, *Sporobolus diander*, *Tridax procumbens*, *Capparis* spp., *Calotropis gigantea*, *Helichrysum* spp., *Jatropha gossypifolia*, *Tephrosia purpurea*, *Ipomoea* spp., *Hibiscus micranthus*, *Indigofera* spp., *Polygala erioptera*, *Blumea obliqua* etc.

2. Estuarine vegetation

This is characterised by the presence of "dense woody plants including succulent herbs and shrubs in varying proportions disbursed on a coastal relief under the constant influence of tidal and fresh water resources". They are of two types Estuarine and Pro-estuarine. Estuarine vegetation in the typical form does not occur in Kerala. Pro-estuarines like Prohaline, Euhaline and Tidal mangroves are of common occurrence along the coast. The entire back-water system in Kerala coast can be classified under these types.

(a) **Tidal mangroves** : This type is found all along the back-waters of Kerala. Abundant growth of *Acanthus ilicifolius* and *Acrostichum aureum* are seen along the margins of all these lakes. The common trees found are *Aegiceras corniculatus*, *Avicennia officinalis*, *A. marina*, *Barringtonia racemosa*, *Bruguiera gymnorrhiza*, *B. conjugata*, *Carallia brachiata*, *Rhizophora apiculata*, *Lumnitzera racemosa*, *Sonneratia caseolaris*, *Scaevola sericea* etc. *Clerodendrum inerme*, *Cerbera odollam*, *Exoecaria agallocha*, *Sphenoclea zeylanica*, etc., are also seen. Some of the common climbers in this area include *Cissus vitiginea*, *Derris trifoliata*, *Flagellaria indica*, *Gloriosa superba* and *Parsonsia alboflavescens*.

(b) **Prohaline** : Salt-tolerant fresh water plants are characteristic to this type. *Ceratopteris siliquosa*, *Corchorus aestuans*, *Crinum asiaticum*, *Hygrophila erecta*, *Salvinia molesta*, *Sphenoclea zeylanica*, *Caesalpinia crista*, *Cyperus javanicus*, *Xyris indica*, *Tylophora tenuis*, *Dolichandrone spathacea*, *Barringtonia acutangula*, *Kandelia candel*, *Striga asiatica*, *Scirpus littoralis*, etc., are common in this type.

(c) **Euhaline** : This type is characterized by the presence of highly salt tolerant plants like *Acanthus ilicifolius*, *Acrostichum aureum*, *Pandanus fascicularis*, *P. odoratissimus*, *Cerbera odollam*, *Samadera indica*, *Dalbergia* spp., *Burmannia coelestis*, etc.

II. VEGETATION IN THE MIDLANDS

Most of the areas in the midlands are under extensive cultivation of crops like coconut, arecanut, cashew, tobacco, paddy, tapioca, pepper etc. This area being thickly populated, has lost its original features and what remains still as patches at certain areas are representatives of moist deciduous and evergreen forest. *Albizia odoratissima*, *A. chinensis*, *Alstonia scholaris*, *Anacardium occidentale*, *Artocarpus hirsutus*, *Bridelia retusa*, *B. scandens*, *Macaranga peltata*, *Mallotus philippensis*, *Terminalia paniculata*, *T. cremulata*, *Trema orientalis*, *Cycas circinalis*, *Clerodendrum viscosum*, *Ervatamia heyneana*, *Ixora coccinea*, *Wrightia arborea*, etc., are still seen in this region.

That the entire state was once covered by forest is substantiated by the presence of several sacred groves (*Kavus*) in the midlands (and a few in the coastal region also).

1. Sacred groves (Kavus)

The area of these groves of Kerala have been surveyed and many endemic / rare plants have been recorded from these areas (Ramachandran and Mohanan, 1989; Mohanan and Nair, 1981; Nayar, 1987).

The dominant trees found in the groves are *Adenanthera pavonina*, *Aegle marmelos*, *Aglaia elaeagnoidea*, *Alstonia scholaris*, *Aporosa lindleyana*, *Artocarpus hirsutus*, *A. heterophyllus*, *Bambusa arundinacea*, *Buchanania axillaris*, *B. lanceolata*, *Calophyllum inophyllum*, *Carallia brachiata*, *Caryota urens*, *Cinnamomum malabattrum*, *Diospyros candolleana*, *D. malabarica*, *Ficus exasperata*, *F. religiosa*, *Holigarna arnottiana*, *Hydnocarpus pentandra*, *Knema attenuata*, *Litsea glutinosa*, *Macaranga peltata*, *Mangifera indica*, *Mimusops elengi*, *Olea dioica*, *Sterculia urens*, *Strychnos nux-vomica*, *Syzygium cumini*, *S. travancoricum*, *Trema orientalis*, etc.

The smaller trees and shrubs are represented by *Alangium salvifolium*, *Canthium angustifolium*, *Chasalia curviflora*, *Clerodendrum inerme*, *C. viscosum*, *Coffea travancorensis*, *Glycosmis pentaphylla*, *Hibiscus tiliaceus*, *Litsea coriacea*, *Mackenzia integrifolia*, *Memecylon edule*, *M. wightiana*, *Ochna obtusata*, *Polyalthia korintii*, *Samadera indica*, *Streblus asper*, *Syzygium jambos*, *Tarenna asiatica*, etc.

Trees are mostly covered by lianas like *Acacia caesia*, *Anamitra cocculus*, *Ampelocissus latifolia*, *Cissus glauca*, *Connarus monocarpus*, *Gnetum ula*, *Kamettia caryophyllata*, *Sarcostigma kleinii* and climbers like *Abrus precatorius*, *Asparagus racemosus*, *Cayratia pedata*, *Cissus repens*, *Flagellaria indica*, *Merremia* spp., *Micania micrantha*, *Mucuna pruriens*, *Mukia maderaspatana*, *Naravelia zeylanica*, *Tragia involucrata*, *Wattakaka volubilis* and *Ziziphus oenoplia*. Some of the common epiphytes are *Acampe praemorsa* and *Drynaria quercifolia*. Herbaceous flora of the groves include plants like *Commelina* spp., *Cyanotis* spp., *Fioria vitifolia*, *Justicia* spp., *Malaxis rheedii*, *Costus speciosus*, *Tephrosia purpurea*, *Zingiber zerumbet*, etc.

2. Wetland vegetation

Wetlands are of two types: natural and man-made. The natural high altitude wetlands are generally formed by glacial action. Swamps and

ponds are created due to depressions. Reservoirs, canals and ditches are man-made wetlands. Vast areas in the midlands are under paddy cultivation. Kuttanad paddy fields cover about 774 sq km. Besides, there are several streams, rivers, ponds and canals also. All these wetlands constitute an aquatic habitat which harbour a luxuriant vegetation. The wetland vegetation is classified here as: (a) Aquatic (b) Semiaquatic and moisture loving.

(a) Aquatic vegetation : Submerged aquatic plants that frequent the streams and ponds are *Blyxa aubertii* var. *aubertii* and var. *echinosperma*, *B. octandra*, *Hydrilla verticillata*, *Indotristicha ramosissima* and *Valisneria natans*. Floating plants like *Azolla filiculoides*, *Eichhornia crassipes*, *Lemna perpusilla*, *Ludwigia adscendens*, *Pistia stratiotes*, *Utricularia aurea* and the noxious aquatic weed *Salvinia molesta* are also common. The rooted aquatics include *Aponogeton nutans*, *A. undulatus*, *Eleocharis dulcis*, *E. retroflexa*, *Ipomoea aquatica*, *Lagenandra ovata*, *Leersia hexandra*, *Limnocharis flava*, *Limnophila aquatica*, *L. heterophylla*, *L. repens*, *Monochoria vaginalis*, *Nymphaea nouchali*, *Nymphoides indica*, *N. parviflora*, *Panicum paludosum*, *Paspalidium geminatum*, *Potamogeton javanicus*, *Rotala rotundifolia*, *Schoenoplectus juncoides*, *Utricularia stellaris*, *U. reticulata* and pteridophytes like *Ceratopteris thalictroides* and *Marsilea coromandelica*.

(b) Semiaquatic and moisture loving plants : These are plants found on margins of ponds, on bunds of paddy fields and other semiaquatic situations. Some of these are *Alternanthera sessilis*, *Amischophacelus axillaris*, *Aneilema scaberrima*, *Bacopa monnieri*, *Colocasia esculenta*, *Commelina diffusa*, *C. benghalensis*, *Cyanotis vaginata*, *Cynodon dactylon*, *Cyperus pilosus*, *C. corymbosus*, *C. cyperoides*, *Eriocaulon quinquangulare*, *E. truncatum*, *E. xeranthemum*, *Imbristylis aestivalis*, *Miliaceae*, *Pschoenoides*, *Tetragona*, *Glinus oppositifolius*, *Grangea maderaspatana*, *Hedyotis auricularia*, *Heliotropium marifolium*, *Hydrocera triflora*, *Hygrophiza aristata*, *Lindernia antipoda*, *L. anagallis*, *Lobelia trigona*, *Melochia corchorifolia*, *Pandanus fascicularis*, *Panicum brevifolium*, *P. repens*, *Paspalum scrobiculatum*, *Pilea microphylla*, *Polygonum* spp., *Pouzolzia zeylanica*, *Sacciolepis interrupta*, *Sphaeranthus indicus*, *Wedelia chinensis* and pteridophytes like *Acrostichum aureum*, *Adiantum latifolium*, *Selaginella delicatula* and *Stenocleane palustris*.

3. Cultivated land

A major portion of the midland is under cultivation of different crops. The common weeds found in the paddy fields are *Cyperus iria*, *C. polystachyos*, *C. tenuispica* and grasses like *Isachne dispar*, *I. pulchella*, *Sacciolepis interrupta*, etc.

In the cultivated lands of the other crops like coconut, arecanut, tapioca, etc., are found common weeds like *Acalypha ciliata*, *Acrocephalus hispidus*, *Ageratum conyzoides*, *Alloteropsis cimicina*, *Biophytum sensitivum*, *Borreria articularis*, *B. latifolia*, *B. ocymoides*, *Bulbostylis barbata*, *Catharanthus pusillus*, *Centella asiatica*, *Cleome viscosa*, *Cyperus killinga*, *C. rotundus*, *Emilia sonchifolia*, *Euphorbia thymifolia*, *Dactyloctenium aegyptium*, *Hedyotis corymbosa*, *Heliotropium scabrum*, *Micrococca mercurialis*, *Peperomia pellucida*, *Phyllanthus amarus*, *Pouzolzia zeylanica*, *Synedrella nodiflora* and *Tridax procumbens*.

4. Wasteland

Kerala state has a very little area of wastelands compared to other states of India. The wastelands are mostly seen in the northern part of Kerala particularly Kasaragode and Palakkad which are often rocky and with less biotic interference. A number of herbaceous elements are found in these areas. *Eriocaulon keralense*, *Exacum bicolor*, *Justicia jayachandranii*, *Kalanchoe pinnata*, *Mollugo pentaphylla*, etc. are common. Dominant among the grasses are *Arundinella mesophylla*, *Bhidea burnsiana*, *Danthonidium gammiei*, *Glyphochloa acuminata* etc. Shrubs like *Canthium parviflorum*, *Ixora coccinia*, *Ervatamia heyneana* and scattered trees of *Sapium insigne* are also found in these areas.

Wastelands near habitations in the plains and coastal region are with very luxuriant growth of weeds like *Abelmoschus manihot*, *Asystasia dalzelliana*, *Ageratum conyzoides*, *Alternanthera sessilis*, *Breynia vitis-idea*, species of *Cassia*, *Sida*, *Chromolaena odorata*, *Crotalaria* spp., *Datura metel*, *Hibiscus aculeatus*, *Indigofera hirsuta*, *I. tinctoria*, *Tephrosia purpurea*, etc. The common climbing plants are *Abrus precatorius*, *Cyclea peltata*, *Cardiospermum halicacabum*, *Coccinia grandis*, *Diploclisia glaucescens*, *Hemidesmus indicus*, *Melothria heterophylla*, *M. maderaspatana* and *Smilax zeylanica*. The other common herbaceous plants include: *Acanthospermum hispidum*, *Achyranthes aspera*, *Amaranthus spinosus*, *Blumea lacera*, *B. virens*, *Emilia sonchifolia*,

Leucas aspera, *Mimosa pudica*, *Portulaca oleracea*, *Tridax procumbens* and *Vernonia cinerea*.

The cashew and other plantations of the midlands are generally covered with grasses. The most common ones are *Apocopis mangalorensis*, *Arundinella cannanorica*, *Chrysopogon tadulingamii*, *Danthonidium gammiei*, *Glyphochloa acuminata*, *Heteropogon contortus*, *Ischaemum indicum*, *I. mangaloricum*, *Oplismenus burmannii* and *Pseudanthistiria heteroclita*. Among these grasses are found herbs like *Drosera indica*, *Indigofera glabra*, *I. prostrata*, *Ophioglossum gramineum* and *Zornia quilonensis*.

5. Roadsides and railway tracks

Roads and railways are the important sources through which many alien elements spread. Common weeds of this habitat are *Cassia tora*, *Croton bonplandianum*, *Heliotropium indicum*, *Leea indica*, etc. The trees along the roadsides are *Ficus exasperata*, *Holigarna arnottiana*, *Lophopetalum wightianum*, *Sterculia guttata*, *Strychnos nux-vomica*, etc. Alien trees like *Adenanthera pavonina*, *Samanea saman*, species of *Acacia*, *Eucalyptus*, *Casuarina*, etc. are also seen. Along the road cuttings are seen *Cassia tora*, *Canscora diffusa*, *Impatiens minor*, *Osbeckia muralis*, etc. *Aerva lanata*, *Boerhavia diffusa*, *B. repens*, *Calotropis gigantea*, *Evolvulus nummularius*, *Sesamum* spp. etc. are very frequent along railway tracks.

6. Wall flora

Ancient walls of the fort (East and West fort of Thiruvananthapuram, Beccal Fort, etc.) and old buildings form a specialized habitat for certain plants. The importance of the wall flora has been stressed by Varshney (1968). Some of the common inhabitants of these walls are *Acalypha indica*, *Achyranthes aspera*, *Ageratum conyzoides*, *Amaranthus spinosus*, *A. viridis*, *Apluda mutica*, *Bhumea mollis*, *Boerhavia diffusa*, *Cassia tora*, *Chloris barbata*, *Cyperus compressus*, *Eclipta prostrata*, *Eleusine indica*, *Euphorbia hirta*, *E. thymifolia*, *Evolvulus alsinoides*, *E. nummularius*, *Ficus exasperata*, *F. religiosa*, *Lantana camara* var. *aculeata*, *Lindernia crustacea*, *Ocimum basilicum*, *Oxalis corniculata*, *Paspalum distichum*, *Phyllanthus amarus*, *P. reticulatus*, *Physalis minima*, *Pilea microphylla*, *Portulaca oleracea*, *Ravina humilis*, *Polygala elongata*, *Solanum nigrum*, *Tridax procumbens*, *Vernonia cinerea* and *Vicoa indica*.

III. VEGETATION IN THE HIGHLANDS

The forest of the highlands of Kerala comes under the following categories

1. Tropical moist forest
2. Subtropical montane forest,
3. Southern tropical thorny forest and
4. Southern dry mixed deciduous forest (which are of limited occurrence).

1. Tropical moist forest

These forest are characterised by high rainfall, high temperature, uniform photoperiods throughout the year and high humidity. This type occurs generally between 200–1500 m with several broken hills, long spurs and extensive ravines. The hills and valleys are densely covered by forest dominated by tall, broad-leaved trees. This type is subdivided as

- a. Tropical wet evergreen forest
- b. Tropical semievergreen forest
- c. Tropical moist deciduous forest
- d. Tropical fresh water swamp
- e. Wet bamboo brake
- f. Grassland

a. Tropical wet evergreen forest

These forest are unique by the presence of various synusiae viz. trees, shrubs and herbs, lianas, stragglers and epiphytes. The forest are multistoreyed with some emergent trees of 60 m or more height rising above the canopy. These trees have straight boles, buttressed bases, and light coloured thin barks. Among the other remarkable characteristic of these forest, mention may be made about the presence of feeder-roots in the decaying litter layer of the soil, cauliflory, laurel type of leaves, a ground layer matted with seedlings of trees and herbs; luxuriant growth of lichens, mosses, ferns, orchids and other epiphytes.

(i) **West-coast tropical evergreen forest** : This type is seen in valleys around high ranges and is generally confined to altitudes ranging from 200 to 1500 m. The main type of association observed in this forest

biome is *Cullenia - Mesua - Palaquium* series which is considered to be biologically the richest. Only 867 sq km of this type in Kerala is protected now in nature reserves like Silent Valley (90 sq km) and Periyar (777 sq km). The rest of the forest are under severe threat.

The top canopy is formed of trees like *Aglaia elaeagnoidea*, *Acrocarpus fraxinifolius*, *Ailanthus triphysa*, *Antiaris toxicaria*, *Artocarpus hirsutus*, *Bombax ceiba*, *Calophyllum apetalum*, *Canarium strictum*, *Cullenia exarillata*, *Dillenia bracteata*, *Diospyros bourdillonii*, *D. candolleana*, *Dimocarpus longan*, *Dipterocarpus indicus*, *Drypetes macrophylla*, *Dysoxylum malabaricum*, *Elaeocarpus tuberculatus*, *Epiprinus mallotiformis*, *Garcinia* spp., *Holigarna arnottiana*, *Hopea parviflora*, *Lophopetalum wightianum*, *Mangifera indica*, *Mastixia arborea*, *Mesua ferrea*, *Myristica dactyloides*, *Ostodes zeylanicus*, *Palaquium ellipticum*, *Poeciloneuron indicum*, *Polyalthia* spp., *Reinwardtiidendron anamalayanum*, *Syzygium* spp., *Tetrameles nudiflora* and *Vateria indica*.

The second storey consists of medium sized trees which are adapted to shady conditions are *Actinodaphne bourdillonii*, *Apodytes dimidiata*, *Aporosa lindleyana*, *Aglaia elaeagnoidea* var. *roxburghiana*, *Canthium dicoccum*, *Carallia brachiata*, *Chrysophyllum roxburghii*, *Cinnamomum* spp., *Diospyros paniculata*, *D. pruriens*, *Ficus* spp., *Elaeocarpus serratus*, *Euodia lunu-ankenda*, *Flacourtia montana*, *Garcinia gummi-gutta*, *Glochidion ellipticum*, *Gordonia obtusa*, *Goniothalamus cardiopetalus*, *Hydnocarpus pentandra*, *Knema attenuata*, *Litsea coriacea*, *Macaranga peltata*, *Mallotus philippensis*, *Mimusops elengi*, *Nageia wallichianus*, *Polyalthia coffeoides*, *Symplocos cochinchinensis*, *Xanthophyllum flavescens*.

The third storey consists of small trees and large shrubs like *Acronychia pedunculata*, *Agrostistachys indica*, *Antidesma menasu*, *Atlantia wightii*, *Callicarpa tomentosa*, *Canthium angustifolium*, *Chionanthus malabarica*, *Elaeocarpus munronii*, *Euonymus indicus*, *Eurya nitida*, *Flacourtia montana*, *Glycosmis cymosa*, *Humboldtia* spp., *Ixora nigricans*, *I. malabarica*, *Isonandra lanceolata*, *Leea indica*, *Psychotria curviflora*, *Tabernaemontana gamblei*, etc. Undershrubs and herbs which form the ground layer include *Acranthera grandiflora*, *Alpinia galanga*, *Asplenium indicum*, *Begonia malabarica*, *Boesenbergia* spp., *Calamus* spp., *Commelina ensifolia*, *Costus speciosus*, *Curcuma* spp., *Elatostema lineolatum*, *Elettaria cardamomum*, *Neanotis monosperma*, *Neurocalyx*

calycinus, *Nilgtrianthus* spp., *Ophiorrhiza brunonis*, *O. eriantha*, *O. mungos*, *Orophea uniflora*, *O. zeylanica*, *Psychotria* spp., *Saprosma corymbosum*, *Sarcandra chloranthoides*, *Soneriila rheedii*, *Schumannianthus virgatus*, *Thottea* spp. and *Zingiber* spp. Saprophytic orchids like *Aphyllorchis montana*, *A. prainii*, *Epipogium roseum*, *Zeuxine* spp. etc. are frequently seen. Species of *Eulophia*, *Habenaria*, *Malaxis*, *Nervilia*, *Peristylus*, etc. are the common ground orchids. *Aeginetia pedunculata*, *A. indica*, *Balanophora* spp., *Buchnera hispida*, *Christisonia bicolor* etc. are the common root parasites in the ground storey. Along the valleys of these forest are seen large formations of palms like *Arenga wightii*, *Caryota urens* and *Pinanga dicksonii* and large ferns like *Angiopteris evecta*, *Marattia fraxinea*, and *Cyathea gigantea*. Semiparasites like *Dendrophthoe falcata*, *D. memecilifolia*, *Helicanthus* spp., *Helixanthera intermedia*, *H. wallichiana*, *Macrosolen parasiticus*, *Taxillus cuneatus*, *T. tomentosus* and *Viscum orientale* are commonly met with in addition to the common epiphytic species of genera *Bulbophyllum*, *Coelogyne*, *Dendrobium*, *Eria*, *Oberonia*, *Pholidota*, *Polystachya*, *Pyrrosia*, *Peperomia*, etc. Lianas and climbers are characteristic of these forest. They are represented by *Adenia hondala*, *Ancistrocladus heyneanus*, *Argyreia hirsuta*, *Aristolochia indica*, *Artabotrys zeylanicus*, *Bauhinia phoenicea*, *Butea parviflora*, *B. purpurea*, *Calamus pseudotenuis*, *C. hugelianus*, *Calicopteris floribunda*, *Derris brevipes*, *Dioscorea oppositifolia*, *Entada rheedii*, *Erycibe paniculata*, *Erythropalum populifolium*, *Gnetum ula*, *Hugonia bellii*, *Miquelia dentata*, *Myxopyrum serratum*, *Piper* spp., *Pothos armatus*, *P. crassipedunculatus*, *P. scandens*, *Raphidophora laciniata*, *Sarcostigma kleinii*, *Senecio walkeri*, *Strychnos colubrina*, *Thunbergia mysorensis* and *Uvaria hookeri*.

(ii) **Southern hilltop tropical evergreen forest** : This type of forest is generally seen along valleys surrounding ridges and is confined to altitudes above 1200 m. The trees are shorter with fuller and rounded crowns. This is generally considered to be a transitional stage from tropical to subtropical forest.

The upper storey consists of trees *Cullenia exarillata*, *Elaeocarpus serratus*, *E. tuberculatus*, *icus arnottiana*, *Garcinia morella*, *Glochidion ellipticum*, *Gluta travancorica*, *Gordonia obtusa*, *Holigarna arnottiana*, *Mesua ferrea*, *Persea macrantha*, *Semecarpus anacardium*, *Syzygium zeylanicum*, etc.

The medium sized trees in the second storey are the younger forms of the trees of upper storey along with *Alstonia venenata*, *Baccaurea courtallensis*, *Cinnamomum* spp., *Debregeasia ceylanica*, *Harpullia arborea*, *Humboldtia brunonis*, *Memecylon angustifolium*, *Meliosma simplicifolia*, *Otonephalium stipulaceum*, *Sapindus laurifolius*, *Toona ciliata*, and *Turpinia malabarica*.

The lower storey is formed by herbs and shrubs like *Asystasia dalzelliana*, *Clausena heptaphylla*, *Diotacanthus grandis*, *Nilgirianthus heyneanus*, *N. foliosus*, *N. warrensis*, *Pavetta oblanceolata*, *Phaulopsis dorsiflora*, *Plectranthus wightii*, *Pogostemon paniculatus*, *P. travancoricus*, *Psychotria flavida*, *Rauwolfia densiflora*, *Rostellularia quinqueangularis*, *Sarcandra chloranthoides*, *Tarenna alpestris*, *T. canarica*, *Thottea* spp., *Wendlandia bicuspidata*, *Elaeagnus conferta*, *Jasminum cordifolium*, *Milletia rubiginosa*, *Mouliuva spicata*, *Mucuna hirsuta*, *Salacia beddomei*, *Shuteria vestita* and *Vigna* spp. The trees are generally carpeted with mosses and lichens as in the earlier type. Epiphytes and parasites are also common.

b. Tropical semievergreen forest

The semievergreen forest seen in the highlands of Kerala are West Coast semievergreen forest. This type is common adjoining evergreen forest and along the banks of rivers and is confined to areas wherever alluvial deposits are rich. Being an intermediate form between deciduous and evergreen forest, these constitute a mixture of both evergreen and deciduous plants. The dominant elements of the first storey are *Alstonia scholaris*, *Artocarpus heterophyllus*, *A. hirsutus*, *Buchanania lanceolata*, *Baccaurea courtallensis*, *Calophyllum apetalum*, *C. inophyllum*, *Carallia brachiata*, *Dimocarpus longan*, *Elaeocarpus tuberculatus*, *Grewia tiliifolia*, *Holigarna arnottiana*, *Hopea parviflora*, *H. ponga*, *Hydnocarpus alpina*, *H. pentandra*, *Humboldtia vahliana*, *Ixora brachiata*, *I. nigricans*, *Knema attenuata*, *Lagerstroemia microcarpa*, *L. speciosa*, *Madhuca neriifolia*, *Mangifera indica*, *Mastixia arborea*, *Nothopegia travancorica*, *Otonephalium stipulaceum*, *Sterculia guttata*, *Syzygium gardneri*, *Tamilnadia uliginosa*, *Terminalia paniculata*, *Vateria indica*, *Vitex pinnata* and *Xylia xylocarpa*.

The lower storey consists of *Agrostistachys meeboldii*, *Aporosa lindleyana*, *Arenga wightii*, *Bischofia javanica*, *Cinnamomum* spp., *Clerodendrum viscosum*, *Elaeocarpus serratus*, *Hemingia strobilifera*,

F. semialata, *Homonoia riparia*, *Hydnocarpus pentandra*, *Mallotus philippensis*, *Saraca asoca*, *Uvaria narum*, *Xanthophyllum flavescens*, etc. Large portions of ground are covered by *Costus speciosus* and species of Zingiberaceae. *Nilgirianthus* spp., *Psychotria* spp., *Geophila repens*, *Gymnostachya febrifugum*, *Mussaenda belilla*, etc. are also common in the ground layer. The common climbers in this area include *Abrus pulchellus*, *Adenia hondala*, *Aristolochia indica*, *Butea parviflora*, *Calamus* spp., *Calycopteris floribunda*, *Combretum latifolium*, *Entada rheedii*, *Ipomoea* spp., *Jasminum* spp., *Strychnos minor*, etc. Large formations of *Bambusa arundinacea* are common along the margins of rivers.

c. Tropical moist deciduous forest

The type of moist deciduous forest occurring in Kerala are termed southern secondary moist mixed deciduous forest. These forest occur at lower elevations (500–900 m) and receive less rainfall (250–350 m). The composition is mixed with a few evergreen trees also. The canopy is not as compact as in the earlier type. The common association found in this type is *Tectona - Dillenia - Lagerstroemia lanceolata - Terminalia paniculata* - series. The dominant trees in the top storey are *Acronychia pedunculata*, *Albizia amara*, *A. odoratissima*, *A. procera*, *Anogeissus latifolia*, *Bridelia retusa*, *Buchanania lanzan*, *Careya arborea*, *Chukrasia tabularis*, *Dalbergia latifolia*, *Dillenia pentagyna*, *Haldina cordifolia*, *Lagerstroemia lanceolata*, *L. speciosa*, *Lannea coromandelica*, *Macaranga peltata*, *Mastixia arborea* subsp. *meziana*, *Mitragyna parvifolia*, *Olea dioica*, *Pongamia pinnata*, *Pterocarpus marsupium*, *Scleropyrum pentandrum*, *Tectona grandis*, *Terminalia* spp., *Vitex altissima*, etc. *Phyllanthus emblica* is common amidst dense growth of grasses. *Cyrtococcum oxyphyllum*, *Imperata cylindrica*, *Pennisetum polystachyon*, *Pseudanthistiria umbellata*, etc. are seen where soil is shallow and poor.

In the middle layer plants like *Bauhinia racemosa*, *Bridelia scandens*, *Butea monosperma*, *Cipadessa baccifera*, *Cassia fistula*, *Clausena heptaphylla*, *Cycas circinalis*, *Dalbergia sissoo*, *Eriolaena quinquelocularis*, *Ficus hispida*, *Gmelina arborea*, *Kydia calycina*, *Morinda tomentosa*, *Nothopodytes foetida*, *Trema orientalis*, *Trewia nudiflora*, *Wrightia arborea*, etc. are met with.

The undergrowth consists of species like *Baliospermum montanum*, *Cassia* spp., *Clerodendrum serratum*, *C. viscosum*, *Desmodium* spp.,

Flemingia strobilifera, *Cynoglossum zeylanicum*, *Gomphostemma heyneana*, *Gardenia* spp., *Pavetta* spp., *Ixora* spp., members of Acanthaceae, Orchidaceae and ferns are also common. Some of the climbers found in this type of forest are *Asparagus gonoclados*, *Calycopteris floribunda*, *Cynanchum* spp., *Capparis rheedii*, *Combretum ovalifolium*, *Connarus wightii*, *Dalbergia volubilis*, *Dioscorea* spp., *Diploclisia glaucescens*, *Erythralium populifolium*, *Jasminum azoricum*, etc.

d. Tropical fresh-water swamp

These are of two types

(i) **Myristica swamp** : This is an unique type of evergreen vegetation of India found only in Kollam and Thiruvananthapuram Districts of Kerala. The valleys in Shendurunny and Kulathupuzha still has this distinct edaphic formation which is less than 390 m high. The bottom of these valleys are often under the influence of inundation. The floor of the swamp is fully covered by looped knee-roots of *Myristica* species. As the name indicates, the members of Myristicaceae are the dominant elements in the swamps, *Myristica magnifica* (= *M. fatua* var. *magnifica*) being an indicator. Other inhabitants of these swamps are *Myristica dactyloides*, *M. malabarica*, *Knema attenuata*, *Hydnocarpus alpina* and *Lophopetalum wightianum* and members of Dipterocarpaceae, Myrtaceae, Lythraceae, Rhizophoraceae and Pandanaceae. The ground is generally covered with large population of *Lagenandra ovata* and *L. toxicaria*. On the edges of these swamps are found *Humboldtia vahliana* and *Hopea parviflora* with a dense undergrowth of *Nilgirianthus* spp. Most of the swamps are converted into paddy fields now.

(ii) **Tropical riparian fringing forest** : The major rivers of Kerala harbour a specialized plant community having different taxonomic affinity but remarkably similar in appearance. The main elements found in this type are *Agrostistachys meeboldii*, *Anthocephalus chinensis*, *Madhuca neriifolia*, *Calophyllum apetalum*, *Garcinia wightii*, *Lagerstroemia microcarpa*, *L. speciosa*, *Lygodium flexuosum*, *Homonoia riparia*, *Holigarna arnottiana*, *Loptopetalum wightianum*, *Hydnocarpus pentandra*, *Syzygium occidentale*, *Polygonum* spp., *Vateria indica*. Members of Podostemaceae and Tristichaceae like *Polypleurum stylosum*, *Indotristicha ramosissima*, etc. are also encountered. Along the banks *Gymnostachyum febrifugum*, *Hypolytrum nemorum*, *Lagenandra ovata* and members of Zingiberaceae and *Ochlandra* spp. are met with.

e. Wet bamboo brakes

This type generally occurs in places wherever there is a break in the canopy such as sides of streams in the higher slopes or gaps created by felling. The reeds being very aggressive and capable of withstanding partial shade, colonise very rapidly into large population in such gaps. The areas in the higher slopes of peaks are covered by this vegetation which is inhabited by *Ochlandra ebracteata*, *O. scriptoria*, *O. wightii* and *O. travancorica*.

f. Grassland

Grasslands of Kerala can be classified into two (i) Low level grassland and (ii) High altitude grassland.

(i) Low level grasslands : These are found up to altitude of 1000 m and are often scattered amidst other forest types. They are of two types: Dry and wet grasslands.

Dry grasslands: This type is of limited occurrence in Kerala. Large areas in Kasaragode, Kozhikode and Wynaad Districts are dry and rocky and are covered by grasses intermixed by scrub jungles. The grass species frequently encountered in these areas are *Pseudanthistiria heteroclita*, *Dimeria bialata*, *Heteropogon contortus*, *Ischaemum indicum*, *Arundinella mesophylla*, *A. cannonorica*, *Bhidea burnsiiana*, *Danthonidium gammiei*, etc.

Wet grasslands : These are grass communities adapted to wetland situations mostly in the coastal belt of Alappuzha district. Common among these are *Eriochloa procera*, *Paspalum conjugatum*, *Paspalidium geminatum*, *Panicum repens*, *Imperata cylindrica*, *Brachiaria mutica*, etc. Grasses that are adapted to salinity and tidal action in the estuaries of the coast are: *Sporobolus virginicus*, *Paspalum scrobiculatum*, *Zoysia matrella*, etc.

(ii) High altitude grassland : This type usually know as "Montane grasslands" is confined to altitudes above 1000 m at Eravikulam, Munnar, Deviculam, Ponnambalamedu, Pookunnamala, Silent Valley, etc. These grasslands show much resemblance to the 'Patenas' of Ceylon. Most of these grasslands are depleted due to biotic interference. The areas coming

under Eravikulam National Park and Silent Valley are probably the only portion where this biome is protected in Kerala. The chief communities met with in these grasslands are (1) *Sehima - Dichanthium* type wherein *Heteropogon contortus*, *Sehima nervosum*, *Dichanthium* spp., etc. are the dominant species. (2) *Cymbopogon - Themeda cymbaria* type, the dominant species of which are *Cymbopogon flexuosus* and *Themeda cymbaria* (3) *Saccharum - Imperata - Phragmites* association consisting of grasses like *Phragmites karka*, *Saccharum spontaneum*, *Imperata cylindrica*, *Paspalum conjugatum*, etc. Along the estuaries of the coast are seen an association of *Zoysia - Sporobolus* dominated by *Zoysia matrella*, *Sporobolus virginicus*, *Cynodon dactylon*, etc.

Grasses also occur in some other situations as secondary communities such as walls, rocky slopes, water-courses, wasteland situations and cultivated fields.

The common species of grasses that occur on the walls are *Arthraxon lancifolius*, *Dimeria ornithopoda*, *Garnotia courtallensis*, *Sporobolus piliferus*, *Aristida depressa*, *Chloris barbata*, *Arundinella pumila*, etc.

Some grasses are adapted to dry rocky habitats. They are *Zenkeria elegans*, *Z. sebastinei*, *Tripogon bromoides*, *Isachne fischeri* found in the higher elevations and *Bhidea burnsiana*, *Danthonidium gammiei*, *Arundinella cannanorica* and species of *Dimeria* in the plains.

Grasses that are found along the watercourses include, *Phragmites karka*, *Arundo donax*, *Saccharum spontaneum*, *Paspalum conjugatum*, etc. *Hygroryza aristata*, *Pseudoraphis spinescens*, *Leersia hexandra*, *Sacciolepis interrupta*, *Paspalum distichum*, *Isachne miliacea*, *Paspalidium geminatum*, etc. are common in the stagnant pools and canals.

The common grasses found in the wastelands are *Eleusine indica*, *Chloris barbata*, *Panicum repens*, *Dactyloctenium aegyptium*, *Eragrostis tenella*, *E. unioloides*, *Paspalum scrobiculatum*, *Axonopus compressus*, *Alloteropsis cimicina*, etc.

The cultivated fields are often invaded by grasses. Those inhabiting the wetland fields such as paddy fields are *Echinochloa colona*, *E.*

crusgalli, *E. stagnina*, *Eriochloa procera*, *Oryza rufipogon*, *Sacciolepis interrupta* etc. The cultivated fields in the highlands are dominated by weeds like *Panicum repens*, *Chrysopogon aciculatus*, *Alloteropsis cimicina*, *Axonopus compressus*, *Eleusine indica*, etc.

2. Subtropical montane forests or southern subtropical hill forests

This type is found above an altitude of 1500 m in the High Ranges of Kerala. They are confined to depressions and sheltered folds. These are generally called 'sholas' and are non-regenerating and fast receding. Although comparable to the evergreen forests, the vegetation is not as luxuriant. Low stature of trees of these forest are due to high velocity of wind, less favourable conditions of soil, frost during cold season and fire during summer. The trees are short (15 - 20 m high). The common trees in the first storey are *Actinodaphne bourdillonii*, *A. bourneae*, *A. lanata*, *A. salicina*, *Callicarpa tomentosa*, *Chionanthus courtallensis*, *Cryptocarya lawsonii*, *C. neilgherrensis*, *Daphniphyllum neilgherrense*, *Glochidion* spp., *Ficus arnottiana*, *Eurya nitida*, *Gordonia obtusa*, *Heritiera papilo*, *Maesa indica*, *Neolitsea cassia* and *Persea macrantha*.

The second storey is formed of *Canthium rheedii*, *C. dicoccum*, *Cinnamomum* spp., *Memecylon angustifolium*, *Scleropyrum pentandrum*, *Microtropis ramiflora*, *Pavetta brevifolia*, *Pittosporum* spp., *Symplocos* spp. and *Syzygium* spp.

The floor of these sholas are generally covered by *Arundinaria* spp., *Elatostema* spp., *Nilgirianthus foliosus*, *N. heyneanus*, *Pogostemon purpurascens*, *Polygala arillata*, *Psychotria* spp., *Viola serpens*, etc. A number of pteridophytes also occur in this type (species of *Asplenium*, *Selaginella*, *Osmunda*, etc.). *Aerides crispum*, *A. ringens*, *Coelogyne* spp., *Eria reticosa*, *E. dalzelli*, *E. nana*, etc. are common epiphytic orchids in this region. The ground orchids encountered in this region are *Calanthe triplicata*, *Habenaria* spp. and *Peristylus* spp.

3. Southern dry mixed deciduous forests

This type is of limited occurrence in Kerala mostly in some areas of Palakkad District. This forest biome is characterized by light unstoreyed

canopies and are located at lower elevations (300 - 900 m) enjoying less rainfall (100 - 200 cm). The dominant trees of these forest are: *Albizia amara*, *Anogeissus latifolia*, *Bauhinia* spp., *Buchanania lanzan*, *Butea monosperma*, *Dillenia pentagyna*, *Ehretia laevis*, *Phyllanthus emblica*, *Garuga pinnata*, *Gmelina arborea*, *Haldina cordifolia*, *Pterocarpus marsupium*, *Semecarpus anacardium*, *Sterculia* spp., *Terminalia* spp., etc. The small trees and shrubs are: *Acacia pennata*, *Carissa congesta*, *Desmodium* spp., *Holarrhena pubescens*, *Leea indica*, *Solanum* spp. and *Zingiber* spp. The ground flora consists of *Corchorus aestuans*, *Crotalaria* spp., *Desmodium* spp., *Sida* spp., *Mimosa pudica*, *Apluda mutica*, *Eragrostis* spp., *Oplismenus* spp., *Themeda* spp. etc., Large formations of Bamboos, like species of *Dendrocalamus* are also seen.

4. Southern tropical thorny forests

These forests are not common in the western slopes of Western Ghats. Laterite scrubs which are comparable to the "scrub jungles" are found in a few places in the northern most part of Kerala. These are characterised by the presence of stunted deciduous trees like *Bridelia retusa*, *Butea monosperma*, *Cassia fistula*, *Diospyros candolleana*, *Holarrhena pubescens*, *Santalum album*, *Strychnos nux-vomica*, *Tectona grandis*, *Terminalia bellirica*, *T. paniculata*, etc. The common shrubs comprise *Flacourtia indica*, *Gardenia* spp., *Ixora coccinea*, *Ziziphus* spp., etc. The common climbers among them are *Cissus quadrangularis*, *Cyclea peltata*, *Calicopteris floribunda*, *Hemidesmus indicus*, *Ichnocarpus frutescens*, *Jasminum* spp. and *Tylophora* spp. The undergrowth is poor and consists of grasses and herbaceous species of *Barleria*, *Blepharis*, *Borreria*, etc.

FLORISTIC DIVERSITY

Angiosperms

Owing to the position it occupies in the South-Western corner of the peninsula and having the southern part of the Western Ghats as its eastern boundary, Kerala is considered the most important biogeographic region in peninsular India. It falls under the "Malabar region" of the nine Botanical regions of India.

Out of the 19,000 taxa of flowering plants described from India over 4000 species are to be found in the state. Although there is no authentic

estimate of the floristic diversity of the state, the plant explorations conducted by various agencies in the state including the Botanical Survey of India, corroborates the above fact. M. Mohanan and Henry (1994) recorded 1336 species of vascular plants in 251 genera spread over 195 families from Thiruvananthapuram District. C.N. Mohanan (1984) collected 1400 species in 160 families from Kollam District which is adjacent to Thiruvananthapuram District. From Kottayam District, Antony (1989) reported 1151 species (731 genera and 184 families). These three Districts represents a cross-section of south and central Kerala which is equivalent to the erstwhile Thiru-Cochi state. From Malabar region (North Kerala) Palakkad (Vajravelu, 1990) accounts for 1355 species belonging to 737 genera and 196 families. Silent Valley with an area of 39,100 hectares alone contains 966 flowering plants in 559 genera and 234 families. Ramachandran and V.J. Nair (1988) explored Kannur District including a part of present Wynaad also and reported 1132 species of flowering plants in 658 genera. From Kasaragode, which is the northern most end of Kerala, Ansari (1985) enumerated 890 species of vascular plants belonging to 550 genera and 142 families. Similar studies were also undertaken in Thenmala (Subramanyam, 1980), Idukki (Shetty and Vivekananthan, 1971, 1981) and Pooyamkutty (Nair, 1988). These reports include several endemics and new taxa.

An analysis of the available data on the floristic diversity of the state indicates that family Poaceae will top the ten largest families in Kerala which is the same as in Madras Presidency and India. Fabaceae, Orchidaceae, Acanthaceae, Euphorbiaceae, Cyperaceae, Asteraceae, Rubiaceae, Lamiaceae and Scrophulariaceae will follow. The exact species content of these families will be determined soon. An analysis of the grass flora of Kerala (Sreekumar and Nair, 1991) revealed the presence of a total of 296 species belonging to 106 genera and 24 tribes. Interestingly, this study has also resulted in the discovery of 2 new genera *viz.* *Chandrasekharania* and *Silentvalleya* and 26 new species in addition to several other records. Out of the 24 species of Bamboos in peninsular India (Bahadur and Jain, 1983) 10 species in 8 genera are present in Kerala.

Leguminosae, the third largest family in the world (ca 18,000 spp.) is well represented in Kerala. Over 338 species of legumes out of the 982 species reported from India occur in Western Ghats of which 44 species are economically important (Sanjappa, 1991). Most of these are found in Kerala also.

Orchids are another fascinating group of flowering plants exhibiting maximum diversity. About 267 species of orchids belonging to 72 genera are reported from Western Ghats (Satheesh Kumar, 1991) of which over 214 species are collected from Kerala also. The occurrence of the lonely south Indian ladies slipper orchid *Paphiopedilum druryi* in Thiruvananthapuram District is a striking aspect of Kerala flora.

Acanthaceae also contributed much to the floristic diversity of the state. It is represented by several species of *Nilgirianthus*, *Justicia*, *Acanthus* and a new genus *Kanjarum* from Palakkad.

A predominantly herbaceous family the Asteraceae is common with a few arborecent *Vernonias* viz. *V. monosis* and *V. travancorica*.

Rubiaceae is another well represented family with several species in the genera like *Ixora*, *Lasianthus*, *Hedyotis*, *Psychotria*, *Ophiorrhiza* etc.

Asclepiadaceae with highly specialized floral structure contribute 55 taxa (51 species and 4 infraspecific taxa) distributed in 23 genera (Swarupanandan, 1991).

About 40 species of Aroids are reported from Western Ghats, of which many have been collected from the political boundary of Kerala. Kammathy (1983) reported 81 species of Commelinaceae in India of which 45 are from the Western Ghats. Most of them are present in the Kerala region also. Palmae is another family with moderate representation in the state. These include the endemic *Bentinckia condapanna*, *Pinanga dicksonii* and several species of *Calamus*.

Impatiens (Balsaminaceae) a non-endemic genus attained the maximum development in the hill ranges of Kerala with several endemic species. Nair (1991) gave a list of endemic *Impatiens* restricted to certain localities in which 7 are from to Wynaad and 20 from High Ranges of Idukki.

In the enumeration of endemic species of Western Ghats (Shetty and Vivekananthan 1991) 18 endemic *Impatiens* species are from Kerala region alone. Most of these are horticulturally important species.

The other important families which contribute to the floristic diversity of Kerala by their widespread development are Piperaceae with 15 species including *Piper nigrum*, the pepper of commerce and the medicinal *Piper longum*; Zingiberaceae, Santalaceae with the sandal wood of commerce, Clusiaceae, Dipterocarpaceae and Myristicaceae.

The parasites are spread over the families Balanophoraceae, Convolvulaceae, Lauraceae, Loranthaceae, Olacaceae, Opiliaceae, Orobanchaceae, Santalaceae, Scrophulariaceae, etc.

The saprophytes are chiefly the members of Burmanniaceae and Orchidaceae. Floristic diversity of Kerala is further evidenced by the presence of over ten species of curious insectivorous plants in the genus *Utricularia* and 3 species in the genus *Drosera*.

Another remarkable feature of Kerala flora is the presence of a vesselless angiosperm, *Sarcandra chloranthoides* (Chloranthaceae) and plants with defence mechanisms like blistering principles (*Holigarna* spp.) and stinging hairs (*Laportea* spp. and *Tragia* spp.). Several submerged delicate members which are attached to the rocks of Kerala rivers are reported by Nagendran and Areckal (1985).

Gymnosperms

The Gymnospermous flora is poorly represented in the state. The presence of the lonely conifer of southern India *Nageia wallichianus* (= *Deccussocarpus wallichianus*) of Cycadales which has become rare is an unique feature of the flora. Raghavan Nair (1991) has noticed abundant natural regeneration of this species in Goodrical Reserve of the Ranni Forest Division. The widespread *Cycas circinalis* (Cycadales) and *Gnetum ula* (Gnetales) are the other two representatives from this group.

Pteridophytes

Madhusoodanan (1991) estimated about 200 ferns from Kerala and reviewed the earlier work done on this group of plants in Kerala. Vohra, Roychowdhary, Ghosh, Kar and Singh (1982) recorded about 78 species of Pteridophytes from a single expedition trip to Silent Valley. A comprehensive account on the Pteridophytic flora of Kerala was prepared by

Nair, Ghosh and Bhargavan (1988) who have reported 272 species and 13 infraspecific categories of pteridophytes belonging to 85 genera spread over 30 families including 7 endemics. As Nair (1986) states, the most graceful ones among this group are the gigantic tree ferns (*Cyathia* spp.) and the robust ones like *Angiopteris evecta*, *Marattia fraxinea*, *Osmunda regalis*, *Blechnum orientale*, etc.

Bryophytes

Out of the 728 taxa of Liverworts known from the country 225 species occur in southern India (Udar and Srivastava, 1975, 1977) most of which are known from Western Ghats of Kerala also. Except a few reports like Rajeevan (1985) who reported 55 species of Liverworts and 54 species of Mosses from Idukki and Vohra et al. (1982) who reported 83 species of Mosses from Silent Valley, our knowledge about the Bryophytes of Kerala is very poor.

Algae

Apart from a few sporadic collections made by college students and teachers (Panickar and students of Kollam S.N. College), the only information available on this highly interesting group is that of Srivastava (1985) who recorded 231 species of Algae from Idukki of which 109 belong to Chlorophyceae, 11 to Bacillariophyceae, 56 to Cyanophyceae, 3 to Xanthophyceae and two each to Euglenophyceae and Rhodophyceae. It is a challenge for the Botany Departments of the universities of Kerala to venture into the research on Algology.

Fungi

This is another group of plants for which only inadequate information is available. The fact that only 600 species of fungi are recorded from the Western Ghats (Bilgrami et al., 1979) compared to 1,20,000 species occurring in the world indicate the urgent need to investigate this group not only in Kerala but in the whole country as well. Natarajan and Raman (1983) have studied the Agaricales of Western Ghat region of Kerala and Tamil Nadu and recorded 83 species of which 23 are from Kerala. A total of 328 Microfungi are reported from Kerala (Varghese,

1984). Hosagoudar (1985) studied the fungal flora of a limited area in Idukki District and recorded 155 pathogenic Microfungi which included several new taxa and new records also. Hosagoudar (1996) has also attempted to compile the available information on "The Fungi of Kerala" besides preparing a monograph on "The Meliolales of India" (1996) in which most of the species are from the Western Ghat region of Kerala. Accordingly there are 1044 taxa of fungi belonging to 414 genera recorded so far from Kerala.

Lichens

The Lichen flora of Kerala is poorly known. James (James et al., 1981) pointed out that the moist forest of the tropics are rich in Lichens. In the moist shady places of the deciduous forest of Kerala also many Foliose Lichen genera like *Physcia*, *Pyxia*, *Dirinaria*, *Heterodermia*, *Parmelia*, *Leptogium* etc. are found. Crustose Lichens are also common. From Silent Valley, (Vohra et al. 1982) recorded 77 species during the single exploration trip.

ENDEMISM

Angiosperms

The first attempt to compile an exhaustive list of the endemic plants of the state was made by Singh and Subramanyam (1991) who estimated a total of 3535 plant species from Kerala (the source of this estimate is not known) of which 108 species are endemics to Kerala. According to them, there are 25 endemic species in northern Kerala, of which 4 are distributed in the upper ghats; 17 species in the middle ghats and 4 in the lower ghats including the plains. Out of the 29 species of endemics present in central Kerala 11 are found in the upper ghats, 8 in middle ghats and 10 in lower ghats. The southern Kerala is with comparatively more number of endemics; there are 61 endemics of which 10 are confined to upper ghats, 28 to middle ghats and 22 to lower ghats and plains. More exhaustive is the list provided by Chand Bhasha and Nair (1991) which contains 115 endemic species of which 36 are found in Tamil Nadu also. The list given in Table II is also not very exhaustive.

Table II
Endemic Taxa of Angiosperms

Name of the species	Family	Distribution
<i>Acampe congesta</i>	Orchidaceae	Malabar
<i>Actinodaphne campanulata</i> var. <i>obtusata</i>	Lauraceae	T. puram
<i>Adenosma malabaricum</i>	Scrophulariaceae	Malabar and Kottayam
<i>Aglaiia matae</i>	Meliaceae	Aryankavu
<i>Alpinia smithiae</i>	Zingiberaceae	Palakkad
<i>Amorphophalus smithsonianus</i>	Araceae	Kerala
<i>Anaphalis barnesii</i>	Asteraceae	Idukki
<i>Ardisia stoneli</i>	Myrsinaceae	Kollam
<i>Arisaema agasthyanum</i>	Araceae	T. Puram
<i>A. auriculata</i>	Araceae	Nilambur
<i>A. peltatum</i>	Araceae	Idukki
<i>A. psittacus</i>	Araceae	Idukki
<i>A. saracenooides</i>	Araceae	Munnar
<i>Arundinella cannanorica</i>	Poaceae	Kannur
<i>Asteriastigma macrocarpa</i>	Flacourtiaceae	Travancore
<i>Atuna travancorica</i>	Rosaceae	Travancore
<i>Bhidea fischeri</i>	Poaceae	Kannur
<i>Blepharistemma membranifolia</i>	Rhizophoraceae	Travancore
<i>Bombax scopulorum</i>	Bombacaceae	Travancore
<i>Bothriochloa parameswaranii</i>	Poaceae	Eravikulam
<i>Buchanania barberi</i>	Anacardiaceae	Kollam
<i>B. lanceolata</i>	Anacardiaceae	Travancore
<i>Calamus travancoricus</i>	Palmae	Kollam
<i>Calliandra cynometroides</i>	Mimosaceae	Travancore
<i>Canthium pergracile</i>	Rubiaceae	Kollam

Name of the species	Family	Distribution
<i>Ceropegia beddomei</i>	Asclepiadaceae	T. puram and Idukki
<i>Chrysopogon thadulingamii</i>	Poaceae	Kannur
<i>Cinnanomum chemungianum</i>	Lauraceae	T. puram
<i>C. travancoricum</i>	Lauraceae	T. puram
<i>Clematis bourdillonii</i>	Ranunculaceae	T. puram
<i>Colubrina travancorica</i>	Rhamnaceae	Travancore
<i>Curcuma kannanorensis</i>	Zingiberaceae	Kannur
<i>Cyclea fissicalyx</i>	Menispermaceae	Wynaad
<i>Cynometra beddomei</i>	Fabaceae	Wynaad
<i>C. mimosoides</i>	Fabaceae	S. Kerala and Kannur
<i>Dalbergia beddomei</i>	Fabaceae	Silent Valley
<i>Derris benthamii</i> var. <i>travancorensis</i>	Fabaceae	Travancore
<i>Dialium travancoricum</i>	Fabaceae	Ponmudi
<i>Dicraea filifolia</i>	Podostemaceae	Parambikulam
<i>Didymocarpus macrostachya</i>	Gesneriaceae	Idukki
<i>Dimeria borii</i>	Poaceae	Kozhikode
<i>D. chelariensis</i>	Poaceae	Malappuram
<i>D. copeana</i>	Poaceae	Central Kerala
<i>D. eradii</i>	Poaceae	Malappuram, Idukki
<i>D. idukkiensis</i>	Poaceae	Idukki
<i>D. jainii</i>	Poaceae	Kozhikode
<i>D. kanjirapallilana</i>	Poaceae	Idukki and Kollam
<i>D. keralense</i>	Poaceae	Kannur
<i>D. kurumthotticalana</i>	Poaceae	Idukki
<i>D. raizadae</i>	Poaceae	Kozhikode
<i>D. sreenarayanii</i>	Poaceae	Idukki

Name of the species	Family	Distribution
<i>Dysoxylum beddomei</i>	Meliaceae	Idukki, Travancore
<i>Eria boneccordensis</i>	Orchidaceae	T. puram
<i>E. muscicola</i> var. <i>brevilingis</i>	Orchidaceae	T. puram
<i>E. muscicola</i> var. <i>ponmudiana</i>	Orchidaceae	T. puram
<i>E. tiagii</i>	Orchidaceae	Silent Valley
<i>Eugenia argentea</i>	Myrtaceae	Wynaad
<i>Exacum courtallense</i> var. <i>boneccordensis</i>	Gentianaceae	T. puram
<i>Fimbristylis angamoozhensis</i>	Cyperaceae	Pathanamthitta
<i>F. pseudonarayanii</i>	Cyperaceae	Thenmala
<i>Fuirena ponmudiensis</i>	Cyperaceae	Ponmudi
<i>Garcinia imberti</i>	Clusiaceae	S. travancore
<i>Garnotia puchiparensis</i>	Poaceae	Silent Valley
<i>Gomphostemma keralensis</i>	Lamiaceae	Idukki
<i>Haplothismia exanulata</i>	Burmanniaceae	Parambikulam
<i>Hedyotis bourdillonii</i>	Rubiaceae	Travancore
<i>H. santapaui</i>	Rubiaceae	Idukki
<i>H. silent-valleyensis</i>	Rubiaceae	Silent Valley
<i>H. wynaadensis</i>	Rubiaceae	Wynaad
<i>Heterostemma vasudevani</i>	Asclepiadaceae	Sabarimala
<i>Hibiscus sreenarayanianus</i>	Malvaceae	Kollam
<i>Humboldtia trijuga</i>	Caesalpiniaceae	T. puram
<i>H. decurrens</i>	Caesalpiniaceae	Travancore
<i>Hydnocarpus pendulus</i>	Flacourtiaceae	Silent Valley
<i>Hydrobryum johnsonii</i>	Podostemaceae	Malabar
<i>Impatiens aliciae</i>	Balsaminaceae	Munnar
<i>I. anaimudica</i>	Balsaminaceae	Idukki
<i>I. cochinica</i>	Balsaminaceae	Ernakulam
<i>I. coelotropis</i>	Balsaminaceae	Idukki

Name of the species	Family	Distribution
<i>I. concinna</i>	Balsaminaceae	Malabar
<i>I. johnii</i>	Balsaminaceae	Idukki
<i>I. leptura</i>	Balsaminaceae	Travancore
<i>I. macrocarpa</i>	Balsaminaceae	Devikulam
<i>I. munnarensis</i>	Balsaminaceae	Devikulam
<i>I. pandata</i>	Balsaminaceae	Devikulam
<i>I. platyadena</i>	Balsaminaceae	Devikulam
<i>I. pallidiflora</i>	Balsaminaceae	Idukki
<i>I. rivulicola</i>	Balsaminaceae	Travancore
<i>I. verucunda</i>	Balsaminaceae	Idukki
<i>Inga cynometroides</i>	Fabaceae	Kollam
<i>Ipsea malabarica</i>	Orchidaceae	Silent Valley
<i>Isachne fischeri</i>	Poaceae	Ernakulam
<i>I. setosa</i>	Poaceae	Cochin
<i>Ischaemum agastyamalayanum</i>	Poaceae	T. puram and Idukki
<i>I. calicutensis</i>	Poaceae	Kozhikode
<i>I. kannanorensis</i>	Poaceae	Kannur
<i>I. copeanum</i>	Poaceae	Kannur
<i>I. elimalayanum</i>	Poaceae	Kannur
<i>I. jayachandranii</i>	Poaceae	Kannur
<i>I. malabaricum</i>	Poaceae	Kannur and Kozhikode
<i>I. nairii</i>	Poaceae	Kannur
<i>I. rauli</i>	Poaceae	Kannur
<i>I. tadulingamii</i>	Poaceae	Idukki
<i>I. travancorensis</i>	Poaceae	Alapuzha
<i>I. vembanadense</i>	Poaceae	Alapuzha
<i>Ixora johnsonii</i>	Rubiaceae	Cochin

Name of the species	Family	Distribution
<i>I. agasthyamalayana</i>	Rubiaceae	T. puram
<i>Kanjarum palghatense</i>	Acanthaceae	Palakkad
<i>Kunstleria keralensis</i>	Fabaceae	Kollam
<i>Lagenandra nairii</i>	Araceae	Trichur
<i>Leucas vestita</i> var. <i>devicolamensis</i>	Lamiaceae	Devikulam
<i>Limnopoa meeboldii</i>	Poaceae	Ernakulam and Kasaragod
<i>Liparis indiraii</i>	Orchidaceae	Silent Valley
<i>Litsea travancorica</i>	Lauraceae	Kollam
<i>Loesneriella bourdillonii</i>	Hippocrateaceae	S. travancore
<i>Madhuca bourdillonii</i>	Sapotaceae	Kollam and Trissur
<i>Nothopegia beddomei</i> var. <i>wynaadica</i>	Anacardiaceae	Kannur
<i>Nymphoides krishnakesara</i>	Menyanthaceae	Kerala
<i>N. macrocarpa</i>	Menyanthaceae	Kerala
<i>N. sivarajanii</i>	Menyanthaceae	Kerala
<i>Oberonia bisulcata</i>	Orchidaceae	Silent Valley
<i>O. chandrasekharanii</i>	Orchidaceae	Kannur
<i>O. sebastiana</i>	Orchidaceae	Idukki
<i>Ochlandra ebracteata</i>	Poaceae	T. puram
<i>O. travancorica</i> var. <i>hirsuta</i>	Poaceae	Travancore
<i>Ochreinauclea missonis</i>	Rubiaceae	Kerala
<i>Oianthus beddomei</i>	Asclepiadaceae	Wynaad
<i>Ophiorrhiza barnesii</i>	Rubiaceae	Idukki
<i>O. incarnata</i>	Rubiaceae	Kerala
<i>O. munnarensis</i>	Rubiaceae	Munnar
<i>Oxytenanthera bourdillonii</i>	Bambusaceae	Kerala
<i>Palaquium bourdillonii</i>	Sapotaceae	Kollam
<i>Piper silentvalleyensis</i>	Piperaceae	Silent Valley

Name of the species	Family	Distribution
<i>Phaeanthus malabaricus</i>	Annonaceae	Wynaad and Kozhikode
<i>Pogostemon travancoricus</i> var. <i>travancoricus</i>	Lamiaceae	T. puram
<i>P. travancoricus</i> var. <i>devicolamensis</i>	Lamiaceae	Devikulam
<i>Polyalthia shendurunii</i>	Annonaceae	Kollam
<i>Porpax chandrasekharanii</i>	Orchidaceae	Silent Valley
<i>Pothos crassipedunculatus</i>	Araceae	T. puram
<i>Rotala cookii</i>	Lythraceae	Kerala
<i>R. malabarica</i>	Lythraceae	Kerala
<i>R. vasudevani</i>	Lythraceae	Kerala
<i>Sageraea grandiflora</i>	Annonaceae	Kollam
<i>Schefflera bourdillonii</i>	Araliaceae	Chemungi (T. puram)
<i>S. chandrasekharanii</i>	Araliaceae	Idukki
<i>Silentvalleya nairii</i>	Poaceae	Silent Valley
<i>Smithia vencobarawii</i>	Fabaceae	Idukki
<i>Sonerilla nemakadensis</i>	Melastomataceae	Idukki
<i>S. wynaadensis</i>	Melastomataceae	Wynaad
<i>Syzygium bourdillonii</i>	Myrtaceae	Kollam
<i>S. palghatense</i>	Myrtaceae	Palakkad
<i>S. parameswaranii</i>	Myrtaceae	T. puram
<i>S. travancoricum</i>	Myrtaceae	Travancore
<i>Taeniophyllum scaberulum</i>	Orchidaceae	Kottayam
<i>Tephrosia wynaadensis</i>	Fabaceae	S. Travancore
<i>Thottea dinghoui</i>	Aristolochiaceae	Moozhiyar
<i>T. ponmudiana</i>	Aristolochiaceae	Ponmudi
<i>Toxocarpus palghatensis</i>	Asclepiadaceae	Palakkad
<i>Tripogon ananthaswamianus</i>	Poaceae	Idukki

Name of the species	Family	Distribution
<i>T. narayanii</i>	Poaceae	Idukki
<i>Utricularia nayarii</i>	Lentibulariaceae	Idukki
<i>Vanilla wightiana</i>	Orchidaceae	T. puram
<i>Vernonia anaimudica</i>	Asteraceae	T. puram
<i>V. multibracteata</i>	Asteraceae	Peerumedu
<i>Zenkeria jainii</i>	Poaceae	Idukki

Study of endemism in the familial or generic level within Kerala State has not been attempted in the past except in a few cases. Karthikeyan (1982) estimated 13 genera and 155 species of endemic grasses from peninsular India. Most of them occur in Kerala also. A comprehensive floristic account of the grasses of Kerala prepared by Sreekumar and Nair (1991) lists 37 endemic species from Kerala belonging to 14 genera which is about 11.8% of the total number of grasses found in the state. Distribution of the endemic arborescent evergreen species of the Western Ghats including the Kerala region was discussed by Ramesh and Pascal (1991) with a view to understanding the underlying ecological, edaphic and anthropogenic factors responsible for their restricted distribution (Sanjappa 1991). Enumerated 80 endemic taxa of Leguminosae from Western Ghats of which only 16 are confined to Kerala. Jain and Ved Prakash (1995) studied the phytogeography and endemism of Indian Zingiberaceae which is comparatively poor in endemic concentration. Among the other families Balsaminaceae tops with 14 species of endemics, Rubiaceae with 10 and Orchidaceae 6.

Cryptogams

Kerala has a rich concentration of Pteridophytes but the endemism exhibited by this group is comparatively poor. Out of the 285 taxa of Pteridophytes reported from Kerala only 7 species in 6 genera are endemics (Nair et al. 1988). They are *Asplenium grevillei*, *Polystichum travancoricum*, *Bolbitis appendiculata* ssp. *appendiculata*, *Diplazium travancoricum*, *Grammitis palifera*, *Pteris furrunculata* and *Pteris silentvalliensis*. Our knowledge about the other groups (Bryophytes, Algae, Fungi and Lichens) are so meagre that no attempt is made here to analyse the endemism in these groups.

PHYTOGEOGRAPHY

Flora of Kerala show striking similarity with many countries of the Middle East, Central Asia, China and East Africa besides Australia and America. The flora of the state is formed by a mixture of intertropical, subtropical, extra-tropical, pantropical and cosmopolitan families.

Intertropical

Though limited in continental distribution, the intertropical flora is chiefly represented by trees and shrubs. Dipterocarpaceae is the chief family represented by many rare and endemic species of *Hopea*, *Vateria* and *Dipterocarpus*. Ramesh and Pascal (1991) reported 13 species of Dipterocarpaceae out of which 12 are endemics. *Dipterocarpus bourdillonii* and *D. indicus* are dominant in low level evergreen forest of Travancore, the former shows disjunct distribution while the latter widely and evenly distributed. Similarly *Vateria* has two species one with wider distribution (*V. indica*) and the other (*V. macrocarpa*) restricted to Palakkad. *Hopea* has 8 species with two centres of speciation.

Intertropical constituents of mangrove forest are represented in Kerala by members of *Avicennia* (Avicenniaceae), *Rhizophora* (Rhizophoraceae), *Sonneratia* (Sonneratiaceae) and the endemic *Blepharistemma* along the backwaters. Paleotropic members of Pandanaceae and African *Dichapetalum* are also seen.

Subtropical and Extratropical

They are generally seen in the mountainous region. Compositae are the best example represented by tree forms like *Vernonia monosis* and *V. travancorica* and many other species. Other families are Myrtaceae with several endemics in *Syzygium* and *Eugenia*, Magnoliaceae, Theaceae and Oleaceae with many wild as well as cultivated species.

Cosmopolitan

These are members of intertropical zones commonly found in families like Leguminosae, Rubiaceae, Euphorbiaceae, Gramineae, Palmae, Rutaceae and Moraceae. Leguminosae are well developed with many members from pantropic genera like *Dalbergia*, *Millettia*, *Pterocarpus* and

paleotropic *Derris*. *Moulluva* is a monotypic endemic restricted to Western Ghats. *Cassia*, *Caesalpinia* and *Bauhinia* are American genera while African genera include *Dialium* with an endemic *D. travancoricum*. *Cynometra* is a pantropic genus, paleotropic *Albizia* and *Xylia* are also common. Euphorbiaceae are also well represented by several endemics. Malesian genus *Baccaurea* is represented by *B. courtallensis*. Shrubs and herbs of the understoreys of forest representing Rubiaceae are the paleotropic *Canthium*, *Lasianthus*, *Mussaenda*, etc. *Ixora*, *Psychotria* and *Pavetta* are pantropic genera. *Palmae* are moderately represented by endemics like *Bentinckia*, *Pinanga* and *Arenga*. Many species of *Calamus* are also met with. Another fairly represented cosmopolitan family is Gramineae.

Pantropic families

These are those occurring throughout tropics such as Anacardiaceae, Agavaceae, Annonaceae, Apocynaceae, Bignoniaceae, Bombacaceae, Burseraceae, Chrysobalanaceae, Combretaceae, Clusiaceae, Myristicaceae, Simaroubaceae, Verbenaceae, Elaeocarpaceae, etc.

Tropical Asiatic elements

These elements in the flora of Kerala are mostly confined to Indo-Chinese and Malayan region. *Uvaria*, *Goniothalamus*, *Garcinia*, *Saraca*, *Xylia*, *Terminalia*, *Medinella*, *Tetracera*, *Acrotrema*, *Myristica*, *Persea*, *Litsea*, *Anthocephalus*, *Haldina*, *Hedyotis*, *Knoxia* and *Lasianthus* are the common tropical Asiatic genera.

Temperate elements

These are mainly of European origin. *Clematis*, *Viburnum*, *Rubia*, *Anaphalis*, *Senecio*, etc. are well represented.

Mediterranean elements

These are well represented in Brassicaceae and Caryophyllaceae. *Jasminum* and *Diospyros* are sino-Japanese entries to Kerala.

African elements

Examples for these are *Erythralium*, *Acacia*, *Geissapsis*, *Tamarindus*, *Cryptostegia*, *Petalium*, *Ricinus*, *Humboldtia*, *Alstonia*, etc.

Arabian genera found in Kerala are *Acacia*, *Heliotropium* and *Dodonaea*. American representation is less common, weeds of wastelands and cultivated fields like *Eupatorium*, *Parthenium*, *Lantana*, etc. are American genera.

Affinity with Sri Lankan Flora

The flora of Kerala shows some similarity to that of Sri Lanka. The typical Sri Lankan elements present in the Kerala flora are *Acacia torta*, *Aidia gardneri*, *Albizia amara*, *Andrographis zeylanica*, *Begonia malabarica*, *Cayratia pedata*, *Chrysoglossum maculatum*, *Clematis gouriana*, *Eria muscicola*, *Exacum walkeri*, *Fagraea ceilanica*, *Filicium decipiens*, *Garcinia echinocarpa*, *Gordonia obtusa*, *Phaius luridus*, *Rubus micropetalus*, etc. Those which are restricted to peninsular India and Sri Lanka are *Apocopsis courtallensis*, *A. mangalorensis*, *Artabotrys zeylanica*, *Capparis divaricata*, *Firmiana colorata*, *Gouania microcarpa*, *Hedyotis indica*, *Harpullia arborea*, *Hydrophylax maritima*, *Ischaemum mangaloricum*, *I. zeylanicum*, *Mesua ferrea*, *Naravelia zeylanica*, *Neurocalyx zeylanicus*, *Polyalthia korintii*, *Puria trilobata*, *Schumannianthus virgatus*, *Syzygium lanceolatum*, *Tarenna asiatica*, *Tephrosia hookeriana*, *Tetrastigma leucostaphylum*, *Thottea siliquosa* and *Ziziphus xylocarpus*.

Affinity with the flora of other regions of India

Flora of Kerala shows marked affinity with flora of other regions of the country like North-East India, Himalayas, and Eastern Ghats. Arora (1964) observes that 98 families of woody dicotyledons are common for Assam and Western Ghats. Several plants are common to Eastern Ghats and Western Ghats of Kerala also. Presence of *Rhododendron nilagiricum* in the Anaimudis shows its Himalayan affinity.

ECONOMIC USES

Over 3,000 species of the flowering plants in India are economically important besides 152 species of domesticated plants. A correct

estimate of the economically useful plants of India is not available. For Kerala also proper and adequate documentation of the economic aspects of the forest are not yet available.

The major crops cultivated in Kerala are Cereals like *Oryza sativa*, *Eleusine coracana* pulses like *Cajanus cajan*, *Cicer arietinum*, *Vigna mungo*, etc.

The common vegetables and fruit plants grown are *Amorphophallus paeoniifolius*, *Anacardium occidentale*, *Citrus* spp., *Citrullus lanatus*, *Colocasia esculenta*, *Lablab purpureus*, *Mangifera indica*, *Manihot esculenta*, *Musa* spp., *Artocarpus heterophyllus*, *Canavalia gladiata*, *Solanum melongena*, *Momordica charantia*, *Annona reticulata*, *Averrhoa carambola*, *Chrysophyllum cainito*, *Sesamum orientale*, etc.

The plantation crops include *Artocarpus hirsutus*, *Coffea arabica*, *C. robusta*, *Hevea braziliensis*, *Camellia sinensis*, *Theobroma cocoa*, *Hopea* spp., *Tectona grandis*, *Cinnamomum verum*, *Curcuma longa*, *Elettaria cardamomum*, *Piper nigrum* and *Zingiber officinalis*. The other widely cultivated plants are: *Areca catechu*, *Cocos nucifera*, *Nicotiana tabacum*, *Saccharum officinarum*, etc.

The major timber yielding plants are *Albizia odoratissima*, *Anogeissus latifolia*, *Artocarpus hirsutus*, *Dalbergia latifolia*, *D. sissoo*, *Haldina cordifolia*, *Hopea parviflora*, *H. ponga*, *Mesua ferrea*, *Pterocarpus marsupium*, *Swietenia mahogani*, *Tectona grandis*, *Tespesia populnea*, *Terminalia arjuna*, *T. tomentosa*, *Toona ciliata*, *Vateria indica* and *Xylia xylocarpa*.

In addition to these, several plants including orchids are cultivated for horticultural value.

Wild relatives of crop plants

Western Ghats form one of the centres in Indian subcontinent with maximum diversity in wild crop relatives (Velayudhan et al., 1991). Since these plants are the source of potential untapped genetic materials valuable for plant breeders, their preservation should receive adequate attention of the conservation biologists so that these heritable genetic wealth can be properly utilized in future plant improvement programmes. Scientists of the NBPGR Regional Research Station at Trissur, have extensively carried

out survey to collect and preserve the rich wild genetic resources of Kerala (Velayudhan et al., 1991). They have collected 84 species in 14 genera from different parts of Kerala including *Oryza officinalis*, *O. rufipogon*, *O. granulata*, *O. malampuzhaensis*, *O. nivara*, many species of *Piper*, *Curcuma*, etc. The other genera rich in wild crop relatives are *Alpinia*, *Amomum*, *Andropogon*, *Atylosia*, *Canavalia*, *Cinnamomum*, *Cissus*, *Coffea*, *Cymbopogon*, *Dioscorea*, *Eleusine*, *Elettaria*, *Garcinia*, *Glycine*, *Ipomoea*, *Lansium*, *Mangifera*, *Musa*, *Myristica*, *Nephalium*, *Panicum*, *Pennisetum*, *Phaseolus*, *Piper*, *Rauvolfia*, *Saccharum*, *Setaria*, *Vigna* and *Zingiber*.

Some important fiber yielding plants of Kerala are found in the genera *Abelmoschus*, *Acacia*, *Aglaiia*, *Bauhinia*, *Calicopteris*, *Cyathocalyx*, *Decaschistia*, *Hibiscus*, *Julostylis*, *Kydia*, *Polyalthia*, *Sterculia*, *Tetrastigma*, *Thespesia*, *Tylophora*, *Grewia*, *Helicteres*, *Rourea*, etc.

RARE AND THREATENED PLANTS

Information on rare and threatened flora of Kerala is also scarce although there are several scattered reports available (Henry et al., 1984; Jain and Sastry, 1980; Vajravelu and Daniel, 1983). These reports obviously contain some plants of Kerala also. Nair and Daniel (1986) compiled a detailed account on the rare and threatened taxa of different plant groups of Western Ghats. Sreekumar and Nair (1991) listed 19 rare grasses from Kerala. Of the 50 rare and threatened legumes listed by Sanjappa (1991) 20 occur in Kerala also. Binoy et al. (1991) and Mohanan and Henry (1994) have provided lists of rare and endangered plants of Agastyarkudam/Thiruvananthapuram region. Sasidharan (1991) recorded the rare trees in the forest of Thrissur District. A brief account of the rare and endemic aquatic angiosperms is dealt with by Joseph (1991). High Ranges in Idukki District of Kerala are a centre of speciation; Shetty and Vivekananthan (1991) reported 17 rare/threatened plants from this area. Mukthesh Kumar (1991) recorded the rare and endangered Bamboos of Western Ghats most of which are present in Kerala also. Renuka (1991) studied the rarity of Rattan population in the Western Ghats and stated that 10 of the 25 species of Rattans present in the Western Ghats of Kerala are endangered. Orchids form another unfortunate group of plants in Kerala facing threats of various kinds. Satheesh Kumar (1991) and Mukthesh Kumar (1991) have brought out the various threats and suggested conservation strategies. A list of very important rare/threatened plants (Angiosperms) is given in Table III.

Table III
Rare and Threatened Plants

Name of the species with family	Status	Distribution in Kerala
<i>Acacia wightii</i> (Mimosoideae)	R	Travancore
<i>Aeroceras munroanum</i> (Poaceae)	R	Kollam
<i>Adhatoda beddomei</i> (Acanthaceae)	R	Kerala
<i>Aglaia canarensis</i> (Meliaceae)	R	Kerala
<i>Ampelocissus indica</i> (Vitaceae)	V	S. Kerala
<i>Anaphyllum beddomei</i> (Araceae)	R	S. Kerala
<i>Aphyllorchis montana</i> (Orchidaceae)	R	Travancore
<i>Aporosa bourdillonii</i> (Euphorbiaceae)	R	C. Kerala
<i>Aralia malabarica</i> (Araliaceae)	R	N. Kerala
<i>Archidendron gracile</i> (Mimosoideae)	R	N. Kerala
<i>Ardisia blatteri</i> (Myrsinaceae)	R	C. Kerala
<i>Arisaema auriculata</i> (Araceae)	R	Nilambur
<i>Aspidopteris canarensis</i> (Lauraceae)	R	Kannur
<i>Begonia aliciae</i> (Begoniaceae)	I	Idukki
<i>Bentinckia condapanna</i> (Arecaceae)	V	S.Kerala
<i>Beilschmiedia wightii</i> (Lauraceae)	R	N. Kerala
<i>Blepharistemma membranifolia</i> (Rhizophoraceae)	E	S. Kerala
<i>Boesenbergia pulcherrima</i> (Zingiberaceae)	R	N. Kerala
<i>Brachycorythis wightii</i> (Orchidaceae)	E	Travancore
<i>Bulbophyllum aureum</i> (Orchidaceae)	E	Wynaad
<i>B. fusco-purpureum</i> (Orchidaceae)	R	Idukki
<i>Butea purpurea</i> (Fabaceae)	R	Kollam
<i>Calamus gamblei</i> (Arecaceae)	E	S. Kerala
<i>C. travancoricus</i> (Arecaceae)	R	Kerala
<i>C. vattayila</i> (Arecaceae)	E	Kerala
<i>Chilocarpus malabaricus</i> (Apocynaceae)	V	Wynaad
<i>Chilochista pusilla</i> (Orchidaceae)	E	S. Kerala

Name of the species with family	Status	Distribution in Kerala
<i>C. glandulosa</i> (Orchidaceae)	E	Ponmud
<i>Claoxylon anomalum</i> (Euphorbiaceae)	E	S. Kerala
<i>Cleistanthus travancoricus</i> (Euphorbiaceae)	V	S. Kerala
<i>Coelogyne mossiae</i> (Orchidaceae)	V	Idukki
<i>Cordia octandra</i> (Verbenaceae)	V	S. Kerala
<i>Cinnamomum perrotteti</i> (Lauraceae)	R	S. Kerala
<i>C. riparium</i> (Lauraceae)	R	S. Kerala
<i>C. travancoricum</i> (Lauraceae)	V	S. Kerala
<i>Crotalaria barbata</i> (Fabaceae)	R	Travancore
<i>C. bidiei</i> (Fabaceae)	R	Wynaad
<i>C. clarkei</i> (Fabaceae)	R	N. Kerala
<i>C. grahamiana</i> (Fabaceae)	R	N. Kerala
<i>C. peduncularis</i> (Fabaceae)	R	S. Kerala
<i>C. scabra</i> (Fabaceae)	R	S. Travancore
<i>Cryptocorine colubrina</i> (Araceae)	R	Kerala
<i>Cyanotis burmanniana</i> (commelinaceae)	V	S. Kerala
<i>Cynometra travancorica</i> (Fabaceae)	V	S. Travancore
<i>Dalbergia candidatensis</i> (Fabaceae)	E	Kollam
<i>Derris ferrugineum</i> ssp. <i>wynaadense</i> (Fabaceae)	R	N. Kerala
<i>Debregeasia ceylanica</i> (Urticaceae)	R	S. and N. Kerala
<i>Dendrobium wightii</i> (Orchidaceae)	R	Kannur
<i>Didymocarpus missonis</i> (Gesneriaceae)	R	S. Kerala
<i>Dimorphocalyx beddomei</i> (Euphorbiaceae)	R	S. Kerala
<i>Diospyros hirsutus</i> (Ebenaceae)	V	S. Kerala
<i>Drypetes confertiflora</i> (Euphorbiaceae)	V	S. Kerala
<i>D. malabarica</i> (Euphorbiaceae)	V	S. Kerala
<i>Dysoxylum filiforme</i> (Meliaceae)	V	S. Kerala
<i>Elaeocarpus gaussonii</i> (Elaeocarpaceae)	V	S. Kerala
<i>E. venusta</i> (Elaeocarpaceae)	V	S. Kerala
<i>Eria albiflora</i> (Orchidaceae)	R	Silent Valley

Name of the species with family	Status	Distribution in Kerala
<i>Eugenia discifera</i> (Myrtaceae)	E	S. Kerala
<i>E. floccosa</i> (Myrtaceae)	E	S. Kerala
<i>Eulophia cullenii</i> (Orchidaceae)	E	S. Kerala
<i>Glochidion bourdillonii</i> (Euphorbiaceae)	E	S. Kerala
<i>G. fagifolium</i> (Euphorbiaceae)	E	S. Kerala
<i>Goniothalamus wynaadensis</i> (Annonaceae)	V	Wynaad
<i>Gluta travancorica</i> (Anacardiaceae)	R	S. Kerala
<i>Gymnema khandalense</i> (Asclepiadaceae)	R	Palakkad
<i>Habenaria flabelliformis</i> (Orchidaceae)	I	Idukki
<i>H. barnesii</i> (Orchidaceae)	R	Idukki
<i>H. cephalotes</i> (Orchidaceae)	R	Travancore
<i>H. richardiana</i> (Orchidaceae)	V	Travancore
<i>Hedyotis beddomei</i> (Rubiaceae)	R	C. and N. Kerala
<i>H. devikulamensis</i> (Rubiaceae)	I	Idukki
<i>H. ramarowii</i> (Rubiaceae)	R	Idukki
<i>Hemicyclea travancorica</i> (Euphorbiaceae)	E	S. Kerala
<i>Hopea erosa</i> (Dipterocarpaceae)	E	Kannur
<i>H. racophloea</i> (Dipterocarpaceae)	E	Kannur
<i>Hetaeria ovalifolia</i> (Orchidaceae)	E	Travancore
<i>Hoya wightii</i> (Asclepiadaceae)	R	N. Kerala
<i>Humboldtia bourdillonii</i> (Caesalpinioideae)	E	S. Kerala
<i>Humboldtia decurrens</i> (Caesalpinioideae)	R	S. Kerala
<i>H. unijuga</i> (Caesalpinioideae)	E	S. Kerala
<i>Impatiens chinensis</i> var. <i>brevicornis</i> (Balsaminaceae)	R	Munnar
<i>I. dasysperma</i> (Balsaminaceae)	R	Kerala
<i>Ipsea malabarica</i> (Orchidaceae)	R	Kerala
<i>Isonandra villosa</i> (Sapotaceae)	I	N. Kerala
<i>Ixora johnsonii</i> (Rubiaceae)	R	Kerala
<i>Ixora lawsonii</i> (Rubiaceae)	V	N. Kerala
<i>Janakia arayalpathra</i> (Periplocaceae)	V	S. Kerala

Name of the species with family	Status	Distribution in Kerala
<i>Kingiodendron pinnata</i> (Caesalpiniaceae)	R	S. Kerala
<i>Lasianthus capitulatus</i> (Rubiaceae)	R	N. Kerala
<i>Loesneriella bourdillonii</i> (Hippocrateoideae)	V	S. and N. Kerala
<i>Malaxis latifolia</i> (Orchidaceae)	E	T. puram
<i>Mateoromyrtus wynaadensis</i> (Myrtaceae)	V	N. Kerala
<i>Memecylon angustifolium</i> (Melastomataceae)	V	S. Kerala
<i>M. gracile</i> (Melastomataceae)	R	S. Kerala
<i>M. lawsonii</i> (Melastomataceae)	R	N. Kerala
<i>Miquelia dentata</i> (Icacinaceae)	R	S. Kerala
<i>Mitrephora grandiflora</i> (Annonaceae)	R	N. Kerala
<i>Morinda reticulata</i> (Rubiaceae)	R	S. Kerala
<i>Myristica magnifica</i> (Myristicaceae)	V	S. Kerala
<i>M. malabarica</i> (Myristicaceae)	R	S. Kerala
<i>Nageia wallichianus</i> (Podocarpaceae)	E	S. Kerala
<i>Nilgirianthus beddomei</i> (Acanthaceae)	I	S. Kerala
<i>N. lupinus</i> (Acanthaceae)	I	Wynaad
<i>N. urceolaris</i> (Acanthaceae)	I	S. Kerala
<i>Nothopegia aureofulva</i> (Anacardiaceae)	R	S. Kerala
<i>N. travancorica</i> (Anacardiaceae)	R	S. Kerala
<i>Oberonia brachyphylla</i> (Orchidaceae)	R	Palakkad
<i>O. platycaulon</i> (Orchidaceae)	R	Kollam
<i>O. proudlockii</i> (Orchidaceae)	R	Kerala
<i>Ochlandra beddomei</i> (Poaceae)	V	Wynaad
<i>O. wightii</i> (Poaceae)	V	S. Kerala
<i>Octotropis travancorica</i> (Rubiaceae)	R	S. Kerala
<i>Orophea uniflora</i> (Annonaceae)	R	Kerala
<i>Ottonephalium stipulaceum</i> (Sapindaceae)	R	Kerala
<i>Palaquium bourdillonii</i> (Sapotaceae)	R	S. Kerala
<i>Phaeanthus malabaricus</i> (Annonaceae)	R	N. Kerala
<i>Paphiopedilum druryi</i> (Orchidaceae)	E	S. Kerala

Name of the species with family	Status	Distribution in Kerala
<i>Phalaenopsis decumbens</i> (Orchidaceae)	E	N. Kerala
<i>P. mysorensis</i> (Orchidaceae)	R	Palakkad
<i>Phlebophyllum lawsonii</i> (Acanthaceae)	R	S. Kerala
<i>Poeciloneuron pauciflorum</i> (Bonnetiaceae)	R	S. Kerala
<i>Polyalthia rufescens</i> (Annonaceae)	R	S. and C. Kerala
<i>Popowia beddomeana</i> (Annonaceae)	R	S. Kerala
<i>Pothos armatus</i> (Araceae)	V	S. Kerala
<i>Premna glaberrima</i> (Verbenaceae)	V	S. Kerala
<i>Pterospermum reticulatum</i> (Sterculiaceae)	V	S. and N. Kerala
<i>Robiquetia josephiana</i> (Orchidaceae)	R	Silent Valley
<i>Salacia beddomei</i> (Hippocrateaceae)	R	N. Kerala
<i>Sonerilla devicolamensis</i> (Melastomataceae)	R	Idukki
<i>S. travancorica</i> (Melastomataceae)	R	S. Kerala
<i>Symplocos monantha</i> (Symplocaceae)	E	S. Kerala
<i>Thrixspermum album</i> (Orchidaceae)	V	Silent Valley
<i>Trias stocksii</i> (Orchidaceae)	V	Kollam
<i>Vanilla wightiana</i> (Orchidaceae)	E	S. Kerala
<i>Vateria macrocarpa</i> (Dipterocarpaceae)	R	S. Kerala
<i>Vernonia gossypina</i> (Asteraceae)	R	N. Kerala
<i>V. heynei</i> (Asteraceae)	R	S. Travancore
<i>V. ramaswamii</i> (Asteraceae)	R	S. Travancore

E = Endangered I = Indeterminate R = Rare V = Vulnerable

Threatened Cryptogams

Nair et al. (1986) reported that 13 out of the 285 taxa of Pteridophytes of Kerala are rare and or threatened. Madhusoodanan (1991) gave a list of 7 fern-allies in 5 genera and 35 ferns in 30 genera of Pteridophytes from Kerala. A list of threatened Pteridophytes of Kerala is given separately (Table IV).

Table IV
Rare and Threatened Pteridophytes

<i>Adiantum ramyam</i> (Adiantaceae)	R	Wynaad
<i>A. capillis-veneris</i> (Adiantaceae)	I	W. Ghats
<i>Amphineuron terminans</i> (Thelypteridaceae)	R	Silent Valley
<i>A. tomentosa</i> (Thelypteridaceae)	R	Kallar
<i>Anemia wightiana</i> (Anemiaceae)	V	Silent Valley
<i>Angiopteris evecta</i> (Marattiaceae)	R	W. Ghats
<i>Anogramma leptophylla</i> (Marattiaceae)	R	W. Ghats
<i>Arachniodes aristata</i> (Aspidiaceae)	R	W. Ghats
<i>Anisocampium cunninghianum</i> (Athyriaceae)	R	Palakkad
<i>Asplenium phyllitidis</i> (Aspleniaceae)	R	Kerala
<i>Araiostegia pulchra</i> (Davalliaceae)	I	W. Ghats
<i>Bulbitis presliana</i> (Lomariopsidaceae)	R	W. Ghats
<i>Botrychium daucifolium</i> (Botrychiaceae)	V	Silent Valley Wynaad
<i>B. lanuginosum</i> (Botrychiaceae)	V	Silent Valley, W. Ghats
<i>B. virginianum</i> (Botrychiaceae)	V	Silent Valley, W. Ghats
<i>Cheilanthes farinosa</i> (Cheilanthaceae)	R	Throughout W. Ghats
<i>Christella papilio</i> (Thelypteridaceae)	E	Silent Valley
<i>Cyathea gigantea</i> (Cyatheaceae)	R	W. Ghats
<i>C. spinulosa</i> (Cyatheaceae)	V	W. Ghats
<i>Davellia bulbosa</i> (Davelliaceae)	R	W. Ghats
<i>Diplazium polypodioides</i> (Athyriaceae)	E	W. Ghats
<i>Elaphoglossum beddomei</i> (Elaphoglossaceae)	V	W. Ghats
<i>E. nilgircum</i> (Elaphoglossaceae)	V	W. Ghats
<i>Equisetum ramossissimum</i> var. <i>debile</i> (Equisetaceae)	R	W. Ghats
<i>Helminthostachys zeylanica</i> (Ophioglossaceae)	I	T. puram

<i>Hypolepis punctata</i> (Hypolepidaceae)	R	W. Ghats
<i>Isoetes cormandeliana</i> (Isoetaceae)	E	Malappuram
<i>I. sahyadrii</i> (Isoetaceae)	R	Kerala
<i>I. sampathkumaranii</i> (Isoetaceae)	R	Kerala
<i>Lycopodium macrostachys</i> (Lycopodiaceae)	R	W. Ghats
<i>L. phlegmaria</i> (Lycopodiaceae)	R	W. Ghats
<i>L. selago</i> (Lycopodiaceae)	R	W. Ghats
<i>L. squarrossum</i> (Lycopodiaceae)	R	W. Ghats
<i>Microsorium membranaceum</i> (Polypodiaceae)	E	W. Ghats
<i>Marattia fraxinea</i> (Marattiaceae)	V	Silent Valley
<i>Oleandra muscifolia</i> (Oleandraceae)	I	Silent Valley
<i>Ophioglossum reticulatum</i> (Ophioglossaceae)	E	Kerala
<i>O. cortatum</i> (Ophioglossaceae)	R	Palakkad Sabarimala
<i>Osmunda regalis</i> (Osmundaceae)	R	Palakkad
<i>Pellaea boivini</i> (Cheilanthaceae)	R	Nelliampathy
<i>Pronephrium thwaitesii</i> (Thelypteridaceae)	R	Silent Valley
<i>P. triphyllum</i> (Thelypteridaceae)	R	Kannur
<i>Psilotum nudum</i> (Psilotaceae)	R	Kerala
<i>Polystichum kunthianum</i> (Aspidiaceae)	R	Silent Valley
<i>Schizaea digitata</i> (Schizaeaceae)	E	Pallode
<i>Selaginella cataractum</i> (Selaginellaceae)	R	W. Ghats
<i>S. inequalifolia</i> (Selaginellaceae)	R	Sabarimala Ponmudi
<i>S. involvens</i> (Selaginellaceae)	R	W. Ghats

E = Endangered I = Indeterminate V = Vulnerably R = Rare.

Very little information is available on the status of other groups. Mention may be made about Udar and Srivastava (1983) who have listed 9 rare Liverworts and Patwardhan (1983) who gave a list of rare Lichens.

THREATS AND VULNERABILITY

Out of the 38,863 sq km area of Kerala, 21,800 sq km is hilly terrain and was once completely covered with forest. Between 1940 and 1970, about 35,000 sq km of forest land was diverted into non-forestry purposes chiefly plantations (1310 sq km) and at present only 9,400 sq km is under forest cover (Anonymous, 1982). This destruction and resultant habitat loss were due to various factors - natural or man-made. These factors which are hostile to the very existence of life on earth are termed threats.

Grazing by Livestock is a serious threat to natural vegetation in Kerala as farming community in Kerala mostly depend on cattle and mechanised farming is not common. Besides, the farmers also rear a large number of cattle for their daily livelihood. The local people also depend directly on forest for their fuel wood which is also traded in urban and rural areas.

Large portions of forest with natural vegetation are converted into agriculture land which are utilized for plantation crops. Three fourth of the 1310 km² area of plantation in Kerala is under teak and eucalyptus. A major portion of the midland is under rubber plantation also. Adding other crops like cashew, pepper, tea, coffee, arecanut, coconut, tapioca and paddy, 50% of the total area is now utilized for agriculture. Most of these areas were developed at the cost of virgin forest. The forest department also acquired vast areas of land for various forestry operations including monoculture of species like *Eucalyptus*, *Pinus*, *Acacia* oil palm etc. All these factors simultaneously resulted in the large scale shrinkage of the habitats besides several other consequences like floods, drought, soil erosion etc.

Slash-and-burn shifting cultivation which is traditionally practised in some areas of North-Eastern States is not very common in Kerala. This when practised may not only affect the nutrient level of the soil but also cause soil erosion and plant succession by way of competition from introduced weeds (Mishra and Ramakrishnan, 1983a, 1983b, 1983c.).

Pollution is one of the most important factors which depletes the biological diversity to a considerable extent. Unwise use of pesticides in the agricultural fields and untreated effluents released from various

industries cause a serious threat to the very existence of plants in the industrial areas of Kerala like Cochin and Kottayam.

Construction of buildings, roads, dams etc. also cause considerable damage to the existing vegetation. There are 44 major dams in Kerala. The disastrous consequences of construction of dams are many. Vast stretches of virgin forest are submerged besides causing degradation of soil, water-logging, dam diseases, earth quakes etc. Nayar and Nair (1985) studied the environmental impact of the multi-purpose project at Idukki which reflects the many adverse consequences.

Logging in the natural forest not only alter the physiognomy but also damage the plants in the lower levels. The epiphytic flora of these trees selected for felling will be the major victims of this operation (Nair and Daniel, 1986).

Kerala forest are also over-exploited commercially by the plant based industries such as paper, plywood, cane etc. The species exploited for these industries are soft-wood trees, Bamboos and Rattans besides timber yielding trees. That Kerala used to export rose wood to the tune of 10,000 cubic metres in 1970s, and now it is very difficult to procure even a few hundred cubic metres for the domestic wood industries substantiates the gravity of the situation (Viswanadhan, 1991). White Cedar is another example of over-exploited trees.

Many botanically curious plants like *Psilotum nudum*, *Utricularia* spp., *Equisetum* spp., *Gnetum ula*, species of *Isoetes*, *Botrychium*, *Helminthostachys* etc. have been over-collected for either scientific or educational purposes. These species have now become very rare in Kerala.

Unplanned tourism and rapid urbanisation are threats of recent origin. There are 65 tourist centres in Kerala attracting both inland and foreign tourists. Many of these centres (Ponmudi, Neyyar Dam, Sabarimala, Periyar, Thekkady, Anaimudi, Parambikkulam, Malampuzha, etc.) are located in hilly areas covered with thick forest which are liable to be disturbed due to human interference.

The natural threats include those to the species with narrow geographical distribution (endemicity), species with narrow habitat preference and highly patchy distribution, species that are sparse everywhere, they occur and species with very low colonising abilities, mating system etc. Several such species are available in Kerala.

Competition from alien weeds to the native species and the rapid spread of some of these noxious weeds like *Lantana camara* var. *aculeata*, *Eupatorium* spp. *Mikania cordata*, *Parthenium hysterophorus*, etc. have already proved to be destructive in the state. The above mentioned threats are to be taken into account when we formulate our conservation strategies.

CONSERVATION STRATEGIES

The presence of many "sacred groves" in the middle of villages in Kerala elucidate the fact that traditions of conservation were deep-rooted in the civilization of Kerala. However, the conservation ethics of the past have changed with time. Ancient Keralites preserved the plants and animals in 'Kavus' (groves) for mythological reasons whereas now the people have realized the importance of protecting nature for their own well-being.

At present there are three National Parks, one Biological Park and 12 Wildlife Sanctuaries in Kerala (Table V). As the National Parks and Sanctuaries did not yield the desired results (Gadgil, 1983), the current conservation efforts are mostly aimed at establishing Biosphere Reserves. The core of the Nilgiri Biosphere Reserve is the pristine forest of Silent Valley in Kerala. The establishment of another Biosphere Reserve in and around Agastyamalai in Tirunelveli-Thiruvananthapuram Districts of Southern India is on the anvil.

Table V
List of Protected Areas

I.	Wildlife Sanctuaries	Area
1.	Neyyar Wildlife Sanctuary	- 128 sq km
2.	Peppara Wildlife Sanctuary	- 53 sq km
3.	Shendurney Wildlife Sanctuary	- 100 sq km
4.	Idukki Wildlife Sanctuary	- 77 sq km
5.	Chimmony Wildlife Sanctuary	- 100 sq km
6.	Chinnar Wildlife Sanctuary	- 90.42 sq km
7.	Peechi-Vazhani Wildlife Sanctuary	- 125 sq km
8.	Wynaad Wildlife Sanctuary	- 110 sq km
9.	Aralam Wildlife Sanctuary	55 sq km

10.	Parambikulam Wildlife Sanctuary	285 sq km
11.	Thatekkad Bird Sanctuary	25 sq km
12.	Kumarakam Bird Sanctuary	
II. National Parks		
1.	Silent Valley National Park	90 sq km
2.	Eravikulam National Park	97 sq km
3.	Periyar National Park	- 350 sq km
III. Biological Park		
	Agasthyavanam Biological Park	23 sq km

Following the "threat perception", Government of Kerala has also launched some prestigious projects for the rehabilitation of some of the individual species such as : 'Project rose wood' to save Rose wood, Vellakil, Shendurunny and Ebony. Agasthyavanam Biological Park was another project established under the VIII Plan, with a view to introducing and conserving the rare and endemic plants of the Western Ghats, besides conserving the original flora and fauna of that area. It extends over an area of about 24 sq. km at the foothills of Agastyarkudam in Thiruvananthapuram District. Some of the other projects the Government of Kerala proposes to start are "The Operation Watershead" development of Kallar Valley catchment area and genetic improvement of plant species.

The Tropical Botanic Garden and Research Institute, established 11 years back at Pallode in Thiruvananthapuram District is the only Botanic Garden established in Kerala. Another one is being set up at Kozhikode. There are several private nurseries and gardens which mostly serve commercial interests.

As Kerala's floristic diversity is enormous and that *ex-situ* methods of conservation is woefully inadequate, the conservationists have proposed the setting up of a "Net work of Natural Reserves" as the best method of conserving Kerala's biodiversity. The size of such reserves depends on the size of the population to be conserved; for example to maintain a population of large trees of the Western Ghats, areas larger than that of Silent

Valley should be selected (Singh et al., 1984). Nair and Daniel (1986) observes that the number of the nature reserves already established in Western Ghats are inadequate and suggested the setting up of huge reserves having areas over 2500 sq km.

The proposed Agastyamalai Biosphere Reserve (Henry et al., 1984) should be established at the earliest, besides identifying suitable areas in central Kerala for another Biosphere Reserve. Anaimudis and adjoining areas in Idukki District which is a centre of speciation may best serve as a suitable area for Biosphere Reserve in the central Kerala region. Smaller "reserves" also may be set up along the coastal and midland regions so as to conserve the coastal/midland ecosystems of Kerala. The areas of such reserves should be identified in consultation with experts both in Governmental and non-Governmental organisations on the basis of merit of ecological value and administrative viability and finally a network of Natural Reserves must be established with specific management objectives, institutional mechanism for monitoring and scope for research.

The sacred groves (*Sarpakavus*) which are the repositories of the pristine vegetation is a unique source of conserving vegetation in the midlands and coastal region of Kerala. These groves got conserved on the basis of religious belief. Of late, a number of such groves were cleared mostly due to pressure for land. These groves are generally attached to some ancient Hindu families. With the breakdown of the old Hindu joint family system in recent past in Kerala, houses of many such old families having sacred groves were sold to people of other religions who do not attach any importance to such beliefs. Such sacred groves have been either wholly or partially cleared. In spite of this, there still remains a lot of such groves in the south and central parts of Kerala. Induchoodan and Balasubramanian (1991) stressed the importance of these groves as "saviours of endemics" and reported the presence of 28 species endemic to Western Ghats from three such Kavus covering an area of only 36 hectares ! Ramachandran and Mohanan (1989) have conducted a detailed study of these groves. It is suggested that speedy steps may be taken to protect these groves.

At present there is only one Botanic garden in Kerala worth the name. A few more botanic gardens, clonal orchards, arboreta, etc. must be set up covering areas of different geographical zones of Kerala and a Net-work of Botanic Gardens must be established with proper facilities

of interaction between them. This should be regarded as a priority item in any conservation effort.

Biotechnology plays a significant role in rapid multiplications of the otherwise slow multiplying plants which in turn can be re-introduced to same/similar habitats.

The following aspects must also be given top priority while formulating any effective and purposeful conservation strategy

Analysis of the taxonomic data collected by Botanical Survey of India to identify the rare/threatened plants and preparation of a state-of-the-art report on these taxa.

Identifying sites having maximum concentration of plants needing preservation.

Identification of fragile ecosystems like "Myristica swamps" for conservation.

Conducting intensive research on mutualistic interaction between plants and animals; identifying "Key stone mutualists" and "Umbrella species" for conservation.

Establishment of commercial farms for medicinal plants to minimize collections of these plants from the forest.

Popularising potential wild horticultural plants through biotechnology and supplying them to the naturalists and the general public.

Preparation of publicity material for various media like Television, Radio and Newspapers to create public awareness about conservation.

Revision of school and college curriculum to include "Conservation Biology" as a compulsory subject.

Intensive research on Cryptogamic flora of Kerala about which only very little is known.

Table VI
Common Medicinal Plants

<i>Abrus precatorius</i>	Fabaceae
<i>Acacia sinuata</i>	Mimosaceae
<i>Achyranthes aspera</i>	Amaranthaceae
<i>Acalypha racemosa</i>	Euphorbiaceae
<i>Acorus calamus</i>	Araceae
<i>Adhatoda beddomei</i>	Acanthaceae
<i>A. zeylanica</i>	Acanthaceae
<i>Aegle mermelos</i>	Rutaceae
<i>Aerva lanata</i>	Amaranthaceae
<i>Ageratum conyzoides</i>	Asteraceae
<i>Ailanthus triphysa</i>	Simaroubaceae
<i>Alangium salvifolium</i>	Alangiaceae
<i>Alpinia galanga</i>	Zingiberaceae
<i>Alstonia scholaris</i>	Apocynaceae
<i>Alternanthera sessilis</i>	Amaranthaceae
<i>Anamitra cocculus</i>	Menispermaceae
<i>Andrographis paniculata</i>	Acanthaceae
<i>Anisochilus carnosus</i>	Lamiaceae
<i>Anisomeles indica</i>	Lamiaceae
<i>Annona reticulata</i>	Annonaceae
<i>Aristolochia indica</i>	Aristolochiaceae
<i>A. tagala</i>	Aristolochiaceae
<i>Bacopa monnieri</i>	Scrophulariaceae
<i>Baliospermum montanum</i>	Acanthaceae
<i>Bauhinia racemosa</i>	Caesalpiniaceae
<i>Biophytum sensitivum</i>	Oxalidaceae
<i>Bixa orellana</i>	Bixaceae
<i>Boerhavia diffusa</i>	Nyctaginaceae
<i>Buddleja asiatica</i>	Buddlejaceae
<i>Butea monosperma</i>	Fabaceae
<i>Cananga odorata</i>	Annonaceae
<i>Calotropis gigantea</i>	Asclepiadaceae
<i>Canarium strictum</i>	Burseraceae
<i>Cardiospermum halicacabum</i>	Sapindaceae

<i>Cassia</i> spp.	Caesalpiaceae
<i>Catharanthus pusillus</i>	Apocynaceae
<i>C. roseus</i>	Apocynaceae
<i>Centella asiatica</i>	Apiaceae
<i>Celastrus paniculatus</i>	Celastraceae
<i>Clerodendrum inerme</i>	Verbenaceae
<i>C. phlomidis</i>	Verbenaceae
<i>C. viscosum</i>	Verbenaceae
<i>Cerbera odollam</i>	Apocynaceae
<i>Ceropegia</i> spp.	Asclepiadaceae
<i>Centipeda minima</i>	Asteraceae
<i>Cissus quadrangularis</i>	Vitaceae
<i>Coccinia grandis</i>	Cucurbitaceae
<i>Cinnamomum</i> spp.	Lauraceae
<i>Curcuma</i> spp.	Zingiberaceae
<i>Cyclea peltata</i>	Menispermaceae
<i>Desmodium biarticulatum</i>	Fabaceae
<i>Datura metel</i>	Solanaceae
<i>Dioscorea</i> spp.	Dioscoreaceae
<i>Diploclisia glaucescens</i>	Menispermaceae
<i>Drosera peltata</i>	Droseraceae
<i>Eclipta prostrata</i>	Asteraceae
<i>Embelia ribes</i>	Myrsinaceae
<i>Entada rheedii</i>	Mimosaceae
<i>Ensete superbum</i>	Musaceae
<i>Ficus exasperata</i>	Moraceae
<i>Gendarussa vulgaris</i>	Acanthaceae
<i>Gmelina asiatica</i>	Verbenaceae
<i>G. arborea</i>	Verbenaceae
<i>Gymnema sylvestre</i>	Asclepiadaceae
<i>Hedyotis corymbosa</i>	Rubiaceae
<i>Helminthostachys zeylanica</i>	Ophioglossaceae
<i>Helicteres isora</i>	Sterculiaceae
<i>Hemidesmus indicus</i>	Asclepiadaceae
<i>Holarrhena pubescens</i>	Apocynaceae
<i>Holostemma ada-kodiem</i>	Asclepiadaceae
<i>Hibiscus hispidissimus</i>	Malvaceae

<i>H. tiliaceus</i>	Malvaceae
<i>Hybanthus enneaspermus</i>	Violaceae
<i>Hygrophila auriculata</i>	Acanthaceae
<i>Hydnocarpus pentandra</i>	Flacourtiaceae
<i>Hyptis suaveolens</i>	Lamiaceae
<i>Ichinocarpus frutescens</i>	Apocynaceae
<i>Indigofera tinctoria</i>	Fabaceae
<i>Iphiginia indica</i>	Liliaceae
<i>Janakia arayaalpathra</i>	Periplocaceae
<i>Jatropha curcas</i>	Euphorbiaceae
<i>Kaempferia galanga</i>	Zingiberaceae
<i>Knema attenuata</i>	Myristicaceae
<i>Leucas indica</i>	Lamiaceae
<i>Madhuca neriifolia</i>	Sapotaceae
<i>Malaxis rheedii</i>	Orchidaceae
<i>Mallotus philippensis</i>	Euphorbiaceae
<i>Maranta arundinacea</i>	Marantaceae
<i>Mesua ferrea</i>	Clusiaceae
<i>Mimusops elengi</i>	Sapotaceae
<i>Mimosa pudica</i>	Mimosaceae
<i>Momordica</i> spp.	Cucurbitaceae
<i>Morinda citrifolia</i>	Rubiaceae
<i>Murraya paniculata</i>	Rutaceae
<i>Myristica</i> spp.	Myristicaceae
<i>Naravelia zeylanica</i>	Ranunculaceae
<i>Naregamia alata</i>	Meliaceae
<i>Nervilia aragona</i>	Orchidaceae
<i>Neolamarckia cadamba</i>	Rubiaceae
<i>Nilgirianthus ciliatus</i>	Acanthaceae
<i>Ocimum</i> spp.	Lamiaceae
<i>Ophiorrhiza mungo</i>	Rubiaceae
<i>Oroxylum indicum</i>	Bignoniaceae
<i>Phyllanthus amarus</i>	Euphorbiaceae
<i>P. emblica</i>	Euphorbiaceae
<i>Plectranthus barbatus</i>	Lamiaceae
<i>Pterocarpus marsupium</i>	Fabaceae
<i>Plumbago rosea</i>	Plumbaginaceae

<i>P. zeylanica</i>	Plumbaginaceae
<i>Piper</i> spp.	Piperaceae
<i>Rauvolfia serpentina</i>	Apocynaceae
<i>Renacanthus nasutus</i>	Acanthaceae
<i>Ricinus communis</i>	Euphorbiaceae
<i>Rostellularia diffusa</i>	Acanthaceae
<i>Rourea minor</i>	Connaraceae
<i>Rubia cordifolia</i>	Rubiaceae
<i>Samadera indica</i>	Simaroubaceae
<i>Saraca asoca</i>	Caesalpiaceae
<i>Salacia beddomei</i>	Hippocrateaceae
<i>S. fruticosa</i>	Hippocrateaceae
<i>Santalum album</i>	Santalaceae
<i>Scilla hyacinthina</i>	Liliaceae
<i>Semicarpus anacardium</i>	Anacardiaceae
<i>Smilax zeylanica</i>	Smilacaceae
<i>Sida</i> spp.	Malvaceae
<i>Solanum</i> spp.	Solanaceae
<i>Stephania japonica</i>	Menispermaceae
<i>Steriospermum colais</i>	Bignoniaceae
<i>Strychnos minor</i>	Strychnaceae
<i>S. nux-vomica</i>	Strychnaceae
<i>S. wallichiana</i>	Strychnaceae
<i>Syzygium cumini</i>	Myrtaceae
<i>Tephrosia purpurea</i>	Fabaceae
<i>Terminalia</i> spp.	Combretaceae
<i>Tinospora cordifolia</i>	Menispermaceae
<i>Trema orientalis</i>	Ulmaceae
<i>Trichosanthes cucumerina</i>	Cucurbitaceae
<i>Trichopus zeylanica</i> ssp. <i>travancoricus</i>	Dioscoreaceae
<i>Tylophora</i> spp.	Asclepiadaceae
<i>Wattakaka volubilis</i>	Apocynaceae
<i>Wrightia tinctoria</i>	Apocynaceae
<i>Zanthoxylum rhesta</i>	Rutaceae
<i>Zornia diphylla</i>	Fabaceae

Table VII
List of Common Wild Plants Yielding Edible Fruits

<i>Alangium salvifolium</i>	Alangiaceae
<i>Allophylus cobbe</i>	Sapindaceae
<i>Antidesma acidum</i>	Euphorbiaceae
<i>A. menasu</i>	Euphorbiaceae
<i>Artocarpus</i> spp.	Moraceae
<i>Baccaurea courtallense</i>	Euphorbiaceae
<i>Calamus rotang</i>	Arecaceae
<i>Canthium travancoricum</i>	Rubiaceae
<i>Carissa spinarum</i>	Apocynaceae
<i>Dimocarpus longan</i>	Sapindaceae
<i>Coccinia grandis</i>	Cucurbitaceae
<i>Elaeagnus conferta</i>	Elaeagnaceae
<i>Ficus</i> spp.	Moraceae
<i>Flacourtia indica</i>	Flacourtiaceae
<i>Garcinia papilla</i>	Clusiaceae
<i>Ixora coccinea</i>	Rubiaceae
<i>Melastoma malabathricum</i>	Melastomataceae
<i>Passiflora foetida</i>	Passifloraceae
<i>Phoenix humilis</i>	Arecaceae
<i>Phyllanthus embelica</i>	Euphorbiaceae
<i>Physalis minima</i>	Solanaceae
<i>Rapanea wightiana</i>	Myrsinaceae
<i>Rubus</i> spp.	Rosaceae
<i>Sarcostigma kleinii</i>	Icacinaceae
<i>Scolopia crenata</i>	Flacourtiaceae
<i>Solanum</i> spp.	Solanaceae
<i>Sterculia belangas</i>	Sterculiaceae
<i>S. urens</i>	Sterculiaceae
<i>Symplocos macrocarpa</i>	Symplocaceae
<i>Syzygium cuminii</i>	Myrtaceae
<i>S. jambos</i>	Myrtaceae
<i>S. zeylanicum</i>	Myrtaceae
<i>Terminalia</i> spp.	Combretaceae

REFERENCES

- Anonymous 1982. *The State of India's Environment : A Citizens' Report*. Centre for Science and Environment, New Delhi.
- Ansari, R. 1985. *Flora of Kasaragode District*. Ph.D. thesis submitted to Madras University.
- Antony, V.T. 1989. *Flora of Kottayam District*. Ph.D. thesis submitted to the Bharathiar University.
- Arora, R.K. 1964. Phytogeographical notes on the humid tropics flora of India - World distribution of the woody dicotyledonous flora of the Western Ghats and Assam. *J. Indian Bot. Soc.* 43: 220-228.
- Bahadur, K.N. and S.S. Jain 1983. Rare Bamboos of India in: Jain, S.K. and R.R. Rao (ed.): *An Assessment of Threatened Plants of India*. Botanical Survey of India, Howrah. 1983.
- Bilgrami, K.S., Jamaluddin and M.A. Rizwi 1979. *Fungi of India*. Part I and II. New Delhi.
- Binoy, P.C.G. Rajkumar and N. Mohanan 1991. Rare and Endemic plants located on the western slopes of Agastyamala, coming in the Thiruvananthapuram District of Kerala State. *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats*. Thiruvananthapuram. 49-55.
- Chand Bhasha, S. and K.K.N. Nair 1991. Endemic Angiosperms of the Western Ghats of India with special reference to Kerala. *Proc. Symp. Rare. Endang. Endemic Pl. Western Ghats*. Thiruvananthapuram. 276-299.
- Gadgil, M. 1983. Conservation of plant resources through biosphere reserves. In: Jain, S.K. and K.L. Mehra (eds.). *Conservation of Tropical Plant Resources*. 66-67. Howrah. 1983.
- Henry, A.N., M. Chandrabose, M.S. Swaminathan and N.C.Nair 1984. Agastyamalai and its environs. A potential area for a biosphere reserve. *J. Bombay Nat. Hist. Soc.* 81: 282-290.
- Hosagoudar, V.B. 1985. The study of the pathogenic microfungi with special reference to the vegetation of Idukki, Kerala. In M.P. Nayar

and N.C. Nair : *Long-term environmental and ecological impacts of multipurpose river valley projects with special reference to Idukki, Kerala*. 200-252. (mimeographed).

Hosagoudar, V.B. 1996. *Meliolales of India*. Botanical Survey of India, Calcutta.

Induchoodan, N.C. and K. Balasubramanyam 1991. Sacred groves. Saviour of endemics. *Proc. Symp. Rare. Endan. Endemic Pl. Western Ghats*. Thiruvananthapuram. 348-353.

Jain, S.K. and A. R.K. Sastry 1980. *Threatened Plants of India - A State-of-the-art Report*. Botanical Survey of India, Howrah. 1-48.

Jain, S.K. and Ved Prakash 1995. Zingiberaceae in India phyto-geography and endemism. *Rheedea* 5(2): 154-169.

Joseph, K.T. 1991. A few rare and endemic aquatic Angiosperms of Kerala. *Proc. Rare Endang. Endemic Pl. W. Ghats*. Thiruvananthapuram. 90-92.

Kammathy, R.V. 1983. Rare and endemic species of Indian Commelinaceae. In: Jain, S.K. and R.R. Rao (eds.). *An Assessment of the Threatened Plants of India*. Botanical Survey of India. Howrah. 213-221.

Karthikeyan, S. 1982. Synopsis of the unawned grasses of former Madras Presidency. *Bull. Bot. Surv. India* 13: 175-179.

Legris, P. and V.M. Meher-Homji 1977. Phytographic outlines of the hill ranges of Peninsular India. *Trop. Ecol.* 18: 17-23.

Madhusoodanan, P.V. 1991. Rare and endangered ferns and fern allies of Western Ghats of Kerala. *Proc. Symp. Rare Endang. Endemic P. Western Ghats*. Thiruvananthapuram. 103-107.

Misra, B.K. and P.S. Ramakrishnan 1983a. Secondary succession subsequent to slash and burn agriculture at higher elevations of North-east India. 1. Species diversity, biomass and litter production. *Acta Oecologica* 4: 95-107.

- Misra, B.K. and P.S. Ramakrishnan 1983b. Secondary succession subsequent to slash and burn Agriculture of higher elevations of North-east India II. Nutrient cycling. *Acta Oecologica* 4: 237-245.
- Misra, B.K. and P.S. Ramakrishnan 1983c. Slash and burn Agriculture in Northeast India III. Soil fertility changes. *Agriculture, Ecosystem and Development* 9: 83-96.
- Mohanan, C.N. 1984. *Studies on the Flora of Quilon District, Kerala*. Ph.D. thesis. Madras University. Madras.
- Mohanan, C.N. and N.C. Nair. 1981. *Kunstleria* Prain : a new genus record for India and a new species in the genus. *Proc. Indian Acad. Sci. B.* 90: 207-210.
- Mohanan, M. and A.N. Henry 1994. *Flora of Thiruvananthapuram, Kerala*. Coimbatore.
- Mukhtesh Kumar 1991. Habitat distribution of orchids of Western Ghats and their conservation. *Proc. Symp. Rare Endang. Endemic Pl. W. Ghats*. Thiruvananthapuram 202-208
- Nagendran, C.R. and G.D. Areckal 1981. Studies in Indian Podostemaceae. *Bull. Bot. Surv. India* 23: 228-234.
- Nair, K.K.N. 1988. Floristic studies. In: K. Balasubrahmaniyan et al. *Long-term Environmental and Ecological Studies of Pooyamkutty Hydro-Electric Project - Western Ghats of Kerala*. Pre-construction stage analysis. Peechi. 40-140.
- Nair, N.C. 1991. Endemism on the Western Ghats with special reference to *Impatiens* L. *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats*. Thiruvananthapuram. 93-102.
- Nair, N.C., S.R. Ghosh and P. Bhargavan 1988. Fern-allies and Ferns of Kerala. *J. Econ. Tax. Bot.* 12(1): 171-209.
- Nair, N.C. and P. Daniel 1986. Floristic diversity of Western Ghats and its conservation : a review. *Proc. Indian Acad. Sci. (Anim. and Plant Sci.)* Suppl. 127-163.

- Natrajan, K. and N. Raman 1983. *South Indian Agaricales*. New Delhi.
- Nayar, M.P. and N.C. Nair 1985. *Long Term Environmental and Ecological Impacts of Multipurpose River Valley Projects with special Reference to Idukki, Kerala*. Botanical Survey of India, Coimbatore (Mimeographed).
- Nayar, P.K.B. 1987. *Religious Mythology and the Ecosystem*. Report submitted to the Dept. of Environment, New Delhi.
- Patwardhan, P.G. 1983. Rare and endemic lichens in the Western Ghats, south-western India. In: Jain, S.K. and R.R. Rao (eds.). *An Assessment of the Threatened Plants of India*. Botanical Survey of India. Howrah. 318-322.
- Raghavan Nair, T.K. 1991. *Podocarpus wallichianus* Presl. an endemic species. *Proc. Rare Endang. Endemic Pl. Western Ghats*. Thiruvanantha-puram. 70-71.
- Rajeevan, B. 1985. Taxonomy and ecology of bryophytes. In: Nayar, M.P. and N.C. Nair. *Long Term Environmental and Ecological Impacts of Multipurpose River Valley Projects with Special Reference to Idukki, Kerala*. Botanical Survey of India, Coimbatore. 253-280. (Mimeographed).
- Ramchandran, K.K. and C.N. Mohanan 1989. *Studies on the Sacred Groves of Kerala - 2nd Ann. Repor. Mins. Environ. For.*
- Ramesh, B.R. and J.P. Pascal 1991. Distribution of endemic arborescent evergreen species in Western Ghats. *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats*. Thiruvananthapuram. 20-29. 1991.
- Rao, T.A. and A.R.K. Sastry 1972. An ecological approach towards the classification of coastal vegetation of India I. Strand vegetation. *Indian Forester* 98: 594-607.
- Rao, T.A. and A.R.K. Sastry 1974. An ecological approach towards the classification of coastal vegetation of India 2. Estuarine vegetation. *Indian Forester*. 100: 438-452.

- Renuka, C. 1991. Rare and endangered rattans of the Western Ghats and their conservation. *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats*. Thiruvananthapuram. 181-186.
- Sanjappa, M. 1991. Endemic Legumes of Western Ghats. *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats*. Thiruvananthapuram. 30-43.
- Sasidharan, N. 1991. Rare and endemic trees in the forest of Trichur. *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats*. Thiruvananthapuram. 65-69.
- Satheesh Kumar, C. 1991. Native orchids of Western Ghats : a struggle for survival *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats*. Thiruvananthapuram. 209-220.
- Shetty, B.V. and K. Vivekananthan 1971. Studies on the vascular flora of Anaimudi and surrounding regions, Kottayam Dist., Kerala. *Bull. Bot. Surv. India* 13: 16-42.
- Shetty, B.V. and K. Vivekananthan 1981. Endemic, primitive, temperate elements and the relict vegetation of Kundah Range, Nilgiris, Tamil Nadu. *Bull. Bot. Surv. India* 23: 254-264.
- Shetty, B.V. and K. Vivekananthan 1991. The endemic and endangereed plants of the High Range, Idukki District, Kerala. *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats*. Thiruvananthapuram. 135-155.
- Singh, J.S., S.P. Singh, A.K. Saxena, and Y.S. Rawat 1984. India's Silent-Valley and its threatened rain forest ecosystem. *Environ. Conserv.* 11: 223-233.
- Singh, Guru Dev, B. and K.N. Subramanyan 1991. Endemic plants of Kerala and need for its conservation. *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats*. Thiruvananthapuram. 314-327.
- Sreekumar, P.V. and V.J. Nair 1991. *Flora of Kerala - Grasses*. Botanical Survey of India. Howrah.
- Srivastava, N.G. 1985. Taxonomy and ecology of fresh water algae of Idukki, Kerala. In: Nayar, M.P. and N.C. Nair (eds.). *Long Term Environmental and Ecological Impacts of Multipurpose River*

Valley Projects with Special Reference to Idukki, Kerala. Botanical Survey of India, Coimbatore.

Subramanyan, K.N. 1980. *Floristic Studies of Thenmalai area of Western Ghats, Quilon District, Kerala State.* Ph.D. thesis, Calicut University.

Swarupanandan, K. 1991. An analysis of the physical basis and causes of rarity in the Asclepiadaceae R.Br. (s.l.) of Kerala. *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats.* Thiruvananthapuram. 230-236.

Udar, R. and S.C. Srivastava 1975. Notes on south Indian Hepaticae 1. *J. Bombay Nat. Hist. Soc.* 72: 401-406.

Udar, R. and S.C. Srivastava 1977. Notes on south Indian Hepaticae 2. The genus *Herberta* Gray. *J. Bombay Nat. Hist. Soc.* 74: 255-263.

Udar, R. and S.C. Srivastava 1983. Rare and endangered liverworts of India. In: Jain, S.K. and R.R. Rao. *An Assessment of Threatened Plants of India.* Botanical Survey of India, Howrah, 303-312.

Vajravelu, E. 1990. *Flora of Palghat District.* Botanical Survey of India, Howrah. 1990.

Varshney, C.K. 1968. Plant succession on walls. *Proc. Symp. Recent Adv. Trop. Ecol. II Inst. Trop. Ecol.*

Varghese, K.I.M. 1984. Litter fungi of Kerala forest. *Proc. Symp. Fungal Resources and Utilization.* 1.

Velayudhan, K.C., V.K. Muralidharan, V.A. Amalraj and Z. Abraham 1991. Some wild crop relatives and their occurrence in Western Ghats. *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats.* Thiruvananthapuram. 255-269.

Viswanathan, K.P. 1991. Presidential address *Proc. Symp. Rare Endang. Endemic Pl. Western Ghats.* Thiruvananthapuram.

Vohra, J.N., K.N. 1982. Roy Chowdhary, R.K. Ghosh, B.D. Kar and K.P. Singh 1982. *Observations on the Cryptogamic Flora of Silent Valley.* Howrah.



Tropical evergreen forest in Idukki dist.



Pecteilis gigantea : a rare ground orchid in Silent valley



Rhaphidophora laciniata in flower



High altitude grasslands in the high ranges of Idukki dist.



Riparian vegetation along Periyar river



Lepisanthus tetraphylla : an evergreen element



Acrocarpus fraxinifolius : an evergreen element with buttressed base



A population of *Impatiens* in rocky crevices



Psilotum nudum : curious pteridophyte becoming rare due to over collection

