

FLORA OF INDIA

Series - 2

**MATERIALS FOR THE  
FLORA OF  
ARUNACHAL PRADESH**

VOLUME 1

(Ranunculaceae - Dipsacaceae)



BOTANICAL SURVEY OF INDIA

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# MATERIALS FOR THE FLORA OF ARUNACHAL PRADESH

VOLUME 1  
(Ranunculaceae - Dipsacaceae)

Editors  
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and  
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आरतीय वनस्पति सर्वेक्षण  
BOTANICAL SURVEY OF INDIA

BOTANICAL SURVEY OF INDIA  
CALCUTTA

© Government of India

Date of Publication : 1st February, 1996

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Cover photo : *Rhododendron arboreum* Sm. Courtesy : Dr. P.K. Hajra

Price :

Call No. 635.0954163

कॉल संख्या

Accession No. 211765

परिग्रहण संख्या

Published by the Director, Botanical Survey of India, P-8, Brabourne Road, Calcutta-700 001; composed at Computer Unit, Botanical Survey of India, Northern Circle, Dehra Dun - 248 195, and printed at M/s. Deep Printers, 3/26, Ramesh Nagar, New Delhi-110 015.



No : CM/AP/15/93

इटानगर-७६११११  
ITANAGAR-791111  
Date : 25/1/1993

## FOREWORD

It gives me immense pleasure and satisfaction to accede to the request of the authors to write a few words on a 'Foreword' to the current volume which is found to be the beginning of the process of unraveling the Nature's hidden treasure in Arunachal Pradesh.

Ever since its inception the Botanical Survey of India has been conducting Floristic surveys and writings on the subject. Indeed, Indian flora is very rich and found in abundance. It is most gratifying that Botanical Survey of India has been endeavoring their best efforts in conducting systematic survey, studies and writings on the 'Flora' and conserve the rare and endangered species. 'Flora' literally means "the Roman Goddess of Flowers" and our mother nature is adorned with plenty of 'flora'. Our devout duty is to examine its life and beauty in the pursuit of unraveling this hidden treasure of nature.

For the people of Arunachal Pradesh, forest is an inseparable part of our lives. The economic development and prosperity of the people as well as the state lie with our knowledge of the forest and the wild plants that inhabit our land. Here the Botanists and Botanical Survey of India can only help us to study scientifically and explore their varied utility for the economic upliftment of Arunachal Pradesh. Since our state is extremely rich in plant life surrounding with magnificent forest trees and amazingly vast variety of wild plant resources, we owe to the Botanical Survey of India for their National Programme for conducting surveys and conservation of our plant resources which will undoubtedly help the people living in this evergreen State of India in attaining and maintaining a quality of life which they truly deserve.

I am confident that the publication of this book will further enlighten the people of this State about their natural plant resources and will meet the long felt requirement of a book on 'flora' in Arunachal Pradesh.

(Gegong Apang)

## PREFACE

Arunachal Pradesh, in the extreme north-eastern corner of the country, harbours a very rich and diverse flora. Its unique phytogeographical position, topography and high degree of precipitation are some of the important factors which are mainly responsible for its enormous biological diversity comparatively in such a small area. Arunachal may also be regarded as a store house of many wild relatives of economic plants. These wild genetic resources of Agricultural importance are of immense value to the mankind in the present day world under the pressure of rapidly multiplying human population. The ruthless destruction and unplanned exploitation of natural living resources by human for various purposes necessitates appropriate measures towards germ-plasm conservation for future generations. In the fast developing states like Arunachal Pradesh the natural vegetation has been continuously and increasingly under pressure, and even before an inventory of the plant resources of the region could be undertaken, the ecological disasters have begun to take toll of several species. In order to cope with the increased domestic requirements for food, cloth and shelter, etc., owing to the population explosion, it has become essential to conserve and make the best use of all our natural resources.

Though the discovery of the wild plant resources in Arunachal Pradesh had been initiated by Griffith as back as in 1836, but it was only with the setting up of the Eastern Circle of the Botanical Survey of India, with headquarters at Shillong in 1955, the survey of plant resources in various parts of the districts of Kameng, Subansiri, Siang, Lohit and Tirap have been intensified.

Since its inception in 1977, Arunachal Field Station, Botanical Survey of India (BSI) is also actively engaged in the exploration of the flora of this region. In the present "Materials for the flora of Arunachal Pradesh" an attempt has been made to compile data from all the herbarium material housed in different herbaria of Botanical Survey of India and other Institutions and from the published literature. This publication will be helpful to the students of botany, foresters, agriculturists, pharmacologists, etc., in their research and management programmes since there is no other flora available for this region which can be consulted to assess its natural plant wealth.

The authors express their deep sense of gratitude to Dr. S.K. Jain and Dr. M.P. Nayar, Ex-Directors, Botanical Survey of India, for their invaluable suggestions and to Dr. B.D. Sharma, Ex-Director, Botanical Survey of India for assigning this important task and for his encouragement and guidance at different stages of its condensation. The authors also express their indebtedness to Dr. P.K. Hajra, Director, Botanical Survey of India, for his keen interest and guidance with valuable suggestions which he gathered through several

explorations particularly in the Kameng district of Arunachal Pradesh during his long tenure of service at the Eastern Circle of Botanical Survey of India, Shillong.

Sincere thanks are due to Sri J.K.Mehta, the Principal Chief Conservator of Forest, Arunachal Pradesh and other forest officials for their help during exploration work and to Dr. V.J.Nair, Scientist-SD-in-Charge, Eastern Circle, Botanical Survey of India (at present Deputy Director, Southern Circle, B.S.I.), Shillong, Dr. D.K. Singh, Deputy Director, Northern Circle, B.S.I.; Dr. L.K. Banerjee, Deputy Director, I.S.I.M., B.S.I. for providing library, herbarium and computer facilities. We are also thankful to Dr.K.Haridasan, Scientist, Forest Department, Arunachal Pradesh for useful suggestions. The authors also wish to place on record their sincere gratitude to the Director, Geological Survey of India, Operation Arunachal Pradesh, Regional Geology Division, North Eastern Region, Itanagar, for providing the details on the geology of Arunachal Pradesh. Our thanks are also due to technical and other staff of Arunachal Field Station, Botanical Survey of India, Itanagar and Sanjay Kumar Uniyal, Northern Circle, B.S.I. for providing all types of cooperation during the preparation and finalisation of this work.

Calcutta  
01.01.1996

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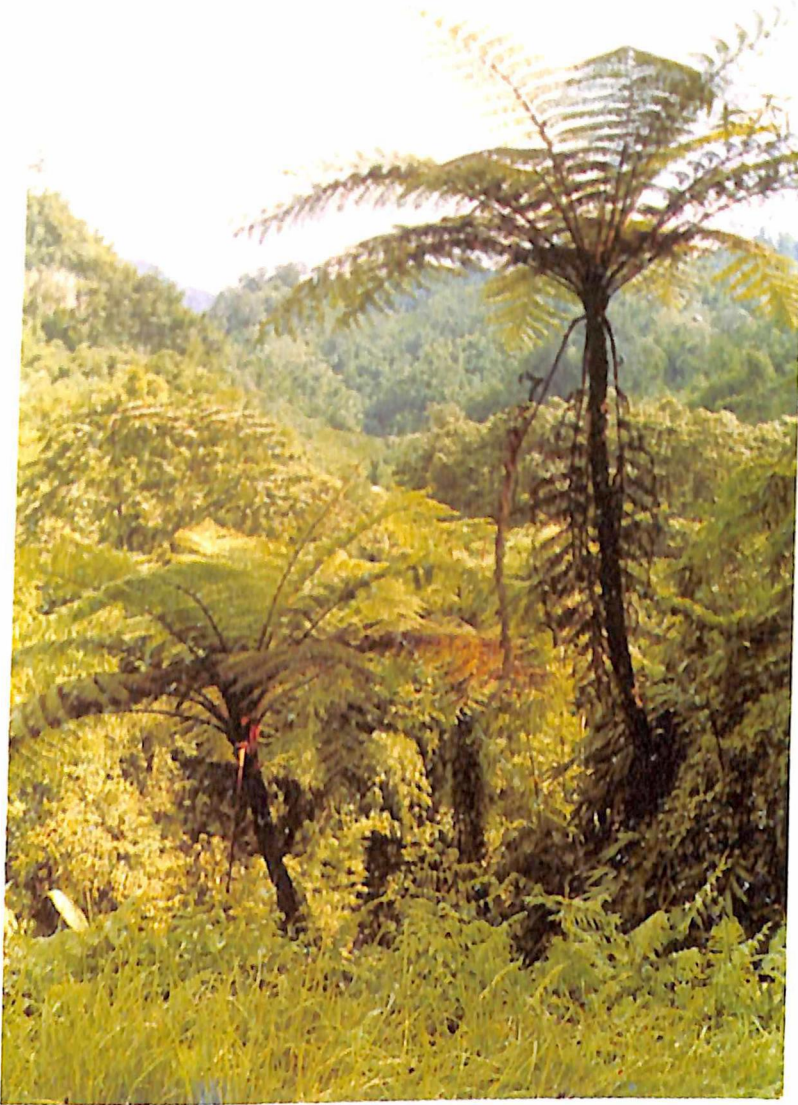
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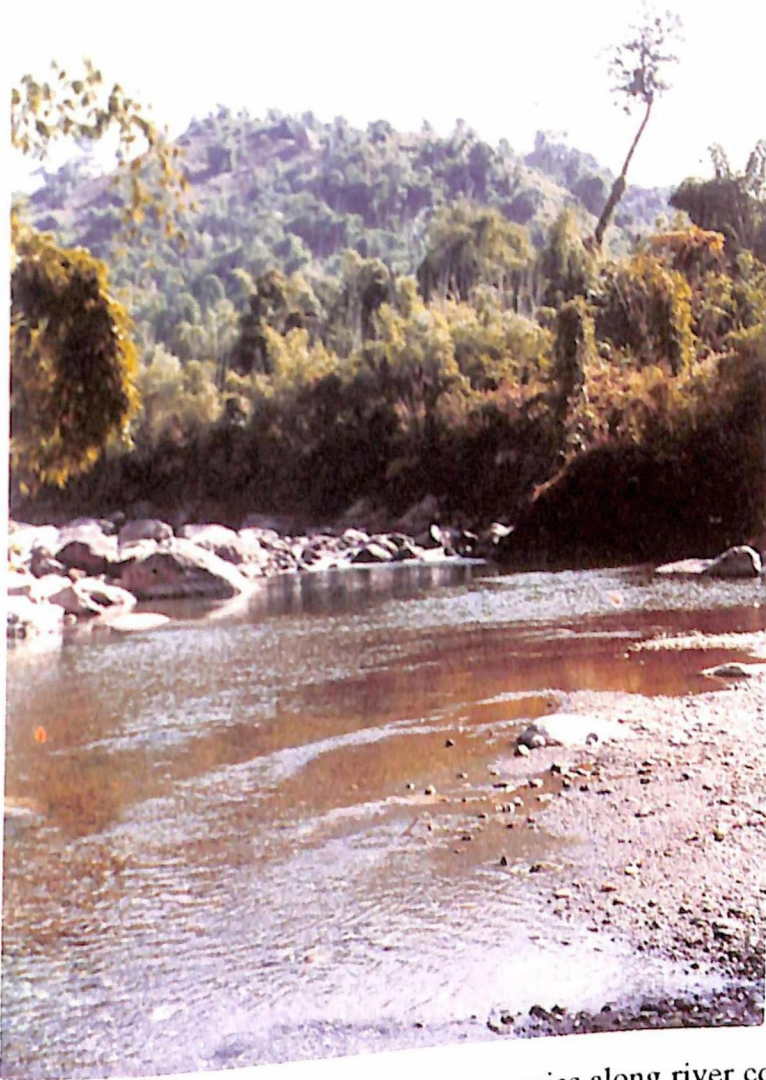




Primary open forest showing *Cyathea* sp. - a threatened element.



Ganga lake, Itanagar : Primary tropical semievergreen forest.



Secondary forest with dominant Bamboo species along river course  
(Sankie View, Itanagar).



Riverine forest (West Kameng district along the river 'Gea Bharali')



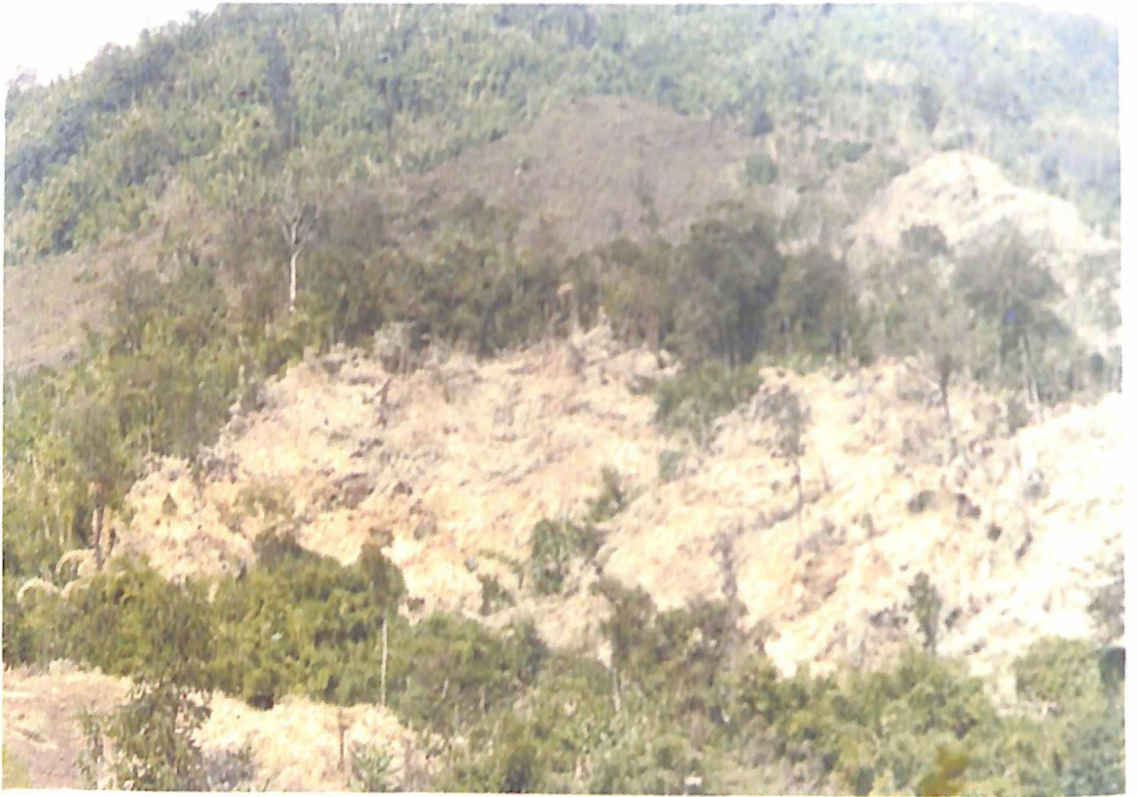
Pine forest - West Kameng district.



Open primary forest - showing Bamboo and *Pandanus* species.



Secondary forest with Bamboo and *Musa* species.



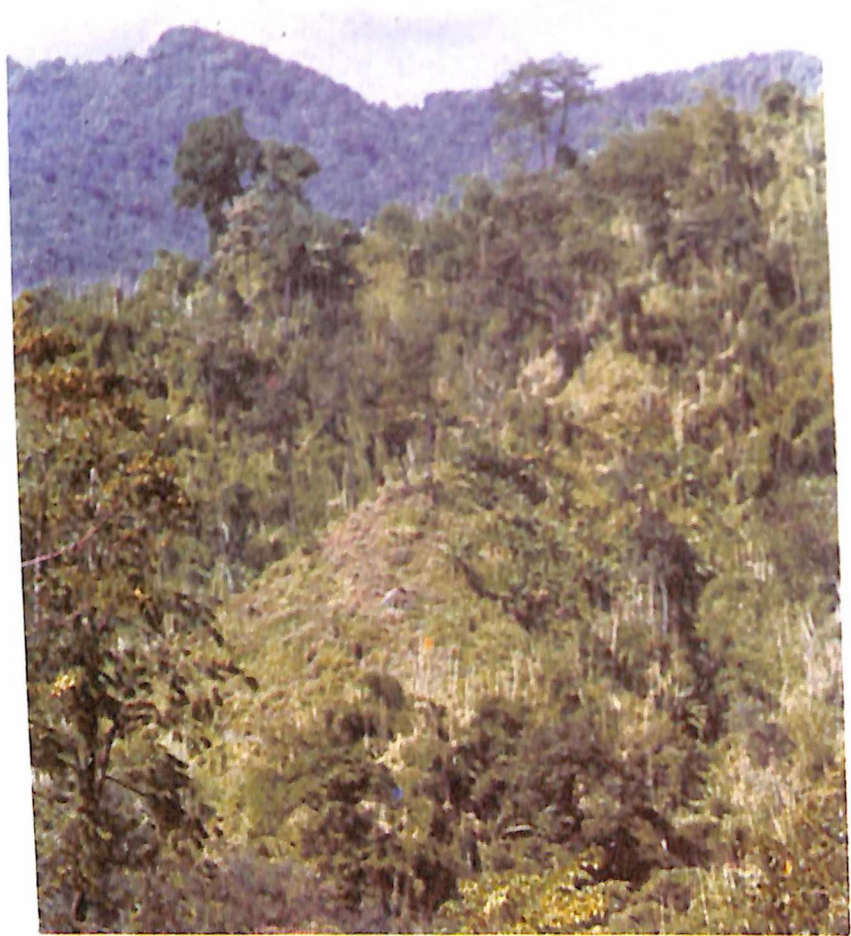
'Jhum' cultivation drying of felled primary forest vegetation.



'Jhum' cultivation - burning of dried vegetation.



'Jhum' cultivation - paddy and maize crop.

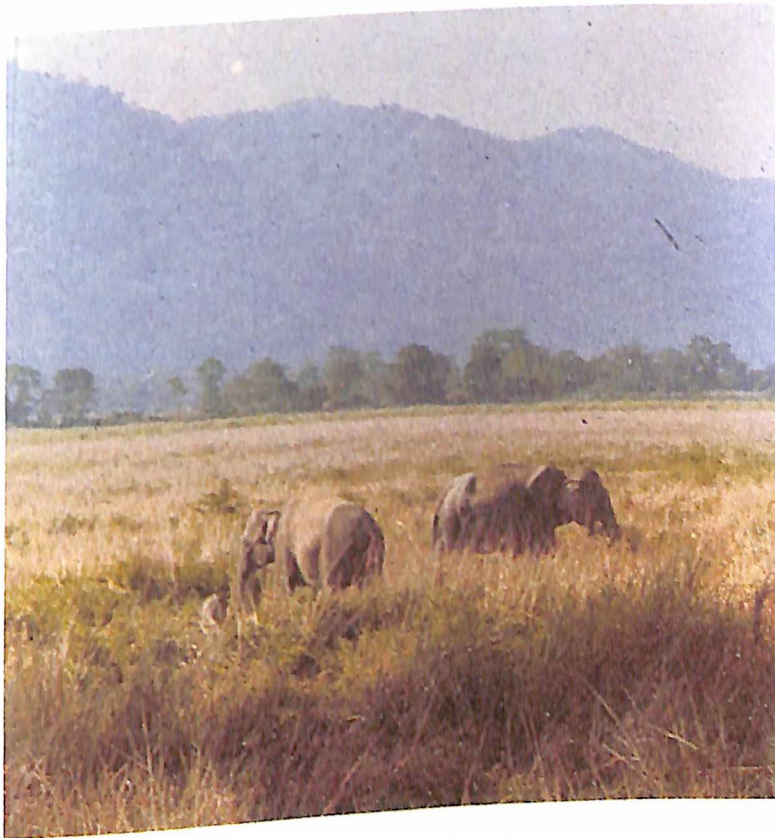


Secondary forest on abandoned 'Jhum' land.





Mithum (*Bos gaur*) - the majestic semi-domesticated cow of Arunachal Pradesh.



'Asiatic Elephant'



*Podophyllum hexandrum* Royle



*Impatiens latiflora* Hook.f. & Thomson



*Oxalis debilis* H.B.K. var. *corymbosa* (DC.) Lourt.



*Oxalis debilis* H.B.K. var. *corymbosa* (DC.) Lourt.



*Dalhousia bracteata* (Roxb.) Baker



*Melastoma normale* D. Don

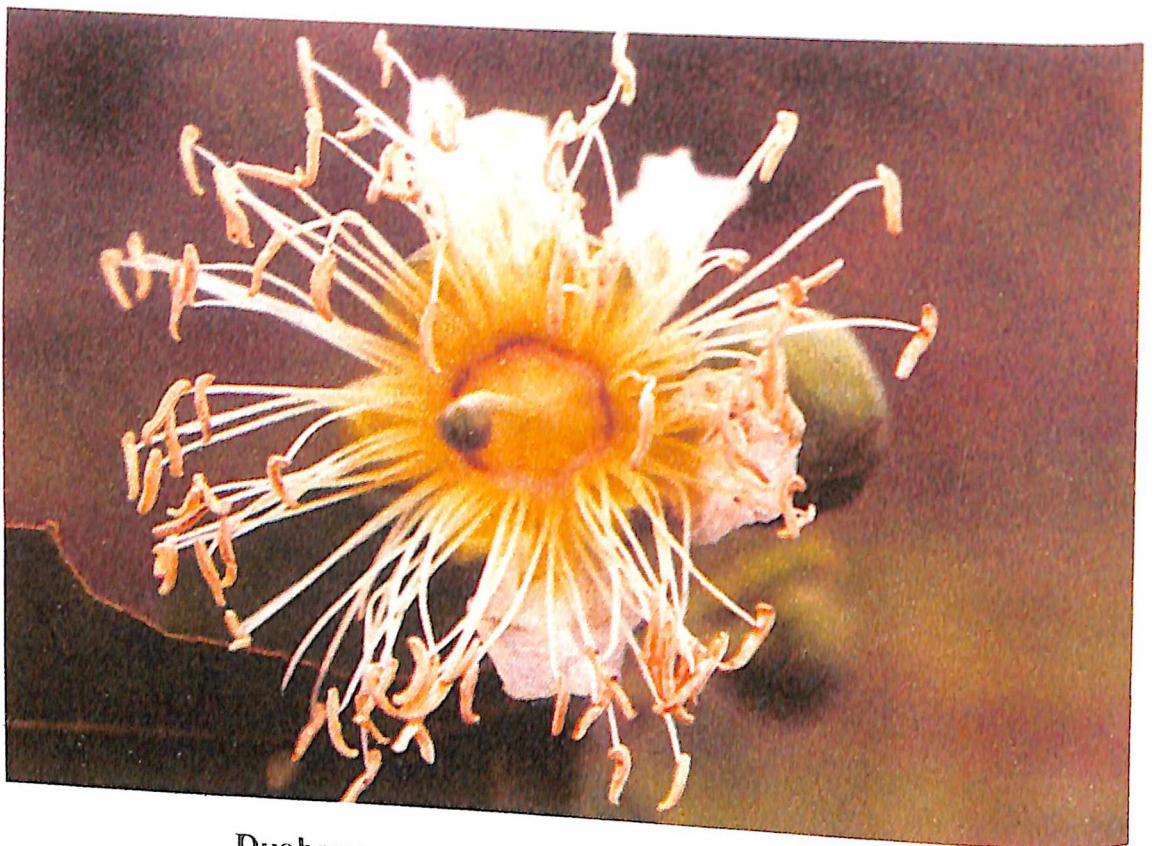


*Melastoma normale* D. Don



*Lagerstroemia reginae* Roxb.





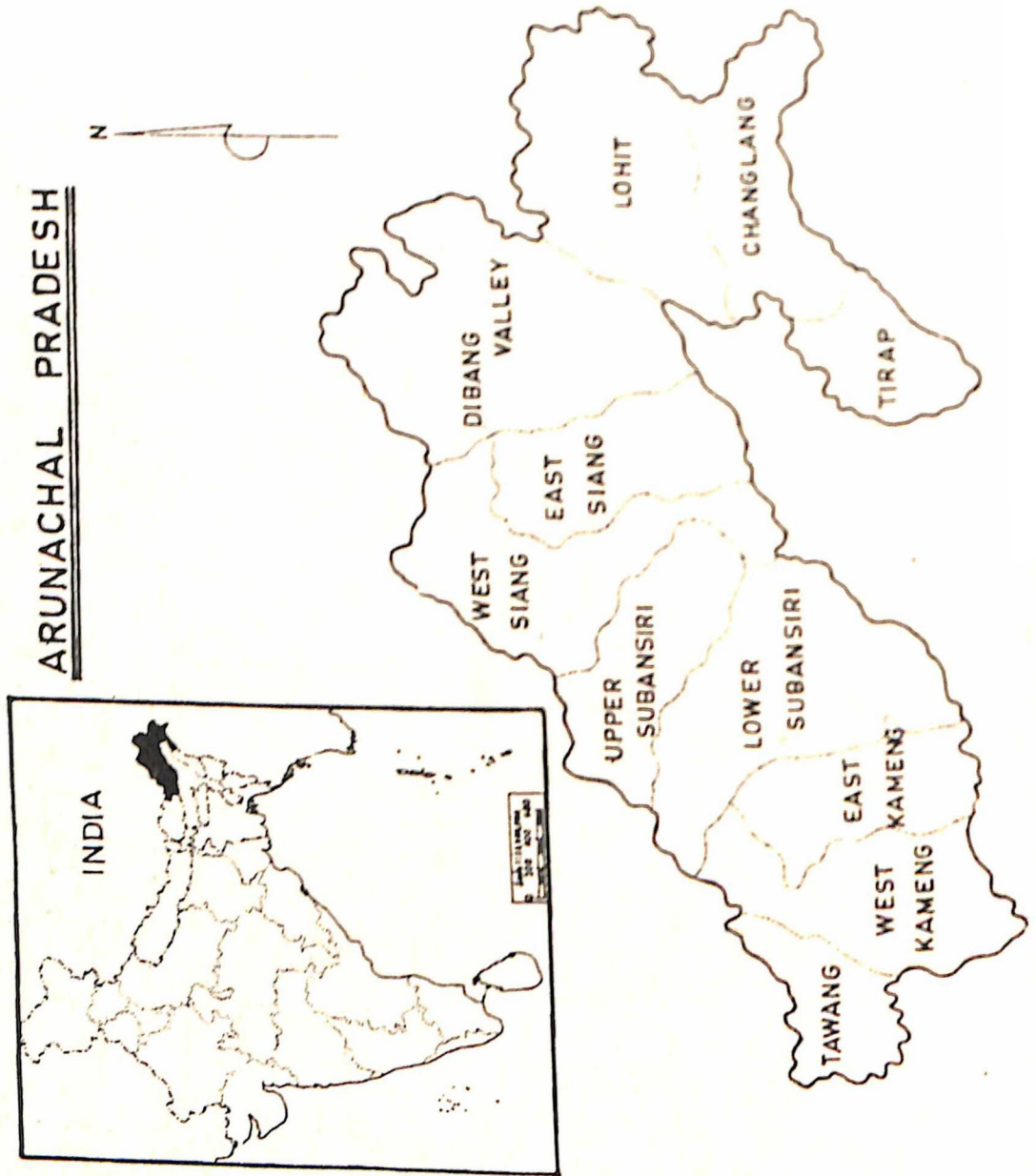
*Duabanga grandiflora* (Roxb. ex DC.) Walp.

## INTRODUCTION

Arunachal - the land of the rising sun, in the extreme north-eastern corner of India covers an area of 83740 Sq.Km. It lies between 26° 28' and 29° 30' North latitude and 90° 30' and 97°30' East longitude. It is bounded in the north by Mc-Mohan Line, in the east by China and Burma(Myanmar), in the south by the states of Nagaland and Assam and in the west by Bhutan.

Arunachal Pradesh- the 24th State of the Indian Union attained full fledged statehood on February 20th, 1987. It was known as North East Frontier Agency (NEFA) until 1972 when it was given the status of a Union Territory and renamed as Arunachal Pradesh and is the largest among the seven north-eastern states of the country. The state capital Itanagar, at an altitude of 530 m above sea level, is located at 93° East longitude and 27° North latitude in the Lower Subansiri district and has been named after a historical fort, the "Ita Fort" (meaning fort of bricks), built in 14-15th century. The use of bricks which are almost akin to the present day bricks is an interesting aspect of Archaeology. Arunachal finds mention in the ancient literature too, like in the "Kalika Purana" and "Mahabharata". The place is supposed to be the "Prabhu Mountains" of the Puranas. It is said that sage Parashuram washed away his sins here. This legendary place in the lower reaches of Lohit river is now a pilgrimage called "Parasuram Kund" where a large number of people from different walks of life come to have a holy dip on Makar Sankranti day. "Malinithan", a place in East Siang district, has rich granite sculptures belonging to 14-15th century depicting Indra on elephant 'Airavata', Surya on chariot and 'Nandi bul'. According to logical legends it is here the Lord Krishna married Rukmini, the daughter of the Bhisma.

Krishna and Rukmini were welcomed here by Parvati with garlands, and Parvati thus acquired the name Malini and the place subsequently named Malinithan. These widely scattered archaeological remains at different places in Arunachal bear testimony to its rich cultural heritage. Arunachal, apart from having an important place in Hindu mythology, is also an abode of 400 years old Monastery of Mahayana Buddhist in Tawang district at an altitude of about 3100 m. Built in 17th century the place is the focal point of spiritual life of the Buddhists of this region even today and houses more than 500 Buddhist priests. It is also the birth place of the Dalai Lama the VIth.



Map 1. Arunachal Pradesh showing different districts.

- c. **The Greater Himalayas :** It is the dominant division of the state. Peaks reaching as high as 6000 m and more are located in this division. Some of the known peaks of this division are : Gorichen (7300 m), Kangto (7090 m), Namcha Barwa (7756 m), Kulangri (7544 m) and Chomo Lhari (7344 m).

### GEOLOGY

The eastern Himalayas of Arunachal Pradesh can geographically be divided into three zones from south to north viz. (1) the Sub-Himalayas, (2) the Lesser Himalayas and (3) the Greater Himalayas.

The Sub-Himalayan zone consists of Neogene molassic sediments (Siwaliks) whereas the Lesser Himalayas comprises Upper Proterozoic to Lower Palaeogene self sediments (Bomdila Group, Buxa-Miri Formations) and the Greater Himalayas has been characterised by para and ortho metamorphites and acid to intermediate igneous intrusions from Precambrian to Tertiary age (Sela Group, Siang Group, Lumla Formation, etc.). It is a well known fact that these zones are directly or indirectly controlled by the distinct structural features called MBF, MCT, Lohit and Mishmi thrusts.

The Main Boundary Fault (MBF) separates the foot Hill molassic sediments from the shelf sediments of Lesser Himalayas. The main Central Thrust (MCT) generally identified at the base of the central crystallines of Greater Himalayas is a low angle feature. It shows the tectonic junction between the crystallines and the underlying metasediments. The north westward extension of the Lohit and Mishmi thrusts terminate the main Arunachal Himalaya against the Mishmi massif sequence - older crystalline complex and flysch of meta-sediments with serpentinite intrusives.

After the crystallines and metamorphic complex the next older sediments are the lower and middle Palaeozoic Buxa-Miri sequences of shelf sediments deposited in an extensive basin prevailed in northern part of the Lesser Himalayas. These sedimentary stratas do not show distinct fossil bearing horizons except a few remains of algal stromatolites and worm burrows at places.

During Upper Carboniferous to Lower Permian times, a marine transgression swept away parts of Arunachal Pradesh and extended its arm upto the foothill. During this period, the sedimentation commenced under glacio-

marine, marine and continental lagoonal environments and formed the glacio-marine diamictite, fossiliferous marine sediments in foothills, deposition of coal beds and intercalations of marine units with continental facies. (Bichom - Bhareli units of Gondwanas). At the end of Permian, marine regression took place and the entire part of Lesser and foothills of Arunachal Pradesh remained as land till the beginning of the Tertiary period when another episode of marine transgression and regression took place and subjected to form marine Eocene units with rich faunal and floral assemblages (Dalbuing, Dunro, Garu-Gensi, Yembung and Pasighat horizons).

The eruptive rocks in Arunachal Himalaya is represented by an extensive occurrence of Abor volcanics. From the field evidences it is found that the Abor Volcanics occur interbedded both with Buxa Permian Gondwanas and earlier workers equated them with Panjal Volcanics and Rajmahal traps. Recent studies have been brought out the infra and inter-trappen horizons with Palaeocene-Eocene marine fauna and hence the associated major basalt flows of Abor Volcanics may be related to Late Eocene period.

In the south-eastern part of the Arunachal Pradesh in Tirap district, the middle Tertiary sequences are exposed. These have been formed under a different sedimentary environment prevailed in a rapidly subsiding through and formed a mixed type of rocks under fluvial, deltaic, lagoonal conditions.

In the frontal foredeep basins developed due to the upliftment of land in the Sub-Himalayas, the Siwalik formation formed in the reversal of slope towards north-west. The Quaternary sediments after a hiatus in sedimentation history rest unconformably over the Siwalik.

### DRAINAGE SYSTEM

The natural drainage system is maintained by numerous streams and rivers dissecting the varied topography of Arunachal Pradesh which usually flow from the west-north to east-south direction. The main watershed system of the state is constituted by eleven rivers which are fed through rain water or through melting snow at the sources. These rivers receive water of all other substantial streams and rivulets and are finally drained to the westerly flowing Brahmaputra. There are six principle rivers in the state namely: Kameng, Subansiri, Siang, Lohit, Tirap and Dibang. The others include Kamlang, Sissini, Kamala, Dikrong, Ranga, Noa-Dihing and Namphuk (Buri-Dihing).

## SOIL

Owing to predominantly hilly terrain the soil in major parts of the state is rocky. These rocks are of Himalayan type mainly shales, schists and conglomerates. In general the soil has a high degree of acidity due to heavy rainfall and are rich in humus with higher percentage of nitrogen because of dense and rich vegetational cover. These soils have thick layer of organic matter as a result of accumulation of huge quantities of rotting/decaying plant materials. The erosion and deposition by rivers has resulted in sandy to sandy-loam, clayey soil mixed with heterogeneous matrix in some places. Sometimes soil mixed with mica is also found in river belt regions, whereas in some places the sedimentary nature of the soil can be observed. The soil in the foothill regions may be sandy or loamy or mixed, while it is clay alluvium with rich organic content in the plain areas or in the valleys.

The cultivation on the hill slopes in Arunachal Pradesh, which is being practiced since time immemorial, plays an important role in the rapid depletion of the organic matter from the surface layers of the soil as it is washed away due to heavy and prolonged rainfall, and as a result these slopes gradually lose their fertility.

The soil in higher regions are dark brown to yellowish brown in colour and somewhat coarse textured. It may be coarse sandy loam to loamy sand while the subsoil is loamy or clayey loam. These soils are well drained and granular. The soil of this region have developed from high grade metamorphics consisting schist, shales, granodiorite, sandstone, quartzites, conglomerates, mica, schist, etc.

## CLIMATE

By and large the state exhibits a mosaic of climatic zones varying from place to place which is mainly due to its geographical position and varied topography. The state receives heavy rain almost throughout the year and practically without any dry months (Rao 1972). In general the major parts of the state have humid subtropical climate with wet summer and winter, whereas it is cold humid in the remaining parts. On the basis of the monsoon, roughly the 12 months can be divided into 4 seasons which sometimes overlap one another:-

1. Winter season : January to February
2. Premonsoon season : March to May

3. Monsoon season : June to September
4. Postmonsoon season : October to December

The average mean maximum and minimum temperature is 29.5° C and 17.7° C in subtropical humid regions and 21.4° C and 2.4° C in cold humid regions. Generally December, January and February are the coldest months whereas, July and August are normally the warmest months and the maximum temperature is normally  $\pm 30^{\circ}$  C. However, sometimes the temperature rises as high as 35° C during summer month in the plains and broad valleys.

The average annual rainfall in the humid subtropical region is about 2972.7 mm while it is 2086.9 mm in cold humid regions. East Siang and neighboring areas of Lohit receives the highest rainfall, whereas west Kameng experiences the least annual rainfall.

## PEOPLE AND CULTURE

The population of Arunachal Pradesh according to 1991 census is 8.5 lakhs. Arunachal with its rich floristic diversity is also said to possess the largest number of Tribes. There are 26 major tribes and about 72 subtribes in the state. The different tribes inhabiting in different parts of the state lead an intricate life totally dependent on the forest resources, and virtually all of their requirements ranging from food, fuel, fodder, medicine, cordage and various other domestic needs are met by the local vegetation. Some attempts have been made to record and list such plant used by the local tribes by R.K.Arora (1981); D.P.Dam & P.K.Hajra (1981); G.D.Pal (1984), K.Thothathri & G.D.Pal(1987); H.C.Pandey (1988), K.Haridasan *et al.*(1990); H.C.Pandey *et al.* (1990); and G.D.Pal (1992).

### Different Tribes of Arunachal Pradesh

Aka; Apatani; Ashings; Bagins; Boris; Digarumishmis; Gallongs; Hill Miris; Idumishmis; Khamtis; Khonsa; Membas; Mijis; Mijumishmis; Minyongs; Monpas; Nishis; Noktes; Padams; Pailibos; Shor dukpens; Singphos; Tagins; Tangsas; Wanchos and Yobins.

These tribes may be divided into 3 cultural groups on the basis of their socio-religious affinities :-

- The Monpas, Membas and Shordukpens of Tawang and West Kameng follow Mahayan sect of Buddhism. Their villages have richly decorated "Gompas". They breed yaks, mountain goats and practice terrace cultivation. Khamtis and Singphos of the eastern part of the state follow Hinayana sect of Buddhism and are said to have migrated from Thailand, Burma (Myanmar) long ago.

- Adis, Akas, Apatanis, Bagins, Tagins, Nishis, Mijis, Tangsas, etc., worship sun and moon god called Donyi-Polo and Abo-Tani, the believed original ancestors for most of these tribes. They traditionally practice shifting or 'jhum' cultivation.

- Noktes practice elementary form of Vaishnavism.

Arunachalees are traditional craftsman having deep aesthetic sense. They master a variety of crafts like weaving carpets, rugs, garments of vivid colours and exquisite patterns, painting, pottery, wood carving, cane and bamboo furniture, house hold goods and other attractive and decorative articles.

## FLORA AND FAUNA

The wide ranging altitudinal variations from 100 m in the foothills to ca 7800 m high Himalayan mountains, rippling water over stones and boulders of the streams and mighty rivers flowing down to the delightful valleys, high rainfall and humidity, soil conditions, etc., have blessed Arunachal with a rich and very diverse flora and fauna. Keeping in view the varied flora and fauna of Arunachal, a good number of protected areas have been established covering an estimated area of 5094.98 Sq.Km.

Arunachal abounds in elephants and tigers in the grassy foothills, whereas red pandas and musk deer are found in higher altitudes. The most important among the mammals is the swinging Hoolock Gibbon which occurs only here. The white winged Wood Duck is one of the most threatened birds of the world. The great Indian Hornbill is also found frequently throughout Arunachal. The "Mithun" which is found both in wild and domesticated forms has religious significance and has got close relation with socio-cultural life of the people. It is also regarded as a unit of wealth and is frequently used for barter or food on festive occasions and ceremonial functions. Some important wildlife of the state are :-



i) Mammals: Hoolock, Capped Langur, Assamese Macaque, Phebus Macaque, Slow Loris, Tiger, Leopard, Snow Leopard, Clouded Leopard, Golden Cat, Fishing Cat, Leopard Cat, Marbled Cat, Crab eating Mongoose, Otter, Himalayan Weasel, Civet, Sloth Bear, Himalayan Black Bear, Wild Dog, Red Panda, Indian Pangolin, Crestless Porcupine, Giant Flying Squirrel, Namdapha Flying Squirrel, Red Chicked Squirrel, Malayan Giant Squirrel, Asiatic Elephant, Sambar, Hog Deer, Barking Deer Musk Deer, Gaur, Ghoral, Takin, Hispid Hare.

ii) Birds: Hodgeons Hawk Eagle, Black Eagle, Gray Headed Fishing Eagle, Crested Serpent Eagle, Common Hill Partridge, Kalij Pheasant, Red Jungle Fowl, Peacock, Pintailed Green Pigeon, Green Imperial Pigeon, Spotted Dove, White Winged Wood Duck, Bay Owl, Red Headed Trogon, Blue Bearded Bee-eater, Rofous Necked Hornbill, Blue Throated Barbet, Rofous Wood Pecker, Black Headed Myna, Pied Myna, Common Myna, Jungle Myna, Hill Myna, Jungle Crow, Flycatcher Shrike, Large Wood Shrike, Scarlet Minivet, Small Minivet, Leaf Bird, Fairy Blue Bird, Redvented Bulbul, Black Bulbul, Wren Babbler, Red Headed Babbler, Black Throated Babbler.

iii) Reptiles: Moonitor Lizard, Geeko, Diards Blind Snake, Great Tree Racer, Black Banded Trinket Snake, Wolf Snake, King Cobra, Indian Spectacled Cobra, Russells Viper, Bamboo Pit Viper, Python, Black Krait.

#### LIST OF DECLARED SANCTUARIES & NATIONAL PARKS IN ARUNACHAL PRADESH

Sl. No.	Sanctuary/National Park	District	Area in Sq.Km.
1.	Dibang Wildlife Sanctuary	Dibang Valley	4149.00
2.	Eagle Nest Wildlife Sanctuary	East Kameng	217.00
3.	Itanagar Wildlife Sanctuary	Papum Pare	140.30
4.	Kamlang Wildlife Sanctuary	Lohit	783.00
5.	Kane Wildlife Sanctuary	West Siang	55.00
6.	Lali 'D' Ering Wildlife Sanctuary	East Siang	190.00

Sl. No.	Sanctuary/National Park	District	Area in Sq.Km.
7.	Mehao Wildlife Sanctuary	Dibang Valley, Lohit	281.50
8.	Pakhui Wildlife Sanctuary	East Kameng	861.95
9.	Sessa Orchid Sanctuary	West Kameng	100.00
10.	Mouling National Park	East Siang	483.00
11.	Namdapha National Park (Tiger reserve)	Tirap	1983.23

#### STATUS OF FORESTS IN ARUNACHAL PRADESH

Sl. No.	Status	Area in Sq.Km.	% of total Forest area	% of total Geographical area
1.	Reserve Forests	9815.37		
2.	Wildlife Sanctuaries National Parks	6777.75 2468.23	37.32	22.97
3.	Village Reserve Forests	175.20		
4.	Anchal Reserve Forests	256.08	0.50	0.30
5.	Protected Forests	7.79	0.01	0.009
6.	Unclassed State Forests	32039.00	62.17	36.27
	Grand Total	51539.42	100.00	61.54

\*Source: "Arunachal Forests" by Arunachal Pradesh Environment & Forest Department, Arunachal Pradesh, Itanagar, 22nd March, 1993.

## BIOSPHERE RESERVE IN ARUNACHAL PRADESH

"Dehang-Debang Biosphere Reserve" is the proposed Biosphere falls under the East Siang, West Siang and Dibang Valley districts of Arunachal Pradesh and is likely to spread over an area of 8400 sq. km.

BRIEF HISTORY OF PLANT EXPLORATIONS IN  
ARUNACHAL PRADESH

The geography, location, climate and varying topography have contributed to the characteristic, rich and diverse flora of Arunachal Pradesh. But, despite its fabulous plant wealth this region was not able to attract as many plant collectors or explorers as compared to other regions within Eastern Himalayas 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 1954. However, some important explorations were conducted prior to 1954 of which mention may be made of the following.

Though Lieutenant R. Wilcox and Captain Bedford visited Mishmee (Mishmi) in Arunachal Pradesh during their Survey of Asam (Assam) and the neighboring countries in view of geographic discoveries on the N.E. Frontier (1825-1828), but it was only Griffith who botanised this region for the first time. His 'Flora of Mishmee Hills' was based on the collections made by him during October-December, 1836 following more or less the route of Wilcox and Bedford. The account deals with 900 species of flowering plants and 22 species of ferns and fern allies. Thomas J. Booth undertook 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 such as, "On the Botany of Abor Expedition" by I.H. Burkill (1924-1925); "Botanical Expedition in the Mishmi Hills" by Kingdon Ward (1929-1931); "Lohit Valley" by Kingdon Ward (1953); "A sketch of the vegetation of Aka Hills" by N.L. Bor (1938). In 1941, K.P. Biswas published "The Flora of Aka Hills" based on the collections of N.L. Bor for a period of 3 years (1931-1934) which includes 1549 species of flowering plants (Angiosperms), 9 species of Gymnosperms and 58 species of Ferns and Fern allies.

The huge collection and work of U.N.Kanjilal, the Chief Commissioner of Assam came in the light of botanical world only after his death in 1928. It was P.C.Kanjilal with A.Das, C.S.Purakayastha and R.N.De of the Forest Department of Assam published the 'Flora of Assam' in five volumes (1934-1940), where the 5th volume deals with Gramineae is by N.L.Bor (1940). This work is still regarded as a major floristic account so far as the flora of this region is concerned. G.K.Deka of the Forest Department of Assam who later on joined the Botanical Survey of India explored some parts of Kameng district mainly the foothills in 1951, while K.Srinivasan in early 1955 surveyed along the Rupa valley in Kameng district. In the late 1955, R.S.Rao undertook plant exploration along the Rupa and Dirang valley and Apatani valley and surrounding areas of Subansiri district.

With the inception of the Eastern Circle of Botanical Survey of India in December 1955, various parts of Arunachal Pradesh namely Kameng, Subansiri, Siang, Lohit, Tirap, etc., were surveyed by the botanists of Botanical Survey of India to explore the vegetational wealth of the state. Some major explorations may be summarised as: R.S.Rao (1955-59, 1973: Kameng, Subansiri, Siang, Tirap); G.Panigrahi (1957-59: Kameng, Subansiri, Siang, Lohit, Tirap); J.Joseph (1957-58, 1964, 1969: Kameng, Siang, Lohit); D.B.Deb (1961: Tirap); A.S.Rao (1964, 1969, 1970, 1973: Kameng, Siang, Lohit); A.R.K.Sastry (1964-66: Subansiri); C.L.Malhotra (1970-71: Subansiri); P.K.Hajra (1970, 1973, 1976: Kameng).

As the climatic conditions are ideal for the growth and development of orchid in this region, National Orchidarium at Shillong and Experimental Garden at Barapani near Shillong have been set up by the Botanical Survey of India to provide facilities for conservation, multiplication and thorough systematic studies of Orchidaceae of this region and in this regard contributions of S.K.Kataki and N.C.Deori of Eastern Circle, B.S.I. are worth mentioning. S.N.Hegde and A.N.Rao of the Forest Department of Arunachal Pradesh also have made very valuable contributions so far as the Orchid wealth of the state is concerned.

After the establishment of Arunachal Pradesh Field Station, Itanagar in July 1977, R.M.Dutta, A.K.Baishya, Jagadish Lal, H.J.Chowdhery, S.K.Das and A.Pramanik surveyed some selected areas of Arunachal Pradesh. G.D.Pal, one of the authors of this present work surveyed the flora of Lower Subansiri district (1978-85) in detail for his Ph.D. dissertation.

Apart from these, K.C.Sahani (1964,1969); H.B.Naithani, K.N.Bahadur, S.S.R.Bennet and other scientists from the Forest Research Institute, Dehra Dun have explored some parts of Arunachal Pradesh. The forest officers and Scientists of the Forest Department of Arunachal Pradesh who are the custodian of the vegetational wealth of the state also made valuable contributions in respect of survey, protection and conservation of this enormous plant genetic resources.

### GENERAL VEGETATION

The phytogeographical position, irregular and undulated topography with lofty hill ridges and deep valleys accompanied by wide variation in climate and soil have resulted into the formation of varied ecological diversity which subsequently influenced a very rich and fascinating vegetation in the North-Eastern region of India comprising seven states. The dense vegetation right from the foothills up to the snow line is estimated to harbour 7000-8000 species of flowering plants, nearly 50% of the Indian flora. Among these seven states, Arunachal Pradesh, the largest state of North-East exhibits the richest type in terms of both species diversity and concentration and may be considered as the most valuable region of active speciation in the country. The forest cover of the state is about 61.54% of its total geographical area of which a major part still enjoys primary forest, though they are quickly eroding due to various biotic and abiotic factors. The characteristic three storeyed sequence of vegetation particularly in the tropical and subtropical zones is one of the significant features in Arunachal Pradesh where the shrubs and small trees form the ground storey, the medium sized trees form the middle storey and the lofty trees with dense canopy form the top storey.

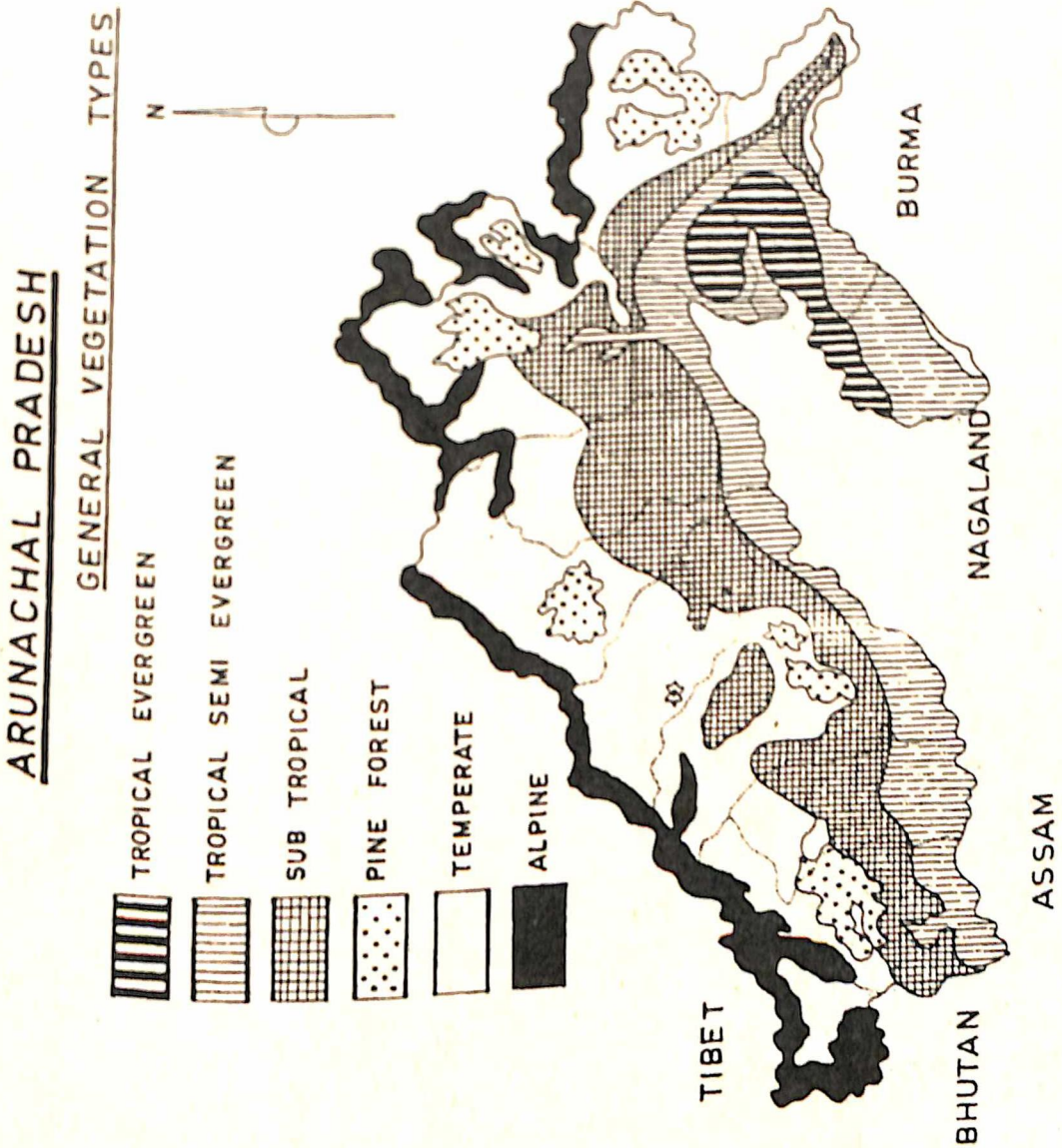
Classification of the vegetation types are followed basically on two lines 1) classification based on vegetation i.e. study of plant communities where the data being grouped in any of the several categories such as physiognomy, structure, composition and dynamics, and 2) classification based mainly on climate. Schimper (1898) put primary importance to the moisture condition and considered mountain separately because of their own climatic peculiarities. Beard's (1944, 1955) classification was mainly based on floristic grouping which was primarily followed by Champion & Seth (1968) where the authors remarked Moisture condition during the growing season are evidently the most important items in determining the type of vegetation which can exist; but neither rainfall alone nor atmospheric humidity indicates the availability of

moisture for growth, many other factors among which the soil is predominant also coming into play'. He classified the vegetation in five major groups namely 1) Tropical forests 2) Montane subtropical forests 3) Montane temperate forests 4) Subalpine forests and 5) Alpine forests with several subtypes in each major category. The vegetation of Arunachal Pradesh may be ascribed to his wet evergreen and semievergreen subtypes of Tropical forests, subtropical broad leaved and subtropical pine subtypes of Montane subtropical forests, Himalayan moist temperate subtype under Montane temperate forests, subalpine forests and moist alpine scrubs of Alpine forests. M.A.Rau (1974) discussed the vegetation and phytogeography of the Himalayas and categorised the vegetation of Arunachal Pradesh into tropical, subtropical, temperate and subalpine zones, while A.S.Rao (1974) on 'The vegetation and phytogeography of Assam-Burma' proposed 3 major categories viz. tropical (subtropical mixed as subtype), temperate and alpine. In the present work, the vegetation of Arunachal Pradesh is considered under 4 major categories namely 1. Tropical 2. Subtropical 3. Temperate and 4. Subalpine & Alpine, based on Champion & Seth (1968) and added information available from recent studies by scientists of Botanical Survey of India and Forest Department of Arunachal Pradesh.

## I. Tropical Vegetation

Such vegetation exists up to an elevation of 900 m in the foothill regions and outer valleys with heavy rainfall and high summer temperature. This vegetation can be further divided into two subtypes based on the composition and structure:-

*I.a. Tropical Evergreen* : The tropical evergreen vegetation typically extends from foothills up to 1000 m in the areas receiving maximum rainfall. The top canopy or the upper storey in these forests mainly consists of tall trees. Some of the most commonly occurring species are *Aglaia hiernii*, *Altingia excelsa*, *Artocarpus chama*, *Bischofia javanica*, *Bombax ceiba*, *Callicarpa arborea*, *Canarium bengalense*, *Castanopsis indica*, *Cinnamomum glaucescens*, *Chukrasia tabularis*, *Dillenia indica*, *Dipterocarpus gracilis*, *D.retusus*, *Duabanga grandiflora*, *Dysoxylum gobara*, *Echinocarpus sp.*, *Lagerstroemia reginae*, *Magnolia campbelli*, *M.caveana*, *Mesua assamica*, *M.ferrea*, *Pterospermum acerifolium*, *Quercus griffithii*, *Q.lamellosa*, *Shorea assamica*, *S.robusta*, *Terminalia chebula*, *T.myriocarpa*.



Map 2. General vegetation types of Arunachal Pradesh.  
(After Kaul and Haridasan 1987).

These tall trees with their close canopy cover stifles plants of the lower storeys of the forest and the dense, dark humid environ thus created provides excellent conditions for the profuse and luxuriant growth of the epiphytes.

The next canopy is represented by small trees and shrubs. Some of the most common elements of this storey are: *Actephila excelsa*, *Ardisia crispa*, *A. humilis*, *Baliospermum corymbiferum*, *Bauhinia purpurea*, *Boehmeria macrophylla*, *B. platyphylla*, *Buddleja asiatica*, *Capparis acutifolia* subsp. *sabiaefolia*, *Clerodendrum bracteatum*, *C. colebrookianum*, *C. serratum*, *C. venosum*, *Coffea benghalensis*, *Dendrocnide sinuata*, *Ficus hispida*, *Friesodielsia fornicata*, *Goniothalamus sesquipetalis*, *Grewia disperma*, *Gynocardia odorata*, *Illicium manipurense*, *Leea robusta*, *Magnolia hodgsonii*, *Michelia doltsopa*, *Micromelum minutum*, *Mussaenda roxburghii*, *Oxyspora paniculata*, *Phlogacanthus* spp., *Pseudodissochaeta assamica*, *Rhus succedanea*, *Sambucus hookeri*, *Saurauia punduana*, *Solanum torvum*, *Sterculia hamiltonii*, *Strobilanthes coloratus*, *Styrax serrulatum*, *Syzygium anisopetalum* and *Triumfetta rhomboidea*. Canes like *Calamus erectus* and *C. leptospadix* occur in swampy areas and form impenetrable thickets. Some palms are also met within these forest, the most common are *Arenga pinnata*, *Caryota obtusa*, *C. urens*, *Didymosperma nana*, *Licuala peltata*, *Livistona jenkinsiana*, *Pinanga gracilis* and *Phoenix rupicola*. *Salacca secunda*, *Wallichia densiflora* and *W. triandra* are found to grow scattered on the drier hill slopes, whereas *Pandanus nepalensis*, species of *Cyathea* -the tree ferns and large leaved fern like *Angiopteris evecta* with fronds measuring upto 6 m in length may be seen growing along the nallahs and moist places. Species of wild banana - *Musa* spp. are one of the prominent features of these forests.

The forest trees are densely covered with numerous climbers and epiphytes. Of the numerous lianas, species of *Acacia*, *Bauhinia*, *Derris*, *Entada*, *Gnetum*, *Hodgsonia*, *Mezoneurum*, *Mucuna*, *Piper*, *Rhaphidophora*, *Thunbergia*, *Toddalia*, *Unona* and *Vitis* are more prominent. Several species of *Calamus* also stretch long distances from one tree to another.

Some of the most common epiphytic orchids are species of *Aerides*, *Coelogyne*, *Cymbidium*, *Dendrobium*, *Eria*, *Oberonia*, *Pholidota*, *Rhynchostylis*, *Saccolabium*, etc., and the epiphytic species of ferns belong to



*Asplenium*, *Nephrolepis*, *Drymoglossum*, *Colysis*, etc. *Aeschynanthus* spp., *Chonemorpha griffithii*, *Clematis* spp., *Dioscorea* spp., *Dischidia rafflesiana*, *Gymnostemma pedata*, *Hoya* spp., *Ipomoea* spp., *Jasminum* spp., *Naravelia zeylanica*, *Piper* spp., *Pothos* spp. *Pueraria phaseoloides*, *Rhaphidophora* spp., *Tetrastigma bracteolatum*, *Trichosanthes cordata*, *Thunbergia coccinea*, *T. grandiflora* are some of the commonly occurring climbers.

The ground flora mainly consists of herbaceous elements such as *Asystasia neesiana*, *Begonia roxburghii*, *B. sikkimensis*, *Chirita oblongifolia*, *C. pumila*, *Commelina* spp., *Deeringia amaranthoides*, *Exacum tetragonum*, *Floscopa scandens*, *Globba* spp., *Lindenbergia indica*, *Lobelia pyramidalis*, *Murdannia nudiflora*, *Oxalis corniculata*, *Polygonum* spp., *Rhynchoglossum obliquum*, etc. *Arundina graminifolia* the bamboo orchid with its beautiful lilac-red flowers may be seen growing along with the tall grasses on the open cut slopes of the hills along the roadsides. *Tacca* spp. with their showy floral bracts are also conspicuous in shady places along the streams and moist places at lower elevations. Profuse growth of *Ichnanthus vicinus* may be seen on moist-wet rocks and boulders in fairly open sunny places whereas *Gonatanthus pumilus* in association with *Selaginella* sp. is found commonly growing on slopes that are regularly moistened with water along the roadsides. Several terrestrial orchids like species of *Goodyera*, *Habenaria*, *Calanthe*, *Malaxis*, *Phaius*, etc., ferns like *Angiopteris* sp., *Diplazium dilatatum*, *Pteris* sp. and fern allies, mainly species of *Equisetum*, *Lycopodium* and *Selaginella* are of common occurrence. Among the interesting root parasites, *Balanophora dioica* infesting the roots of many tree species is worth mentioning. The saprophytic species like *Epipogium roseum*, *Galeola falconeri* - the giant orchid and *Monotropastrum humile* occur in moist, shady, humus rich soils of these forests.

The conspicuous rhizomatous Monocotyledons forming a green-belt at lower elevations along with bamboos are of *Amomum* spp., *Arisaema* spp., *Amischotolype mollissima*, *Colocasia* spp., *Costus speciosus*, *Curculigo capitulata*, *Curcuma* spp., *Curcumorpha longiflora*, *Gonatanthus* spp., *Hedychium* spp., *Homalomena aromatica*, *Musa rosacea*, *M. balbisiana*, *M. acuminata*, *Phrynium rhœdeii*, *Zingiber* spp., etc. *Clerodendrum squamatum* var. *urticifolia* with beautiful red flowers in large terminal bunches is occasionally seen along the forest edges.

*I.b. Tropical Semievergreen* : The tropical Semievergreen type of vegetation occurs along the foothills and river banks up to an elevation of 600 m. The top canopy in this type consists of generally deciduous trees whereas the remaining storeys are dominated by evergreen species and thick undergrowth of shrubs, climbers and lianas. This type may be further divided into two subtypes as follows:

*I.b. (1). Low Hills & Plains Semievergreen*: The upper storey in this vegetation type is dominated by tall tree species like *Aglaia hiernii*, *Ailanthus integrifolia* subsp. *calycina*, *Altingia excelsa*, *Anthocephalus chinensis*, *Artocarpus lacucha*, *Bischofia javanica*, *Bombax ceiba*, *Canarium strictum*, *Castanopsis* spp., *Chukrasia tabularis*, *Cinnamomum glaucescens*, *Dillenia indica*, *Duabanga grandiflora*, *Dysoxylum binectariferum*, *Elaeocarpus aristatus*, *Firmiana colorata*, *Gmelina arborea*, *Khasiaculnea oligocephala*, *Phoebe goalparensis*, *Pterospermum* spp., *Sterculia villosa*, *Stereospermum chelonoides*, *Terminalia myriocarpa*, *Tetrameles nudiflora*, etc.

The next storey is represented by small trees and shrubs. Some of the common tree species are *Crateva religiosa*, *Croton chlorocalyx*, *Ficus* spp., *Gynocardia odorata*, *Litsea panamonja*, *Meliosma simplicifolia*, *Turpinia nepalensis*, etc. Species of *Ardisia*, *Boehmeria*, *Capparis*, *Clerodendrum*, *Phlogacanthus*, *Strobilanthes* are some of the common shrubs.

The ground floor is dominated by species of *Ageratum*, *Amorphophallus*, *Arisaema*, *Colocasia*, *Costus*, *Impatiens*, *Phrynium*, *Strobilanthes*. Among the climbers and lianas, *Gouania tilaefolia*, *Stixis suaveolens* and *Thunbergia* spp. are of common occurrence. Epiphytic species of *Dendrobium*, *Hoya*, *Papilionanthe*, *Eria* and several species of ferns may be seen in this vegetation type.

*I.b. (2). Riverine Semievergreen*: Such vegetation exists along the river banks, riverine plains and swamps. The trees in this vegetation type are generally deciduous, buttressed and lack dense canopy. The top canopy is dominated by species like - *Albizia* spp., *Artocarpus chama*, *Bischofia javanica*, *Bombax ceiba*, *Canarium strictum*, *Castanopsis* spp., *Dalbergia sissoo*, *Dillenia indica*, *Duabanga grandiflora*,

*Lagerstroemia parviflora*, *L. reginae*, *Radermachera gigantea*, *Sterculia villosa*, *Terminalia bellirica*, *T. myriocarpa*.

The second storey, if present is generally consists of species of *Ficus*, *Litsea*, *Magnolia*, *Meliosma*, *Turpinia*, *Villebrunea*, etc. Species of *Calamus*, *Murraya*, *Randia* often form dense covering at the ground level mixed with species of *Phragmites*, *Saccharum*, *Costus* and *Hedychium*. Climbers and epiphytes are not very common in this vegetation type.

## II. Subtropical Vegetation

This vegetation type occurs between 900-2000 m and is basically of evergreen and dense in nature. The forests of Sessini and its surrounding Baha and Kalaktang adjoining Bhutan border in Kameng district, Kherbari onwards to Ziro and beyond up to Amjee in Subansiri district, the entire region of Siang river valley, upper Lohit valley and south-western part of Tirap district are some of the areas where the predominant vegetation is subtropical type. This vegetation can be broadly divided into two subtypes as follows:-

*II.a. Subtropical Broad Leaved Forests:* The dominant tree species of this vegetation are: *Acer oblongum*, *Actinodaphne obovata*, *Alnus nepalensis*, *Beilschmiedia roxburghiana*, *Byttneria grandifolia*, *Callicarpa arborea*, *Castanopsis armata*, *C. indica*, *C. purpurella*, *Dichroa febrifuga*, *Engelhardia spicata*, *Euodia trichotoma*, *Ficus gasparriniana*, *Garcinia acuminata*, *Gynocardia odorata*, *Kydia calycina*, *Magnolia pterocarpa*, *Manglietia insignis*, *Michelia oblonga*, *Ostodes paniculata*, *Prunus napaulensis*, *Quercus acutissima*, *Q. griffithii*, *Q. lamellosa*, *Q. lanata*, *Q. semecarpifolia*, *Q. spicata*, *Saurauia armata*, *S. punduana*, *Schima wallichii* var.  *khasiana*, *Stachyurus himalaicus*, *Sterculia hamiltonii*, *Ulmus lanceifolia*. Among the small trees *Capparis multijlora*, *Lepisanthes senegalensis*, *Photinia integrifolia*, etc., are common alongwith *Ardisia* spp., *Artemisia indica*, *Berberis wallichiana* var. *latifolia*, *Camellia caudata*, *Cassia mimosoides*, *Dianella ensifolia*, *Drymaria diandra*, *Eurya acuminata*, *E. japonica*, *Lasianthus longicauda*, *Mahonia acanthifolia*, *M. napaulensis*, *Plectranthus griffithii*, *P. hispidus*, *Rosa indica*, *Solanum erianthum*, *Sophora acuminata*, *Stellaria uliginosa*, *Symplocos* spp., *Wendlandia* spp., *Tephrosia candida*, *Triumfetta pilosa*, *Urena lobata*, *Vernonia saligna*, *Viburnum foetidum*, *V. mullaha*, whereas *Clematis acuminata*, *Holboellia latifolia* and *Tinospora sinensis* are some of the common woody climbers. Among the other climbers and straggling shrubs met within these forests

are *Actinidia callosa*, *Argyreia wallichii*, *Boehmeria* spp., *Clematis gouriana*, *Clerodendrum* spp., *Clitoria mariana*, *Combretum pilosum*, *Dioscorea pentaphylla*, *Gnetum ula*, *Jasminum* spp., *Lagenaria ciceraria*, *Lygodium japonicum*, *Maesa* spp., *Phlogacanthus* spp., *Rubia cordifolia*, *Rubus moluccanus*, *R. moluccanus* var. *macrocarpa*, *Toddalia asiatica*, *Thunbergia* spp. and *Zanthoxylum oxyphyllum*.

The herbaceous flora is mainly composed of species like *Anaphalis adnata*, *A. busua*, *A. contorta*, *Anemone vitifolia*, *Astilbe rivularis*, *Campanula khasiana*, *Cardamine hirsuta*, *Cynoglossum glochidiatum*, *Exacum tetragonum*, *Inula cappa*, *Justicia khasiana*, *Leucas ciliata*, *Osbeckia stellata*, *Plantago major*, *Polygonum* spp., *Potentilla* spp., *Valeriana hardwickii*, *Viola betonicifolia*, *V. diffusa*, *V. hamiltoniana* and *V. pilosa* along with several species of terrestrial orchids and ferns. Apart from these, some common herbaceous climbers like *Clitoria mariana*, *Parabaena sagittata*, *Pericampylus glaucus* and *Stephania elegans* may also be seen.

The epiphytic flora in this forest comprises of a variety of ferns like *Asplenium ensiforme*, *Drynaria propinqua*, *Lepisorus* spp., *Pyrrosia* spp. The density of Orchid components in these forests are very high belonging to genera like *Bulbophyllum*, *Coelogyne*, *Dendrobium*, *Octochilus*, *Ritaia*, etc.

The common ground orchids present are species of *Goodyera*, *Hebenaria*, *Malaxis* and *Phaius*. The common grasses met with are *Arundo donax*, *Capillipedium assimile*, *Imperata cylindrica*, *Setaria palmifolia* and species of *Panicum* and *Erianthum*.

**II.b. Subtropical Pine Forests:** These forests occur between 1000-1800 m in subtropical and semitemperate regions mainly in Dirang valley of Kameng district, lower hill slopes around Apatani valley of Subansiri district, hill slopes around Walong and along inner Lohit river valley of Lohit district (Rao 1972). These forests are represented by 3 species of *Pinus* viz., *P. merkusii*, *P. roxburghii* and *P. wallichiana* in association with tree species like *Alnus nepalensis*, *Betula alnoides*, *Lyonia ovalifolia*, *Quercus* spp., *Rhus javanica*, *Tsuga dumosa* and shrubby and herbaceous species of *Ajuga*, *Coriaria*, *Desmodium*, *Elsholtzia*, *Indigofera*, *Luculia*, *Plectranthus*, *Pogostemon*, *Potentilla*, *Pteridium*, *Rubus*, etc.

Epiphytes are not very common since recurring annual fires in these forests during winter months destroys the undergrowth, thus not allowing more such species to grow.

### III. Temperate Vegetation

The forests around Chakoo, Peri La, Morsing, Bomdila, Dirang, Rapa and Shergaon in Kameng district; the forests beyond Amjee in Subansiri district; the upper slopes above the valley particularly from Garsing to Kapang La and along the track from Take Pokong to Sirang in Siang district, Lohit and Delei in Lohit district, Waka and along the border of Burma in Tirap district and other areas in this region within the range of altitude 1800-3500 m exhibit temperate vegetation.

The characteristic appearance is open and apparent lax storeyed nature with dominance of Oaks and members of Magnoliaceae and Ericaceae, particularly the species of *Rhododendron*. But in several localities a mixture of temperate with those of tropical and subtropical elements are not uncommon. However, the temperate vegetation can be broadly divided into two distinct subtypes as follows:-

*III. a. Temperate Broad Leaved Forests:* This type is generally found between 1800-2800 m in the cold climatic regions with severe winter and moderately high rainfall.

The top canopy is represented by tall tree species like, *Acer hookeri*, *A. oblongum*, *A. pectinatum*, *Alnus nepalensis*, *Betula alnoides*, *Exbucklandia populnea*, *Castanopsis indica*, *Euonymus spp.*, *Magnolia campbelli*, *M. obovata*, *Photinia sp.*, *Populus ciliata*, *P. gamblei*, *Rhododendron spp.*, *Symplocos racemosa*, etc. The middle storey is predominated by species of *Pyrus*, *Prunus*, *Spiraea*, *Acer*, *Symplocos* and *Rhododendron*, etc. Lower storeys are occupied by small trees and shrubs of *Ardisia spp.*, *Berberis wallichiana*, *Caryopteris odorata*, *Debregeasia longifolia*, *Illicium griffithii*, *Lyonia ovalifolia*, *Mahonia spp.*, *Myrsine semiserrata*, *Rhododendron spp.*, *Vaccinium sprengelii*, etc. Ground floor is mostly occupied by species of *Arisaema*, *Begonia*, *Corydalis*, *Drymaria*, *Fragaria*, *Geranium*, *Polygonum*, *Potentilla*, *Sedum*, *Thalictrum*, etc.

In this vegetation type climbers are of rare occurrence, but it abounds in various epiphytes of which species of *Rhododendron*, *Agapetes*, *Vaccinium* are more common along with many orchid, fern and lichen species. Along the roadsides, forest edges and streams, a prominent herbaceous layer

appears during rainy seasons which commonly includes *Ambrosia artemisiaefolia*, *Cardamine hirsuta*, *Carpesium abrotanoides*, *Oenanthe javanica*, *Pilea umbrosa*, *Rorippa indica*, *Stellaria uliginosa*, etc. Terrestrial ferns are few. Among the dimorphic ferns *Plagiogyria scandens* is common on the forest floor.

*III.b. Temperate Coniferous Forests:* This type occurs between 2800-3500 m altitude above temperate broad leaved vegetation and experiences heavy snowfall during winter months. The lower limits of such vegetation are dominated by mixed coniferous type which include species of *Abies*, *Cupressus*, *Pinus*, *Taxus*, *Tsuga*, etc. Sometimes pure stands of *Cupressus torulosa* are also seen in places like Rupa-Shigao, whereas in the upper limits, species of *Abies*, *Juniperus*, *Larix*, *Picea*, *Taxus*, etc., are predominant. Although the temperate broad leaved forests are always situated below the temperate coniferous ones, a very peculiar phenomenon has been noticed in Tale Valley where the broad leaved forest consisting *Acer*, *Magnolia*, *Michelia*, *Quercus*, *Rhododendron*, *Schima* species and certain members of the family *Fagaceae*, *Lauraceae* are at a higher elevation, whereas the coniferous forest is confined to the bottom of the valley.

#### IV. Subalpine and Alpine Vegetation

There is no sharp division between subalpine and alpine vegetation and only a rough distinction can be made with concentration of certain elements. The zone between 3500-4000 m is termed as the subalpine zone characterised by tree species like *Abies spectabilis*, *Cupressus torulosa*, *Juniperus recurva*, *Larix griffithiana*, *Pinus wallichiana*, *Rhododendron spp.*, *Taxus wallichiana* and *Tsuga dumosa*. The common shrubs are *Berberis asiatica*, *B. wallichiana*, *Eurya acuminata*, *Gaultheria fragrantissima*, *Photinia integrifolia* and *Vaccinium venosum*.

The alpine zones above an altitude of 4000 m, i.e. above tree line remains covered with snow for the major part of the year and is limited nearly at an altitude of 5500 m, above which the vegetation is very very scarce. The vegetation comprises of shrubby *Rhododendrons* and herbaceous elements with attractive brilliantly coloured flowers. Various species of *Aconitum*, *Arenaria*, *Gentiana*, *Meconopsis*, *Polygonum*, *Primula*, *Rhodiola*, *Saussurea*, *Saxifraga* and *Sedum*, etc., dominate the Alpine vegetation.

## SECONDARY FORESTS

The primary forests due to the impact of various adverse biotic and abiotic factors like shifting cultivation or "Jhumming", developmental activities and urbanization, land slides, fires, etc., are destroyed and develop into secondary forests.

The shifting cultivation has been practiced in the state since time immemorial, particularly in the tropical and subtropical belt. In this method a patch of forest is cleared during winter and at the on set of spring when the debris comprising the wood, branches and leaves of herbaceous, shrubby habits and often the medium sized trees fully dry up, they are set on fire to prepare the ground for sowing with an admixture of rice, maize, millet, etc. Usually in the third year when the yield is very low and the plot becomes uneconomical due to decrease in soil fertility, the farmers move to a fresh patch of land abandoning the first plot. Often the farmers return to the first plot after a gap of 8-10 years when reasonably a good vegetation might have appeared with various herbaceous and shrubby secondary forest elements like bamboo, grasses and other weeds. Thus, when the primary forest areas are selected, not only the herbaceous and shrubby habits are destroyed, but the tree habits are often greatly damaged also due to fire, even if they are not felled. And when the same plot is repeatedly used, the hill slopes may appear as barren and bald. Jyrwa (1992) while discussing on 'Improvement on Jhum' mentioned some advantageous points behind the choice of Jhumming by hill people. It is easy, less time consuming and require very simple and minimum agricultural implements. Burning destroys many pests, the ash residues to some extent neutralise excess acidity and acts as manure and as insect repellent. But the disadvantageous part of Jhum cultivation is more and more intense. Apart from the direct effect on the existing vegetation, the burnt and cleared off ground facilitate soil erosion and land slide as the rain directly hit the upper surface of the soil and makes it loose and weak. Further, the soil fertility is quickly reduced as the rain water takes away the nutrients from the soil. However, more attention is being paid by the Government on this issue and hill people are encouraged to develop permanent land for cultivation with irrigation facility. The secondary forests may be divided into three following types:-

a. *Degraded forests*: As compared to the original primary forests these degraded ones have a very low species diversity and are generally dominated by shrubs and small trees. Of the common tree species seen - *Bauhinia*, *Calli-carpa*, *Glochidion*, *Mallotus* species are more prominent whereas, *Capparis*,

*Clerodendrum*, *Croton*, *Eurya*, *Randia*, *Rubus*, *Viburnum* species are common shrubs along with weed species like *Ageratum*, *Eupatorium*, *Mikania*, etc.

b. *Bamboo forests*: This type of secondary forests mostly occur in the areas which are abandoned after "Jhum" cultivation up to the elevation of 2000 m. The common bamboo species are: *Arundina graminifolia*, *Bambusa pallida*, *B. tulda*, *Chimonobambusa callosa*, *Dandrocalamus hamiltonii*, *D. hookeri*, *D. strictus*, *Schizostachyum latifolium*, *S. polymorphum*, etc.

c. *Grasslands*: Generally formed due to the practice of "Jhum" cultivation or sometimes due to fires or over-grazing. The more commonly seen species of grasses like *Arundinella bengalensis*, *Chrysopogon aciculatus*, *Eragrostis tenella*, *E. unioloides*, *Imperata cylindrica*, *Mnesithea clarkei*, *Paspalum sp.*, *Saccharum arundinaceum*, *S. spontaneum*, *Sacciolepis interrupta*, *Setaria palmifolia*, *Themeda caudata* and *Thysanolaena maxima* are found in association with sedges like *Cyperus spp.*, *Fimbristylis spp.*, *Scirpus spp.*, etc. and some scattered trees of *Bombax ceiba*, *Duabanga grandiflora*, *Macaranga denticulata*, etc., at lower altitude.

#### CULTIVATED AND OTHER USEFUL PLANTS

The different tribes inhabiting Arunachal Pradesh have a very rich folk lore and frequently use the plant materials for their daily needs ranging from food, clothing, shelter, medicine and various other domestic purposes. The commonly cultivated cereal crops are : *Coix lacryma-jobi* var. *ma-yuen* (used for preparing beverages), *Eleusine coracana*, *Hordeum vulgare*, *Oryza sativa*, *Pennisetum americanum*, *Setaria italica* and *Zea mays*. Among the commonly cultivated vegetables and pulses are *Abelmoschus esculentus*, *Benincasa hispida*, *Cajanus cajan*, *Canavalia ensiformis*, *Capsicum annuum*, *Chenopodium album*, *Cicer arietinum*, *Colocasia esculenta*, *Cucurbita pepo*, *Dioscorea spp.*, *Glycine max*, *Ipomoea batatas*, *Lablab purpureus*, *Lagenaria ciceraria*, *Lycopersicum esculantum*, *Solanum melongena*, *S. tuberosum* and *Vigna umbellata*. *Brassica juncea*, *B. rugosa*, *Perilla frutescens* and *Sesamum orientale* are commonly cultivated as oil seed crops, whereas *Artocarpus heterophyllus*, *Citrus spp.*, *Musa spp.* are cultivated for fruits. *Amomum aromaticum*, *A. subulatum* and *Curcuma longa* are sometimes cultivated for spice "Cardamom" and "turmeric" respectively. *Zanthoxylum armatum* and *Eryngium foetidum* are cultivated for the leaves used for flavour and aroma in curries and for the fruits used as "pepper".



Apart from the cultivated plants many wild plants are used by the local people as vegetables and fruits (Haridasan *et al.* 1990). Among the commonly used wild fruits eaten raw or cooked as vegetable, mention may be made of *Antidesma acuminatum*, *Ardisia thyrsoiflora*, *Artocarpus chama*, *A. lacucha*, *Baccaurea ramiflora*, *Berberis asiatica*, *B. wallichiana*, *Debregeasia longifolia*, *Dillenia indica*, *Docynia indica*, *Elaeagnus caudata*, *Elaeocarpus floribundus*, *Eriobotrya bengalensis*, *Eugenia spp.*, *Ficus spp.*, *Garcinia spp.*, *Gaultheria fragrantissima*, *Hodgsonia macrocarpa*, *Horsfieldia kingii*, *Illicium griffithii*, *Madhuca longifolia*, *Mangifera sylvatica*, *Meyna laxiflora*, *Phoebe cooperiana*, *Prunus cerasoides*, *Rubus spp.*, *Syzygium cumini*, *Taxus wallichiana*, *Viburnum foetidum* and *Zanthoxylum armatum*.

The plants commonly used as vegetable are the rhizomes and tubers of *Alocasia spp.*, *Alpinia malaccensis*, *A. nigra*, *Amorphophalus paeonifolius*, *Colocasia esculenta*, *Costus speciosus*, *Curcuma montana*, *Dioscorea bulbifera*, *Lasia spinosa*, *Polygonatum multiflorum*, *Tacca integrifolia*, *Zingiber zerumbet*, etc. The commonly used young shoots and leaves are of *Aconogonum molle*, *Amaranthus viridis*, *Pseudodissochaeta assamica*, *Bambusa balcooa*, *Begonia palmata*, *B. hatacoa*, *Calamus flagellum*, *Centella asiatica*, *Chenopodium album*, *Chimonobambusa callosa*, *Clerodendrum colebrookianum*, *Debregeasia longifolia*, *Dendrocalamus hookeri*, *D. hamiltonii*, *Elatostema platyphyllum*, *Fagopyrum dibotrys*, *F. esculentum*, *Gnetum gnemon*, *Houttuynia cordata*, *Dendrocnide sinuata*, *Lasia spinosa*, *Mussaenda roxburghii*, *Oenanthe javanica*, *Persicaria chinensis*, *Phytolacca acinosa*, *Rumex hastatus*, *R. maritimus*, *Solanum nigrum*, *Spilanthes paniculata*, *Urtica mairei*, *Yushania racemosa*, etc.

The flowers and flower buds of *Bauhinia purpurea*, *Bombax ceiba*, *Gmelina arborea*, *Musa spp.*, *Oroxylum indicum*, *Phlogacanthus thyrsoiflorus* are used as vegetable.

The skin of *Zanthoxylum armatum*, *Z. rhetsa* are used in curries and also taken alongwith the local drink "Apong".

Arunachal Pradesh has a flourishing timber industry. Following are some important commercial timber species of Arunachal Pradesh.

Botanical name	Local name
1. <i>Actinodaphne obovata</i>	Pajihuta
2. <i>Aglaiia hiernii</i>	Amari

Botanical name	Local name
3. <i>Ailanthus integrifolia</i> subsp. <i>calycina</i>	Borpat
4. <i>Albizia lucidior</i>	Moz
5. <i>Alstonia scholaris</i>	Satiana
6. <i>Altingia excelsa</i>	Jutuli
7. <i>Anthocephalus chinensis</i>	Kadam
8. <i>Artocarpus chama</i>	Sam, Cham
9. <i>Artocarpus lacucha</i>	Dewa-Chali
10. <i>Bauhinia variegata</i>	Kanchon
11. <i>Beilschmiedia pseudomicropora</i>	Bonhingalo
12. <i>Betula alnoides</i>	Birch
13. <i>Bischofia javanica</i>	Urium
14. <i>Bombax ceiba</i>	Simul
15. <i>Canarium bengalense</i>	Dhuna
16. <i>Canarium strictum</i>	Dhuna
17. <i>Castonopsis indica</i>	Hingori
18. <i>Chukrasia tabularis</i>	Bogipoma
19. <i>Cinnamomum glaucescens</i>	Gonsoroi
20. <i>Dillenia indica</i>	Outenga
21. <i>Dipterocarpus retusus</i>	Hollong
22. <i>Duabanga grandiflora</i>	Khokon
23. <i>Dysoxylum alliarium</i>	Gondhaki-Poma
24. <i>Dysoxylum binectariferum</i>	Bandardima
25. <i>Dysoxylum gobara</i>	Lali
26. <i>Euodia trichotoma</i>	Maiphak
27. <i>Eurya acuminata</i>	Murmura
28. <i>Garcinia cowa</i>	Tekra, Thekera
29. <i>Gmelina arborea</i>	Gomari
30. <i>Gynocardia odorata</i>	Bandapele, Chalmugra
31. <i>Juglans regia</i>	Walnut
32. <i>Khasiaculnea oligocephala</i>	Halud-Sopa
33. <i>Kydia calycina</i>	Pichola
34. <i>Lagerstroemia reginae</i>	Ajar, Ajahar
35. <i>Lannea coromandelica</i>	Jia
36. <i>Macaranga denticulata</i>	Moralia
37. <i>Magnolia hodgsonii</i>	Boromthuri

Botanical name	Local name
38. <i>Magnolia pterocarpa</i>	Baramphthuri-Sopa
39. <i>Mesua assamica</i>	Sia-Nahar
40. <i>Mesua ferrea</i>	Nahar
41. <i>Michelia baillonii</i>	Khorika Sopa, Titasopa
42. <i>Michelia champaca</i>	Champ
43. <i>Michelia doltsopa</i>	Sopa
44. <i>Morus macroura</i>	Bola
45. <i>Phoebe goalparensis</i>	Bonsum (Goalpara)
46. <i>Phoebe paniculata</i>	Mekahi
47. <i>Picea spinulosa</i>	Spruce
48. <i>Pinus roxburghii</i>	Chir Pine
49. <i>Pinus wallichiana</i>	Blue pine
50. <i>Pterpsernum acerifolium</i>	Hatipolia
51. <i>Quercus</i> spp.	Oak
52. <i>Schima wallichii</i>	Makrisal, Gogra
53. <i>Shorea assamica</i>	Mekai
54. <i>Sloanea sterculiacea</i> var. <i>assamica</i>	Joba-Hingori
55. <i>Sterculia hamiltonii</i>	Pahari
56. <i>Sterculia villosa</i>	Udal
57. <i>Syzygium cumini</i>	Jamuk
58. <i>Terminalia bellirica</i>	Bohera
59. <i>Terminalia chebula</i>	Hilika
60. <i>Terminalia myriocarpa</i>	Hollock
61. <i>Tetrameles nudiflora</i>	Bhelu
62. <i>Toona ciliata</i>	Poma, Toon
63. <i>Trewia nudiflora</i>	Bhelkar, merua

### Common Bamboos

1. *Bambusa pallida*
2. *Bambusa tulda*
3. *Dendrocalamus hamiltonii*
4. *Dendrocalamus strictus*
5. *Melocanna baccifera*
6. *Schizostachyum polymorphum*

Makal  
Bijili  
Kakua  
Katabans  
Muli  
Bajal

Botanical name	Local name
<b>Common Canes</b>	
1. <i>Calamus flagellum</i>	Raidang Bet
2. <i>Calamus floribundus</i>	Lejai Bet
3. <i>Calamus latifolius</i>	Hauka Bet
4. <i>Calamus tenuis</i>	Jati Bet

### Aquatic Vegetation

Some of the common hydrophytes growing in the marshes, roadside pools, nallahs and paddy fields are *Alisma plantago-aquatica*, *Eriocaulon luzulifolium*, *Monochoria vaginalis*, *Persicaria nepalensis*, *Potamogeton nodosus*, *Sagittaria trifolia*, *Sanicula elata*, *Utricularia* spp., etc. *Zeylandidium olivaceum* - the liverwort-like plant of the family Podostemaceae grows under water on the stones and boulders in the fast running streams at lower altitudes. Its occurrence in Arunachal Pradesh represents the northern most distribution of this family in India (Rao & Hajra, 1972).

### WEEDS

The modification of vegetation through various anthropogenic causes and through the introduction of exotics is well established. In areas where the primary vegetation is destroyed or modified due to various biotic factors, or lands abandoned after "Jhum" cultivation, a variety of weed species colonize. In the lower elevation *Mikania micrantha*, a presumably introduced species from Tropical America is at present the most problematic weed that has been spreaded over a vast area chocking the other herbaceous and shrubby habits. Similarly, *Tagetes minuta* and different species of *Eupatorium* of Asteraceae and *Cuphea carthagensis* of Lythraceae have become equally noxious and a menace. Some other common weeds in such places are: *Adenostemma lavenia*, *Ageratum conyzoides*, *Bidens biternata*, *Conyza bonariensis*, *Crassocephalum crepidioides*, *Croton bonplandianum*, *Cuscuta reflexa*, *Emilia sonchifolia*, *E. pusilus*, *Eupatorium odoratum*, *Galinsoga parviflora*, *Hedyotis scandens*, *Kyllinga brevifolia*, *Laggera alata*, *Lantana camara*, *Ludwigia octovalvis* subsp. *sessiliflora*, *Mitracarpus verticillatus*, *Persicaria nepalensis*, *Scoparia dulcis*, *Sida rhombifolia*, *Solanum myriacanthum*, *S. nigrum*, *Spermacoce latifolia*, *Spilanthes clava*, *S. paniculata*, *Urena lobata*, *Vernonia cinerea*, etc.

## SOME INTERESTING ELEMENTS OF ARUNACHAL PRADESH FLORA

### Curious Plants

The rich and diverse flora of Arunachal Pradesh also harbours some interesting and biologically curious plants. Among interesting and rare root parasites, mention may be made 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 *Rhopalocnemis phalloides* in Namdapha in Changlang district. *Balanophora dioica* is commonly found associated with the roots of several tree species in dense humid forests, whereas *Aeginetia indica* is a common root parasite is found on grasses. Similarly *Boschniakia himalaica*, a parasite on the roots of *Rhododendron* spp. is found in the alpine meadows of Arunachal Pradesh.

Among the common saprophytes, *Monotropastrum humile* and orchids like, *Epipogium indicum*, *E. roseum*, and *Galeola falconeri* are found in dense humid forests on organic matter and humus rich soil. Among the insectivorous plants mention may be made of *Drosera peltata*.

A large number of endemic species have been recorded from Arunachal Pradesh. Some of the endemic species are : *Acer oblongum* var. *microcarpum*, *A. sikkimense* var. *serrulatum*, *Aconogonum pangianum*, *Begonia aborensis*, *B. scintillum*, *Capparis pachyphylla*, *Coptis teeta*, *Hedychium longipedunculatum*, *Illicium cambodianum*, *Lysimachia congestiflora* var. *santapau*, *Maesa arunachalensis*, *Merrillioanax listeri*, *Paphiopedilum wardii*, *Pholidota watii*, *Primula subansirica*, *Pternopetalum senii*, *Pueraria bella*, *Rhododendron santapau*, *Rhynchoglossum lazulinum*, *Schefflera venulosa*, *Tricarpelema glanduliferum*, and *Wallichia triandra*, etc.

**Rare & Endangered Plants:** There are several factors directly or indirectly involved in the loss of biodiversity of an area and the loss in a quantitative measure may be slow and gradual or may be abrupt and sudden. One of the factors related with quick decline is the ever increasing human population and their many fold increased demand for food and other items of daily need which are taking a heavy toll of the natural resources of this region. Shifting cultivation, over exploitation of medicinal and other useful economic plants, developmental activities such as new townships, roads, industries, clearing of forest

land for permanent agriculture are some of the major threats to the biological diversity of this region and as a result a good number of species have become rare, vulnerable, threatened or endangered. Some of the rare, endangered and vulnerable categories of plants are: *Alniphyllum fortunei*, *Ardisia rhyndrophylla*, *Balanophora dioica*, *Bergenia ciliata* forma *ligulata*, *Blechnum melanopus*, *Boehmeria tirapensis*, *Boschniakia himalaica*, *Bulbophyllum depressum*, *Bulleyia yunnanensis*, *Cymbidium hookerianum*, *C. eburneum*, *Coptis teeta*, *Dioscorea laurifolia*, *D. orbiculata*, *Diplomeris hirsuta*, *Drosera peltata*, *Eria ferruginea*, *Galeola falconeri*, *Gastrochilus inconspicuus*, *Huodendron biaristatum*, *Ilex venulosa*, *Leptodermis scabrida*, *Nertera sinensis*, *Nomocharis synaptica*, *Oberonia sulcata*, *Paphiopedilum fairieanum*, *P. spicerianum*, *Paauia belladonna*, *Podophyllum hexandrum*, *Rhododendron nuttalli*, *R. santapai*, *Rhopalocnemis phalloides*, *Sapria himalayana*, *Saurauia griffithii*, *Sunipia fusco-purpurea*, *S. virens*, *Tylostylis discolor*, etc.

#### Wild Relative of cultivated Plants

The wild species from which the present day cultivated plants were selected still continue to exist today alongwith their close relatives. As compared to the well cared and much looked after crop plants, these wild relatives have continued to evolve and interact with other species in nature, and as a result they have developed a survival strategy to cope with many natural calamities like extreme cold and heat, drought and flood, etc. These have also developed resistance to pests and diseases which entail heavy economic losses to their cultivated counter parts. The genes from wild relatives may help plant breeders to breed crops that can resist pests and diseases and thus are in utmost need more than ever before to feed the fast expanding world population. Arunachal Pradesh falls under 'Hindustan Centre of Origin of Cultivated plants' (Vavilov 1926, 1951) is very rich in *Musa* and *Citrus* wealth. All the basic sets of chromosomes viz.  $2n=18, 20, 22$  &  $24$  in *Musa* have been reported from the state. Some types are found to show resistance to diseases, pests and cold conditions. The state has been considered as a major *Citrus* growing belt in the North-Eastern region of India. Many allied species of *Thaëa* which are used as substitute of tea also have been recorded from the state. Falling within the Eastern Himalayan agro-ecological region. The state has rich crop plant diversity particularly in the case of barley, maize, buckwheat, finger millet, foxtail-millet, amaranth, french bean, soybean, cowpea, blackgram, pea, scarlet bean, pumpkin, cucumber, *Allium*, ginger, chayote, tree tomato, *Brassica*, pome and

stone fruits (Paroda & Arora 1991). Apart from these, the state is very rich in tall and drought-hardy types of Sesame, tree cotton, taros, yam and species of *Colocasia*, *Capsicum*, etc.

### Medicinal and Ethnobotanically Important Plants

*Medicinal Plants:* Parallel with the rich biodiversity, the state also harbours a wide range of medicinal plants used in Ayurvedic, Homoeopathic and Unani medicines or are used by the local people. The scientists of the Regional Research Laboratory, Jorhat and Itanagar and Regional Research Centre (Ayurveda), Itanagar are engaged in the study and research on biologically potential plants. Some medicinally important plants are: *Abies spectabilis*, *Abroma augusta*, *Abrus precatorius*, *Abutilon indicum*, *Acacia catechu*, *Aconitum ferox*, *A.laeve*, *A.novoluridum*, *Acorus calamus*, *Albizia lebbeck*, *Alpinia galanga*, *Alstonia scholaris*, *Aquilaria malaccensis (A.agallocha)*, *Asparagus filicinus*, *A.racemosus*, *Artemisia nilagirica*, *Azadirachta indica*, *Baliospermum montanum*, *Bambusa arundinacea*, *Barringtonia acutangularis*, *Bauhinia variegata*, *Bergenia ciliata* forma *ligulata*, *Berberis asiatica*, *Boerhaavia diffusa*, *Bombax ceiba*, *Caesalpinia bonduc*, *Calotropis gignatea*, *Caltha palustris*, *Canarium strictum*, *Cassia fistula*, *C.occidentalis*, *Celastrus paniculatus*, *Canarium strictum*, *Cassia fistula*, *C.occidentalis*, *Celastrus paniculatus*, *Centella asiatica*, *Centratherum anthelminticum*, *Cinnamomum tamala*, *Clerodendrum colebrookinum*, *C.serratum*, *Coptis teeta*, *Cordia wallichii*, *Costus speciosus*, *Crateva magna*, *Croton tiglium*, *Curculigo orchiioides*, *Curcuma zedoaria*, *Cymbopogon* spp., *Cyperus rotundus*, *Dactylorhiza hatagirea*, *Datura stramonium*, *Dregea volubilis*, *Dioscorea deltoidea*, *D.floribunda*, *Embelia ribes*, *Emblica officinalis*, *Eupatorium trapezoideum*, *Garcinia pedunculata*, *Gaultheria fragrantissima*, *Gloriosa superba*, *Gmelina arborea*, *Gynocardia odorata*, *Gymnostemma pedata*, *Hedychium spicatum*, *Holarrhena pubescens*, *Hydnocarpus kurzii*, *Illicium griffithii*, *Ipomoea mauritiana*, *Juglans regia*, *Justicia adhatoda*, *Litsea cubeba*, *Lyonia ovalifolia*, *Malaxis acuminata*, *Mallotus philippinensis*, *Melia azedarach*, *Melissa axillaris*, *Mesua ferrea*, *Mimosa pudica*, *Mucuna pruriens*, *Myrica esculenta*, *Nardostachys grandiflora*, *Nerium indicum*, *Nymphaea nouchali*, *Oxalis corniculata*, *Paederia foetida*, *Panax pseudoginseng*, *Piper longum*, *Plumbago zeylanica*, *Podophyllum hexandrum*, *Prunus cerasoides*, *Polygonatum verticillatum*, *Rauwolfia serpentina*, *Rheum australe*, *Rhus succedanea*, *Ricinus communis*, *Rubia rhombifolia*, *Scindapsus officinalis*, *Semecarpus anacardium*, *Shorea robusta*, *Sida cordifolia*, *Skimmia anquetilia*, *Solanum anguivi*, *Solanum myriacanthum*, *Spilanthes acmella*, *Stephania japonica*, *Strychnos nuxvomica*,

*Swertia chirayita*, *Syzygium cumini*, *Tamarindus indica*, *Taraxacum officinalis*, *Taxus wallichiana*, *Tectona grandis*, *Tetrastigma serrulatum*, *Tinospora cordifolia*, *T. sinensis*, *Trewia nudiflora*, *Tylophora indica*, *Valeriana hardwickii*, *V. jatamansi*, *Vernonia cinerea*, *Zanthoxylum acanthopodium*, *Z. armatum*, *Z. nitidum*, *Z. rhetsa*, *Zizyphus mauritiana*, etc.

*Ethnobotanically Important Plants:* Comparing other parts of India, the north-eastern region is still ethnobotanically underexplored though the richness of its flora and a large number of tribal population offer immense scope for such study. As discussed earlier some attempts have been made by R.K. Arora (1981); D.P. Dam & P.K. Hajra (1981); G.D. Pal (1984, 1992); H.C. Pandey (1988, 1990); K. Haridasan *et al.* (1990), etc., to record and list ethnobotanically important plants used by the local people for food, medicine, fish-poisoning, dye making, local drinks, etc. Some important plants as studied by G.D. Pal (1984) and Pandey *et al.* (1990) are: *Acacia rugata* (powdered stems are used in fish-poisoning); *Amischotolype molissima* (plant juice is used as arrow-poison); *Gallium mollugo* (decoction is used in dyeing clothes); *Anisomeles ovata* (used to relief muscular pain); *Berberis wallichiana* (bunch of spines are used in tattooing chin and forehead); *Bidens biternata* (leaves are used as substitute for tea); *Callicarpa arborea* var. *ovalifolia* (stems are used as substitute of tobacco); *Chenopodium album* (seeds are used for preparation of country liquor 'Apong'); *Chimonobambusa callosa* (bark is used as rope); *Chlorophytum arundinaceum* (used as substitute of onion); *Crassocephalum crepidioides* (leaf juice is used to prevent bleeding); *Dendrobium hookerianum* (flowers are used to prepare yellow dye); *Dendrocalamus strictus* (planted near the house in spiritual belief of keeping the devil spirit away); *Elscholtzia blanda* (paste prepared from leaves is used to clear pus and maggot of cattle); *Gaultheria fragrantissima* (leaves and twigs are used as incense); *Gentiana bryoides* (whole plant mixed with 'sillu' leaves used as incense, leaves are used in malaria and dysentery); *Geranium nepalense* (the paste prepared from whole plant mixed with turmeric and mustard oil is used in cases of eczema, itch and other skin diseases); *Gerbera piloselloides* (used as hot fomentation to relief rheumatic pain); *Impatiens racemosa* (whole plant is used in malarial fever); *Lasianthus longicauda* (fruit extract is used as gum for catching birds); *Plectranthus hispidus* (whole plant is used in cough and cold); *Rubus paniculata* (leaves are used as substitute for peper betel); *Scrophularia elatior* (decoction of whole plant is used in urinary trouble); *Tacca integrifolia* (decoction of leaves is used in blood dysentery and diarrhoea).



*Ornamental Plants:* Considering the density of orchid species, some parts of Arunachal Pradesh can be designated as Orchid Sanctuary. The state alone harbours more than 450 species of orchids out of about 1000 species recorded so far from India and this is because of its wide variation in climatic conditions and humidity spreading over a greater range of elevations starting from foothills up to the snow-clad peaks. The Orchid Research cum Development Centre (ORDC) under the Forest Department of Arunachal Pradesh at Tipi is engaged in research, conservation and commercialization of the potential orchids over the last 20 years.

The 'Convention on International Trade in Endangered Species of Wild Flora and Fauna' is aimed at the regulation of wild species in international trade with a view to the rational and sustainable use of the wild genetic resources. Considering the critical endangered status, the Orchidaceae as a whole is included under Appendix II of CITES, where some species are again placed under Appendix I, and thereby the international trade is subject to strict regulations. In India, their collection from wild sources for trade purpose is prohibited in accordance with the Wild Life Conservation Act 1982 under the category of schedule I and II of endangered species. However, under the above mentioned act, the artificially propagated, either vegetative or adopting biotechnology or other nursery grown orchids can be traded. Hegde & Thapliyal (1992) on 'Prospect and Problems of commercialization of orchid in Arunachal Pradesh' indentified some potential ornamental species from the state as follows: *Acampe rigida*, *Acanthephippium striatum*, *A.sylhetense*, *Aerides fieldingii*, *A.multiflorum*, *A.odorum*, *Anoectochilus roxburghii*, *Arundina graminifolia*, *Ascocentrum ampullaceum*, *Calanthe alismaefolia*, *C.biloba*, *C.densiflora*, *C.masuca*, *C.tricarinata*, *Cleisostoma racemiferum*, *C.williamsonii*, *Coelogyne corymbosa*, *C.cristata*, *C.punctulata*, *Cymbidium aloifolium*, *C.cochleare*, *C.eburneum*, *C.elegans*, *C.hookerianum*, *C.iridioides*, *C.longifolium*, *C.lowianum*, *C.mastersii*, *Dendrobium candidum*, *D.chrysanthum*, *D.chrysotoxum*, *D.densiflorum*, *D.devonianum*, *D.falconeri*, *D.farmeri*, *D.fimbriatum* var. *occulatum*, *D.formosum*, *D.gibsonii*, *D.heterocarpum*, *D.hookerianum*, *D.moschatum*, *D.nobile*, *D.sulcatum*, *D.transparens*, *D.wardianum*, *Esmeralda cathcartii*, *E.clarkei*, *Gastrochilus dasypogon*, *Neogyne gardneriana*, *Paphiopedilum fairieanum*, *P.wardii*, *Papilionanthe teres*, *Phaius flavus*, *P.mishmiensis*, *P.tancarvilleae*, *Phalaenopsis manni*, *Pleione hookeriana*, *P.humilis*, *P.maculata*, *P.praecox*, *Renanthera imschoo-*

*tiana*, *Rhynchostylis retusa*, *Thunia alba*, *Vanda alipna*, *V.coerulea*, *V.cristata* .

In addition to the wide variety of orchids, the state is also extremely rich in other wild ornamental plant resources like the species of *Begonia*, *Hedychium*, *Hypericum*, *Impatiens*, *Ixora*, *Meconopsis*, *Melastoma*, *Rhododendron*, *Viola* and various aroids.

### Primitive Angiosperms

The presence of a large number of primitive Angiosperms in Arunachal Pradesh such as *Alnus nepalensis*, *Altingia excelsa*, *Aspidocarya uvifera*, *Betula alnoides*, *Decaisnea insignis*, *Euptele pleiosperma*, *Exbucklandia populnea*, *Haematocarpus validus*, *Holboellia latifolia* var. *angustifolia*, *Houttuynia cordata*, *Magnolia caveana*, *M.griffithii*, *M.hodgsonii*, *M.pterocarpa*, *Pycnarrhena pleniflora*, *Tetracentron sinense* and other species of *Camellia*, *Magnolia*, *Michelia*, *Rhododendron*, various orchids and several wild and economic plants suggest that perhaps in this region evolutionary development of Angiosperms have taken place. Takhtajan (1969) has suggested North Eastern Region of India as the true "Cradle of flowering plants" due to the presence of large number of primitive Angiosperms. C.B. Clarke (1898) based upon his studies on the Cyperaceae (*Carex*) treated Eastern Himalaya and Assam as distinct sub-areas unlike Hooker (1904) who considered major parts of Assam as part of Gangetic Plains and included hilly areas of Assam, Shillong Plateau, Patkoi, Naga and Manipur hills in Burma and treated Eastern Himalaya as distinct separate area, whereas Chatterjee (1962) treated Assam as a distinct area based on its characteristic flora. Takhtajan (1969) attempted to localize the Cradle of flowering plants from the analysis of the distribution of primitive angiosperms, which do not occur in any other part of India except in the North-Eastern region, mainly the Eastern Himalaya, Assam and Burma. It is clearly indicated that the North-Eastern Himalayan Province under Eastern Asiatic region of Boreal subkingdom by Takhtajan (1986) includes parts of eastern Nepal in the west up to Kali river valley, 83° East longitude, Darjeeling, Sikkim, Bhutan, parts of Assam Himalaya, certain extreme south province extends up to Mt. Namcha Barwa and approaches Dihing river valley excepting tropical vegetation found below 100 m above sea level.

### GYMNOSPERMS

Gymnosperms, specially the conifers, form a significant part of the vegetation and are economically important too being used in house construction, tea

chests, furniture, fuel and for tapping of resin (mainly from *Pinus* spp.). The known Gymnosperms from the state are listed below :

#### Araucariaceae:

*Agathis robusta* Bailey. Cultivated ornamental.

*Araucaria columnaris* (Forster) Hooker. Cultivated ornamental.

#### Cupressaceae:

*Cupressus corneyana* Hort. ex Carr. Local name- "Dhupi". Lofty trees. Valued for its durable timber.

*C. torulosa* D. Don - Large, rather close-foliaged trees. Valued for its durable timbers.

*Juniperus indica* Bertol. (Black Juniper). Large gregarious shrubs. Used as incense in Buddhist temples.

*J. recurva* Buch.-Ham. ex D. Don (Drooping Juniper). Low spreading shrubs. The common dwarf Juniper.

*Thuja orientalis* L. Cultivated ornamental shrubs.

#### Cephalotaxaceae:

*Cephalotaxus griffithii* Hook. f. Small trees. Cultivated ornamental.

#### Gnetaceae:

*Gnetum montanum* Markgraf

#### Pinaceae:

*Abies delavayi* (Van Tiegham) Franchet. Tall trees.

*A. densa* Griffith ex R. Parker (East Himalayan Silver Fir). Tall trees.

*A. spectabilis* (D. Don) Mirb. (Himalayan Silver Fir). Tall trees.

*Cedrus deodara* (Roxb. ex D. Don) G. Don (Deodar, Himalayan Cedar). Large, robust trees. A valuable timber tree. Wood durable, aromatic, extensively used for furniture, building, etc. Oil extracted by distillation is used medicinally.

*Larix griffithiana* (Hook. f. ex Lindley) Hort. ex Carr. (East Himalayan Larch). Small trees.

*Picea brachystyla* (Franchet) Pritzl. Trees.

*P. spinulosa* (Griffith) Henry (East Himalayan spruce). Lofty trees.

*Pinus armandi* Franchet. Tall trees.

*P. bhutanica* Grierson. Trees.

*P. merkusii* Jungh. et Desr. 2 needled pine.

*P. roxburghii* Sargent (Chir Pine). Large trees. Wood is used in general construction but not durable. Sap-wood yields resin, bark yields tannin which is used in dyeing. Turpentine oil extracted from wood is used medicinally. Seeds edible.

*P. wallichiana* A. B. Jackson (Himalayan blue pine). Tall trees. Wood is highly resinous and used for general construction, matches, tea chests, etc. Tree also yields turpentine oil and Tar.

*P. wallichiana* var. *parva* Sahn. Reported only from Tawang district of Arunachal Pradesh.

*Tsuga dumosa* (D. Don) Eichler (Himalayan Himlock). Tall trees. Logs are often used for construction of bridges over small rivers.

#### Podocarpaceae:

*Podocarpus neriifolius* D. Don. Lofty evergreen trees.

#### Taxaceae:

*Amentotaxus assamica* Ferguson. Small dioecious trees, 3-8 m tall. Endemic to Arunachal Pradesh (Lohit district). Rare and vulnerable due to habitat destruction.

*Cedrus deodara* (Roxb. ex D. Don) G. Don (Deodar, Himalayan Cedar). Large, robust trees. A valuable timber tree. Wood durable, aromatic, extensively used for furniture, building, etc. Oil extracted by distillation is used medicinally.

*Larix griffithiana* (Hook. f. ex Lindley) Hort. ex Carr. (East Himalayan Larch). Small trees.

*Picea brachystyla* (Franchet) Pritzel. Trees.

*P. spinulosa* (Griffith) Henry (East Himalayan spruce). Lofty trees.

*Pinus armandi* Franchet. Tall trees.

*P. bhutanica* Grierson. Trees.

*P. merkusii* Jungh. et Desr. 2 needled pine.

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*P. wallichiana* var. *parva* Sahni. Reported only from Tawang district of Arunachal Pradesh.

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#### Podocarpaceae:

*Podocarpus neriifolius* D. Don. Lofty evergreen trees.

#### Taxaceae:

*Amentotaxus assamica* Ferguson. Small dioecious trees, 3-8 m tall. Endemic to Arunachal Pradesh (Lohit district). Rare and vulnerable due to habitat destruction.

*Taxus wallichiana* Zucc. (Himalayan Yew). Tall trees. Wood is used for making furniture, poles and axles of cart. The bark and leaves are used for extraction of "Taxol" - a highly potential drug used in the treatment of ovarian and breast cancer. Fleshy fruits are eaten.

#### Taxodiaceae:

*Cryptomeria japonica* (L.f.) D. Don (Japanese Red Cedar). Cultivated ornamental. Tall evergreen trees with long drooping branches. Wood is used for making tea chests.

*Taxodium distichum* (L.) Richard. Cultivated ornamental.

#### Salient Feature of the Flora

In the present account of flora of Arunachal Pradesh, only species of flowering plants (Angiosperms) have been included. The proportion of the dicots and monocots is 2.7 : 1 whereas, genera and species is 1 : 3.3 (Table -I).

TABLE -I

	Genera	Species
Monocotyledons	325	1096
Dicotyledons	894	2959
Total	1219	4055

Based on the studies carried out by Botanical Survey of India and with available information regarding this region a comparative account of the ten dominant families of this area is given below (Table -II).

