FLORISTIC DIVERSITY AND CONSERVATION STRATEGIES IN INDIA

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

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Volume - III

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CONTENTS

(Volume- III)

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LAKSHADWEEP

P. Bhargavan
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Lakshadweep or Laccadives, the smallest Union Territory of India is an archipelago consisting of 27 small islands with a number of sunken banks, open reefs and sandbanks, scattered irregularly in the Arabian sea between 8° and 12° North latitude and 71° and 74° East longitude. These are away from the Kerala coast by 220 - 440 km. The total area is about 32 sq km. Though the land area is extremely small, Lakshadweep islands are bestowed with a large lagoon area of 4,200 sq km which is the basis of the physical existence of these islands. Out of 27 islands only 10 are inhabited (Mannadiar, 1977), of which Bitra is the smallest (0.1 sq km) and Androth is the biggest (4.8 sq km). Now Cheriyam, a small island near Kalpeni is being developed and Bangaram is expected to become a tourist resort soon.

These enchanting coral islands are biological in origin. Corals are invertebrates with several tiny organisms (polyps) inhabiting pore-like cups in a calcareous skeleton. Massive dead corals bound by their own lime-stone superimposed by branching corals and skeletons of coralline algae go into the making of coral reefs. The coral islands are formed by the initial deposition of sandbanks due to wind and wave action. There is no conclusive theory about the formation of these coral atolls. It is believed as Darwin concluded that the subsidence of a volcanic island resulted in the formation of a reef and the continued subsidence allowed this to grow upward and the atoll was formed encircling the lagoon and subsequently by the action of wind and waves the coral islands were formed. Sand banks were first formed in an atoll and later resulted in the formation of ground vetetation. These crescent shaped coral islands with reefs and lagoons on the western side look like emeralds in the vast expanse of blue sea. These vibrant and beautiful coral atolls with matchless marine environment and scenic beauty will give any one who gets a chance to have a glimpse of it an everlasting memory.

These islands do not show any major geomorphological differences as there are no hills, mountains or rivers in any of these islands. The land is almost plain with a rise of about 3 - 9 m above sea level. The lagoonal shore of the islands are bestowed with beautiful sandy beaches and are

interrupted by beach rock at the low-tide mark. The reefs and storm beaches of certain islands consist of coral pebbles and boulders with no soil or sand. The shallow lagoons comprise of coral sand and gravel. The bottom of the lagoon is smooth except for the rugged reefs.

Lakshadweep Islands lie on the prominent North-south Lakshadweep Ridge and are considered to be a continuation of Aravalli system of rocks of Rajasthan and Gujarat. There are five submerged banks indicating that fresh reef formation has already been initiated. The occurrence of submerged terrace on the seaward reefs and continuity of these levels within the lagoons indicate that the atolls were affected by the lowered sea level during pleistocene glaciation. Shallow sandbank bordering on the reefs are covered by coarser sediments. The deeper lagoons at Cheriya Panniyan, Perumalpar, Bitra, Bangaram, Suheli and Minicoy have fine sand and silt whereas shallow lagoons such as Chetlat, Kiltan and Kavarathi are carpeted by medium to coarse sands.

Chemically lagoonal sand, consists of calcium carbonate with very little silica and alumina. Phosphate deposits occur in almost all islands and excretions of birds seem to be the cause of these deposits. Calcium carbonate is useful in the production of cement, chemicals, glass and paper. But the dredging of sand will certainly affect the shoreline ecosystem.

The coastal geology is varied. Coastal ecosystem of any area can never be static due to several reasons. Normally coastal climate may be uniform and it is determined by the moisture intensity and is regulated by wind and rainfall rate. Thus the coastal biosphere is the cumulative effect of several factors such as topography in general and nature of substratum in particular, salinity of water, wind, wave action, tides and precipitaion.

Majority of the islands are blessed with large lagoons on the western side. The eastern sides are with rocky relicts consisting of fossiliferous, clayey conglomerates of sand-stone and are subjected to heavy action of waves and wind. This area is usually devoid of any plants.

Being within the equatorial region, these islands experience tropical humid climate and are influenced by the south-west and north-east monsoons. The average rainfall is about 155 cm. During April-May the highest temperatures are experienced with an average of about 33°C and the maximum of about 37°C. It is tempered by sea breeze now and then.

Air is generally humid and the relative humidity is about 75 percent throughout the year. The winds are light to moderate during October-March and the mean wind velocity varies from 6 17 km. The cyclonic depressions during October-December result in winds of very great velocity that affect the weather.

Prain (1889) seems to be the first person to make an attempt to study the flora of Lakshadweep. Prain conducted a series of expeditions during 1889, 1892, 1893 and 1894 and has collected several plants. Willis visited Lakshadweep during 1901. Willis and Gardiner (1901), Ellis (1924), Krishnaswamy (1955), Wadhwa (1960, 1961), Rao (1971), Rao and Sastry (1977, 1972), Mannadiar (1977), Sivadasan and Joseph (1981), Sivadasan *et al.* (1983), Wafar (1986), Joseph and Madhusoodanan (1989) and Rao and Ellis (1995) are the various workers who have done some work on the flora of these islands. But a careful and close perusal of these studies reveal that these collections are casual and fragmentary. This is mainly due to the isolated and scattered position of these isles followed by lack of timely voyage facilities. Recent remote sensing studies by Bahuguna, Ghosh, Nayak, Patel and Agrawal (1991), Nayak, Pandeya, Shaikh and Gupta (1989) and Nayak, Bahuguna, Shaikh, Chauhan, Rao and Arya (1992), also give meagre information on floristics of these islands.

FLORISTIC DIVERSITY

Lakshadweep is within the tropical region, but, as the land area consists of narrow strips of plain coral sandy land surrounded by sea devoid of any hills or rivers and bestowed with uniform climate, one can hardly expect a diverse flora. The overall pattern of vegetation of Lakshadweep is almost uniform with little exception in the case of Androth and Minicoy. In general the vegetation cover of Lakshadweep is mainly of coconut groves interrupted by shrubs, herbs, climbers, scramblers, introduced trees, etc. The recent work by Rao and Ellis (1995) on the flora of Lakshadweep gives all relevant and reliable data such as location, geomorphology, vegetation, classification of vegetation types, phytogeography, etc. However, the report of some endemic and rare species of the Western Ghats like *Silentvalleya nairii, Seshagiria sahyadrica* and two species of *Anaphyllum* viz. *Anaphyllum beddomei* and *A. wightii*, etc. can be accepted only after verification. The occurrence of these plants in these islands is doubtful. These authors reported 238 species of angiosperms with no gymnosperms, ferns or mangrove plants. As the area being saline and the soil is calcareous one can not expect any gymnosperm unless it is introduced. Even on

introduction the question of their survival is doubtful. Joseph and Madhusoodanan (1989) reported 5 species of ferns from Lakshadweep. One of the present author has been conducting detailed studies on the flora of these islands during the past 5 years and has collected some more plants including a fern from Minicoy and two mangrove species namely *Ceriops tagal* and *Avicennia officinalis* from Minicoy and Kalpeni respectively.

VEGETATION

Vegetation of Lakshadweep is mainly "strand coral" (Rao and Sastry, 1972). However, small formations of "strand rock" and "strand sand" are descernible, in some places. Shores towards north and south are rocky, bordered by boulders piled up by wave action. Above this, some areas are dominated by *Pandanus tectorius, Pemphis acidula* and *Cordia subcordata.* In the middle sandy areas *Guettarda speciosa, Thespesia populnea* and *Ficus benghlensis* are common. Towards the inner region herbaceous plants such as *Acalypha indica, Ageratum conyzoides, Amaranthus spinosus, Blumea mollis, B. oxyodonta, B. virens, Corchorus aestuans, Crotalaria retusa, C. verrucosa. Dactyloctenium aegyptium, Digitaria ciliaris, Euphorbia hirta, E. indica, Laportea interrupta, Launaea sarmentosa, Mariscus pedunculatus, Micrococca mercurialis, Mirabilis jalapa, Pancratium zeylanicum, Paspalum vaginatum, Sida acuta, S. cordata, Thecagonum biflorum, Vernonia cinerea,* etc. are common.

One of the common coastal plants in almost all islands is *Scaevola sericea* (local name : *Kanni*) followed by trees and shrubs such as *Artocarpus utilis, Calophyllum inophyllum, Casuarina equisetifolia, Dodonaea viscosa, Guettarda speciosa, Hibiscus tiliaceus, Messerschmidia argentea, Pemphis acidula, Suriana maritima* and *Thespesia populnea.* Some of the common shrubs of these islands are *Clerodendrum inerme, Premna serratifolia, Lawsonia inermis,* etc. *Cobubrina asiatica* and *Leptandenia reticulata* are some of the climbing shrubs found here. In shady places there are some weak climbers such as *Cynanchum tunicatum, Teramnus labialis, Tragia involucrata, Trichosanthes anguina* and *Tylophora indica.*

The vegetation of Minicoy, the second biggest of Lakshadweep Islands is characterised by the presence of some rare plants such as *Euphorbia articulata, Lepturus repens, Pancratium zeylanicum* and

Thuarea involuta. These are all found in the coastal areas. *Lepturus repens* is found also in Kalpeni and Bangaram. Other plants mentioned above could not be observed in any of the other islands. Minicoy is also notable by the presence of large populations of *Canavalia cathartica, Hernandia peltata* and *Ochrosia oppositifolia.*

Parasitic plants are less common in Lakshadweep. Loranthaceae is totally absent. *Cassytha filiformis* a noteworthy slender parasitic twiner seems to be a potential threat to the coastal plants such as *Cyperus pachyrrhiza, Dodonaea viscosa, Fimbristylis ferrugenea* and *Terminalia catappa.*

Mikania micrantha is yet another ruderal weed spreading gregariously on fences and agricultural crops at Androth. This tropical American element is a menace to the agroecosystem because of its very efficient vegetative as well as sexual propagation methods. Probably this would have reached Androth from Kochi where it is very common in coastal areas.

The Andaman and Nicobar archipelago consisting of about 321 large and small island lies in the Bay of Bengal. Even though both are island systems, the floristic composition of Lakshadweep is in no way comparable to that of Anadamans as the latter one is so diverse with so many endemic plants. Rao (1994) reported 72 endemic plants including 2 ferns, 53 dicotyledons and 17 monocotylendons from Andamans. Eventhough certain plants are common to both archipelagos, in Lakshadweep endemic plants are not available.

The Maldvies is yet another archipelago in Indian Ocean nearer to the southernmost island of Lakshadweep, the Minicoy. The Maldives is an independent country since 1965. It has 1190 coral islands of which 202 are inhabited. As per the reports available the floristic composition of these islands is very similar to that of Lakshadweep due to the similarity of soil type, climate and rainfall. Kumar (1996) reported 78 plants of common occurrence from the coastal regions of Male and Villingili. Willis and Gardiner (1901) recorded 183 species. A comparison of these records and the author's observations in Lakshadweep clearly indicate that the floristic composition of Maldives is also similar to that of Lakshadweep.

In general, the strand coral vegetation consists of various groups of plants such as algae, fungi, lichens, mosses, pteridophytes and

angiosperms. Shallow reliefs are dominated by algal elements and sea-weeds. *Cymodocea isoetifolia*, *Syringodium isoetifolium* and *Thalassia hemprichii* are the three species of sea grasses reported from there. The foreshore is free from vegetation being sandy and the backshore is composed of creepers and herbaceous plants, intermixed with shrubs and treelets in coconut groves. In general, these plants may be grouped into herbs, shrubs, climbers/twiners, treelets and trees. Many of these are exotics.

The following are the common trees of these islands. *Achras zaptoa*, *Adenanthera pavonina*, *Albizia lebbeck*, *Alstonia scholaris*, *Areca catechu*, *Artocarpus heterophylla*, *A. utilis*, *Azadirachta indica*, *Barringtonia asiatica*, *Bixa orellana*, *Calophyllum innophyllum*, *Casuarina equisetifolia*, *Ceriops tagal*, *Cordia subcordata*, *Delonix regia*, *Erythrina variegata*, *Ficus benghalensis*, *F. racemosa*, *F. religiosa*, *Guettarda speciosa*, *Gyrocarpus asiaticus*, *Hernandia peltata*, *Hibiscus tiliaceus*, *Leucaena latisiliqua*, *Mangifera indica*, *Messerschmidia argentea*, *Morinda citrifolia*, *Moringa oleifera*, *Muntingia calabura*, *Murraya koenigii*, *Ochrosia oppositifolia*, *Pemphis acidula*, *Pithecellobium dulce*, *Polyalthia longifolia*, *Psidium guajava*, *Punica granatum*, *Suriana maritima*, *Syzygium cumini*, *Tamarindus indica*, *Terminalia catappa* and *Thespesia populnea*.

From backshores to inland areas in waste places treelets and shrubs along with some herbs occur. Vegetation in these areas is very much denuded due to anthropogenic factors and also by grazing of goats. The following are some of the treelets/shrubs and climbers coming across in such areas. *Abutilon indicum*, *Annona reticulata*, *A. squamosa*, *Averrhoa bilimbi*, *Caesalpinia crista*, *Calotropis gigantea*, *Clerodendrum inerme*, *Colubrina asiatica*, *Dodonaea viscosa*, *Lantana camara*, *Lawsonia intermis*, *Leptadenia reticulata*, *Pavetta indica*, *Premna serratifolia*, *Ricinus communis*, *Sesbania grandiflora* and *Tecoma stans*.

In association with these shrubs, some twiners and herbaceous plants are sparsely distributed. Some of these are *Acalypha indica*, *A. lanceolata*, *Acanthospermum hispidum*, *Achyranthes aspera*, *Adenostemma lavenia*, *Aerva lanata*, *Ageratum conyzoides*, *Allmania nodiflora*, *Alternanthera sessilis*, *Alysicarpus bupleurifolius*, *A. vaginalis*, *Amaranthus spinosus*, *A. viridis*, *Ammannia baccifera*, *Anisomeles indica*, *Argemone mexicana*, *Asparagus racemosus*, *Bacopa monnieri*, *Bidens biternata*, *B. pilosa*, *Blumea mollis*, *B. obliqua*, *B. oxyodonta*, *B. virens*, *Boerhavia diffusa*,

B. chinensis, B. repens, Kalanchoe pinnata, Capsicum annuum, C. frutescens, Cardiospermum halicacabum, Cassia occidentalis, C. sophera, C. tora, Cassytha filiformis, Catharanthus roseus, Cayratia trifolia, Chrysopogon aciculatus, Cleome rutidosperma, C. viscosa, Clitoria ternatea, Coccinea grandis, Codium variegatum, Commenlina diffusa, C. paludosa, Corchorus aestuans, C. capsularis, Crinum defixum, Crotalaria pallida var. *obovata, C. retusa, C. verrucosa, Cucumis trigonus, Cucurbita maxima, C. moschata, Cymbopogon flexuosus, Cynanchum tunicatum, Cynodon dactylon, Cyanotis cristata, Cyperus compressus, C. pachyrrhizus, C. rotundus, Cyrtococcum trigonum, Dactyloctenium aegyptium, Desmodium gangeticum, D. triflorum, Digera muricata, Digitaria ciliaris, D. longiflora, Dipteracanthus prostratus, Echinochloa colona, Eclipta prostrata, Elaeocharis geniculata, Eleusine indica, Emilia sonchifolia, Eragrostis ciliaris, E. tenella, E. unioloides, Euphorbia articulata, E. heterophylla, E. hirta, E. indica, E. rosea, E. serpens, Evolvulus alsinoides, Fimbristylis cymosa, F. falcata, F. ferruginea, F. miliacea, Gloriosa superba, Hedyotis corymbosa, H. herbacea, H. puberula, Hyptis suaveolens, Impatiens balsamina, Indigofera cordifolia, I. tinctoria, Ipomoea alba, I. batatas, I. littoralis, I. pes-caprae, Ischaemum indicum, Laportea interrupta, Launaea sarmentosa, Leucas aspera, Malvastrum coromandelianum, Mariscus dubius, M. pedunculatus, Merremia vitifolia, Micrococa mercurialis, Mimosa pudica, Momordica charantia, Ocimum basilicum, Ophiuros exaltatus, Pancratium zeylanicum, Peperomia pellucida, P. tetraphlla, Peristrophe paniculata, Phyla nodiflora, Phyllanthus maderaspatensis, P. urinaria, Physalis minima, Piper betle, P. nigrum, Pistia stratiotes, Plumbago zeylanica, Polygala erioptera, Polycarpaea spicata, Polygonum barbatum, Portulaca oleracea, Pouzolzia zeylanica, Psilotum nudum, Pycreus polystachyos, Rostellularia procumbens, Rungia parviflora, Sesuvium portulacastrum, Sida acuta, S. cordata, S. rhomboidea, Solanum melongena, S. nigrum, S. torvum, Spermacoce repens, Spilanthes calva, Sporobolus piliferus, Striga angustifolia, S. asiatica, Synedrella nodiflora, Tephrosia pumila, T. purpurea, T. strigosa, Teramnus labialis, Thecagonum biflorum, Thuarea involuta, Tragia involucrata, Trichosanthes anguina, Tridax procumbens, Tylophora indica, Vernonia cinerea* and *Wedelia biflora.*

As coral reefs and atolls are of recent origin, one can hardly expect any indigenous plant in Lakshadweep. Many plants of these islands are usually dwarf. Some of these plants also show some modifications such as the presence of root nodules and pink colouration of stems and leaves.

PHYTOGEOGRAPHY

Majority of the plants that are found growing in these islands are naturalized exotics and imprudent intruders. Nearly 400 species of plants were collected so far. A careful study of all these plants reveal the absence of any endemic flowering plant here.

Rao and Ellis (1995) have given a detailed phytogeographic analysis of Lakshadweep. According to them the plants have come "through different routes to occupy the present position in these Islands". The major contributions are from Sri Lanka, Africa, Malesia, Myanmar, Australia, Tropical America, Polynesia, China and West Indies.

Maximum percentage of such plants are from Sri Lanka, main constituents of which are *Allophylus cobbe, Canavalia cathartica, Pancratium zeylanicum* and *Pouzolzia zeylanica*. African elements have the second position. Some representative species of which include *Aerva lanata, Alstonia scholaris, Claoxylon mercurialis, Eleusine indica, Jacquemontia paniculata, Hibiscus vitifolius* and *Ziziphus mauritiana*. *Adenostemma lavenia, Crepis acaulis, Leea indica* and *Rauvolfia serpentina* are elements from Myanmar area. Common Malesian constituents are *Hibiscus tiliaceus, Ipomoea denticulata, Ochrosia oppositifolia, Tacca leantopetaloides, Tournefortia argentea* etc. *Laportea interrupta, Morinda citrifolia* and *Polycarpaea spicat*a are some of the Australian elements reported from Lakshadweep.

Some of the wasteland species like *Abutilon indicum, Annona muricata, Argemone mexicana, Carica papaya, Dodonaea viscosa, Eclipta prostrata, Mirabilis jalapa, Ocimum basilicum* and *Peperomia pellucida* constitute the tropical American elements. Polynesian elements that are common here are *Acalypha lanceolata, Lindernia crustacea* and *Solanum surattense*. Of the Chinese elements, *Synedrella nodiflora* and *Wedelia chinensis* are notable weeds. *Pedilanthus tithymaloides* and *Suriana maritima* are examples of the West Indies elements.

The common cosmopolitan elements like *Adenostemma lavenia, Ageratum conyzoides, Amaranthus viridis, Bidens biternata, Boerhavia diffusa, Cassia occidentalis, C. tora, Catharanthus roseus, Phyllanthus amarus, Sophora tomentosa, Tridax procumbens*, etc. are quite prevalent in Lakshadweep.

It is sad to note that the relative density of certain plants mentioned above is gradually decreasing day by day due to anthropogenic activities and various other factors.

THREATENED AND RARE TAXA

Flora of Lakshadweep is not very rich and almost all the plants of these islands are available in the mainland of India as well. However, some of the species reported earlier from Lakshadweep could not be observed at present. Populations of some of the plants reported to have been collected earlier by Mr. M. Alimacokfan (pers. comm.) are dwindling now. *Abroma angusta, Acalypha wilkesiana, Acorus calamus, Adensonia digitata, Allophylus cobbe, Vetiveria zizanioides, Aristolochia* sp., *Calamus rotang, Entada pursaetha, Nicotiana tabacum, Passiflora edulis, Tribulus terrestris*, etc. are some such plants. The following species are also very rare in these islands and may soon disapper from here. Plants like *Canavalia cathartica, Ceriops tagal, Euphorbia articulata, Ochrosia oppositifolia, Premna serratifolia* var. *minor, Thuarea involuta, Tephrosia strigosa, Wedelia biflora*, etc. come under this category.

ECONOMIC USES

Cocos nucifera, the coconut tree is the most important economically important plant of this area. In earlier days *Oryza sativa*, the paddy and *Eleusine coracana*, the ragi were known to be cultivated in Androth.

The Agricultural Department is taking proper interest and initiative in introducing many plants of horticultural, medicinal and economic uses to these islands. *Abelmoschus esculentus, Annona* spp., *Artocarpus* spp., *Cajanus cajan, Citrus limon, C. medica, Cucumis sativus, Cucurbita maxima, Gossypium herbaceum, Hibiscus rosa - sinensis, Indigofera tinctoria, Ipomoea batatas, Luffa acutangula. L. cylindrica, Lycopersicum esculentum, Mangifera indica, Manihot esculenta, Momordica charantia, Moringa oleifera, Morus alba, Murraya koenigii, Piper betle, Psidium guajava, Punica granatum, Ricinus communis, Saccharum officinarum, Vigna unguiculata* ssp. *cylindrica*, etc. are some such plants.

Some of the medicinal plants that are commonly used by the islanders are, *Abelmoschus esculentus, Abrus precatorius, Abutilon indicum,*

Acalypha indica, Achyranthes aspera, Acorus calamus, Adenanthera pavonina, Adhatoda vasica, Aerva lanata, Ageratum conyzoides, Albizia lebbeck, Allium cepa, Alternanthera sessilis, Alstonia scholaris, Amaranthus spinosus, Ammannia baccifera, Annona squamosa, Areca catechu, Argemone mexicana, Artocarpus utilis, Azadirachta indica, Bacopa monnieri, Barleria prionitis, Bixa orellana, Blumea lacera, Boerhavia diffusa, Bombax ceiba, Brassica juncea, Caesalpinia bonduc, Cajanus cajan, Calophyllum inophyllum, Calotropis gigantea, Capsicum annuum, Cardiospermum halicacabum, Carica papaya, Cassia fistula, C. occidentalis, C. tora, Cassytha filiformis, Catharanthus roseus, Ceratophyllum demersum, Cissus quadrangularis, Citrus medica, Cleome viscosa, Clerodendrum inerme, Clitoria ternatea, Colocasia esculenta, Cymbopogon flexuosus, Cynodon dactylon, Cyperus rotundus, Datura metel, Desmodium gangeticum, D. triflorum, Eclipta prostrata, Emilia sonchifolia, Erythrina variegata, Euphorbia hirta, E. tirucalli, Evolvulus alsinoides, Ficus benghalensis, F. racemosa, F. religiosa, Gloriosa superba, Gossypium herbaceum, Hedyotis corymbosa, Hibiscus rosa-sinensis, Indigofera tinctoria, Ipomoea batatas, I. pes-caprae, Ixora coccinea, Kalanchoe pinnata, Lantana camara var.*aculeata, Lawsonia inermis, Leea indica, Leucas aspera, Lycopersicum esculentum, Mangifera indica, Manihot esculenta, Mimosa pudica, Momordica charantia, Moringa oleifera, Morus alba, Murrya koenigii, Musa paradisiaca, Nerium oleander, Ocimum americanum, O. basilicum, O. tenuiflorum, Operculina turpethum, Pandanus odoratissimus, Phoenix pusilla, Phyla nodiflora, Phyllanthus amarus, P. emblica, Physalis minima, Piper betle, Plumeria rubra, Polyalthia longifolia, Portulaca oleracea, Premna serratifolia, Psidium guajava, Punica granatum, Rauvolfia serpentina, Ricinus communis, Saccharum officinarum, Sesbania grandiflora, Sida acuta, S. cordata, Solanum melongena, S. nigrum, Syzygium cumini, Tamarindus indica, Tephrosia purpurea, Teramnus labialis, Thespesia populnea, Tinospora cordifolia, Tragia involucrata, Tylophora indica, Vernonia cinerea, Vigna unguiculata* ssp. *cylindrica, Vitex negundo* and *Ziziphus mauritiana.*

CONSERVATION

In Lakshadweep Islands tetrapods are generally being made use of along the coastline to protect the sandy beaches and also to check soil erosion. Two pitties (small islands) near Kalpeni and Parali III near Agathi have already submerged due to severe action of wind and waves. These

pitties and Parali III were devoid of any rocky beach and hence they became susceptible to the fierce action of wind and waves.

Large quantities of broken rocks and coral pebbles are being taken away from the coastline by local people in order to make bricks for construction of houses. This unscrupulous action would result in severe damage to the coastal ecosystem.

In Minicoy helipad area, near to seashore, there is a lagoon-like saline marshy area. The surrounding banks have luxuriant growth of two mangrove species viz. *Avicennia officinalis* and *Ceriops tagal*. This appears to be the only mangrove patch in Lakshadweep. Some rare plants like *Euphorbia articulata, Lepturus repens* and *Thuarea involuta* are also found in adjoining areas. It will be worthwhile to protect this area from further deterioration.

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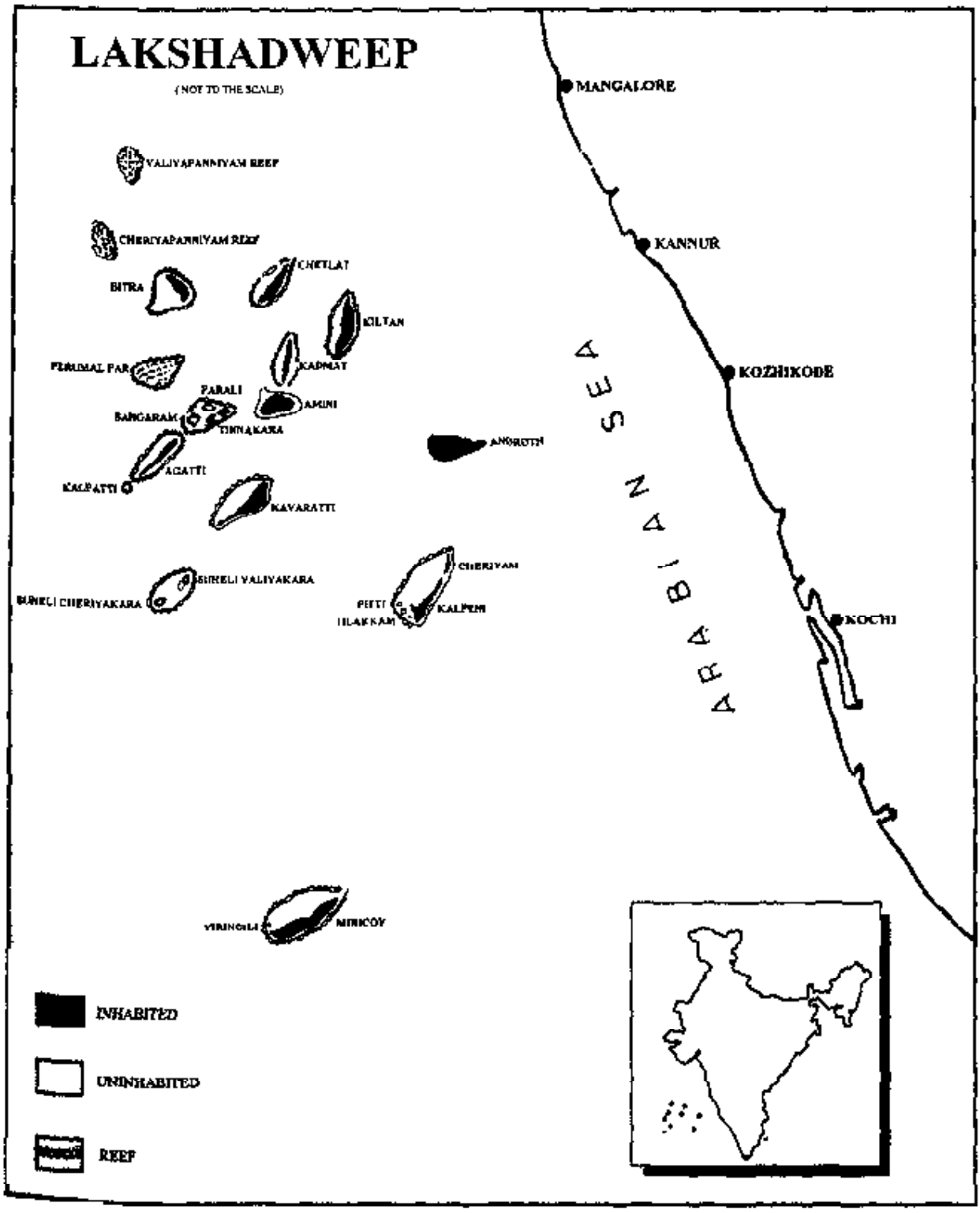


MAP OF LAKSHADWEEP

A view of vegetation in Kalpatti island

A general view of a small mangrove formation in Minicoy

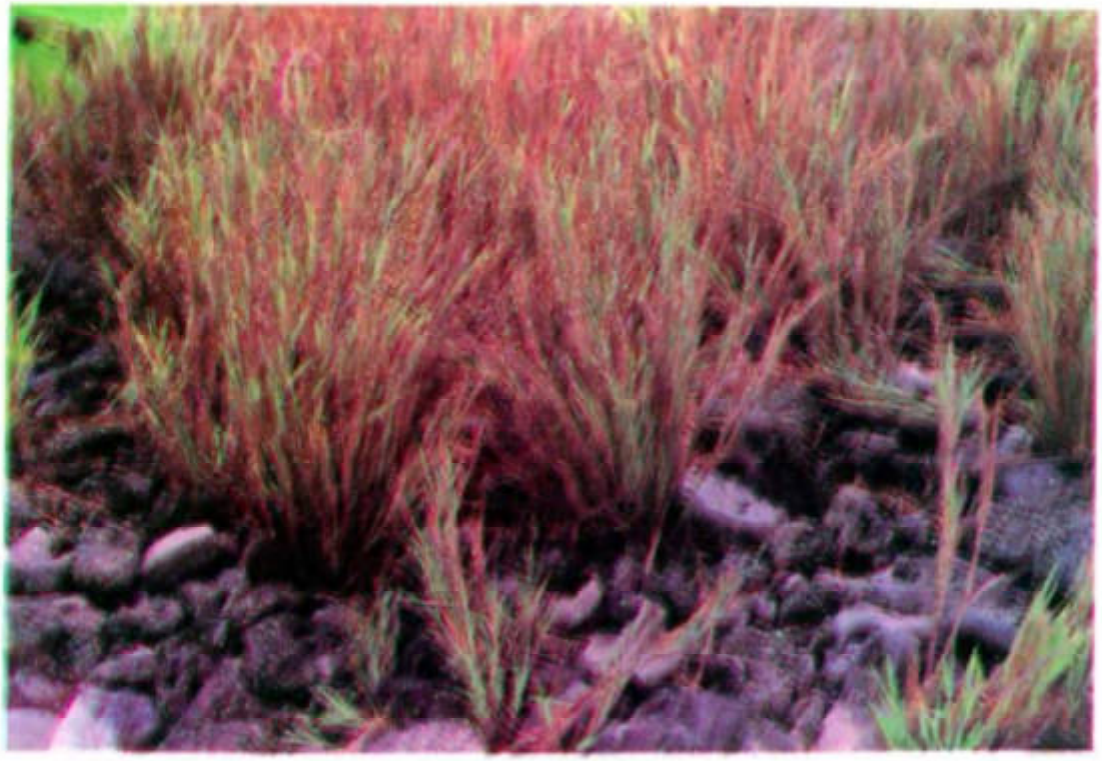
Collection of species of *Cymodocea* (Sea grass) during low tide at Kavaratti

Euphorbia articulata : a rare plant from Minicoy

Pemphis acidula : a coastal bushy shrub

Pancratium zeylanicum : a rare Sri Lankan element in Lakshadweep

Messerschmidia argentea : a lovely small tree in Coastal areas



Lepturus repens : a rare Australian grass from Lakshdweep

MADHYA PRADESH

D.M. Verma
V. Mudgal

Madhya Pradesh, the largest Indian State in the heart of the country is rugged territory of low rising hills, river valleys, plateaus and plains between about 18° to 26° N latitudes and 74° to 84° E longitudes. It covers an area of about 4,50,000 sq km surrounded by seven other Indian States of Andhra Pradesh, Bihar, Gujarat, Maharashtra, Orissa, Rajasthan and Uttar Pradesh. Bordering and traversing it are two hill ranges of moderate elevation, the Vindhyas and the Satpuras, both running from north east to south west forming in between the famous Narmada valley. The two hill ranges meet each other in its eastern part forming a conglomerate of hills and plateaus known as the Maikal hills. In the north west of the Vindhyas is the Chambal valley and yet beyond another tableland, the Malwa Plateau, with small conical or flat-topped hills. In the north east are the Ramgarh hills which are an extension of the Rajmahal hills of Bihar and in the south east is yet another hill mass, the Bailadilla hills connected to the Eastern Ghats. The Chhattisgarh Plains in the south east, drained by Mahanad, Panna hills, Kaimur hills, Pachmarhi hills, Jashpur pats, Gird region and parts of Bundelkhand and Baghelkhand complete the list of major land-marks of Madhya Pradesh. The general elevation of the plains is in between 200-300 m above mean sea level and that of the hills generally between 600-800 m with the highest peak of 1340 m at Dhupgarh in Pachmarhi hills. The whole region is criss-crossed with innumerable rain-fed rivers, streams and rivulets which become raging torrents during monsoon season and also has numerous man-made and natural tanks and reservoirs.

The region enjoys the widespread Indian monsoon climate. The average annual rainfall varies from 700-2000 mm. It is generally higher in the south eastern region and lower in the north west. The mean maximum temperature in May-June varies from 37°-42°c and mean minimum temperature in January varies from 7° - 10° C in different regions.

Madhya Pradesh represents several pre-cambrian rock systems, namely, Archaean, Dharwar, Cuddapah and Vindhyan. The Gondwana system, which derived its name from the ancient Gond kingdoms, exists in Mahadeo and Pachmarhi hills and Jabalpur. Deccan trapes formed by

successive volcanic erruptions during Eocene are found in western and central parts. The major soil groups are alluvial, deep black or regur, medium black, mixed red and black, mixed red and yellow and skeletal soil.

The State has history of dense tropical forest, comparitively less population and very few industries particularly in its southern and eastern regions. The scenario is fast changing but even then it is still predominantly a land of Forest and agriculture. Nearly 31.5% of its area (*ca* 1,46,000 sq. km) is under forest cover which is about 26.3% of the country's total forest area. The densely forested districts are Bastar (70%), Surguja (52%), Balaghat (44%), Mandala (41%), East Nimar (40%), Sahdol (39%), Sidhi (38%), Raipur (38%), Raigarh (35%), Bilaspur (33%), and Chhindwara (32%). Agriculture occupies about 32% of the land area.

The botany of Madhya Pradesh has been studied in the past by many workers. Recently Botanical Survey of India has brought out the flora of state into two volumes, covering all Dicotyledonous plants and Pteriodophytes (Verma *et al,* 1993; Mudgal *et al,* 1997).The third volume dealing with Monocotyledons is under publication.

According to Champion and Seth (1968) in Forest types of India, two main types of forest namely, Tropical and Montane subtropical Forest occur in Madhya Pradesh. Except for some hill tops like Pachmarhi and Bailadila, the entire state falls under Tropical Forest which are further devided into several sub-types. A brief account and diversity of species of these forest are given below.

TROPICAL FOREST

Northern tropical semi-evergreen forest

These are dense forest, with the canopy reaching a height of 24-36 m. Many top storey trees are deciduous but these do not shed their leaves at the same time and are deciduous only for a short peroid. The second storey is entirely evergreen. These are home for a large number of woody climbers, epiphytes, orchids and ferns. These forest are found in south east Madhya Pradesh and areas adjoining to the State of Orissa.

Some important top storey plants are *Terminalia alata, Stereospermum chelonoides, Shorea robusta, Tetrameles* spp. and

Dalbergia paniculata. Plants of lower canopy are *Artocarpus lakoocha, Michelia champaca, Celtis tetrandra, Bridelia squamosa, Calamus* spp., *Dillenia* spp., *Ficus* spp., *Glochidion* spp., *Phoebe lanceolata, Diospyros* spp., *Litsea nitida, Leea* spp., *Bambusa arundinacea,* etc. Sometimes some cane clumps belonging to *Calamus viminalis* and *C. tenius* also occur.

Some of the large woody climbers are *Gnetum ula, Entada phaseoloides, Milletia extensa, Dalbergia volubilis, Bauhinia vahlii, Argyreia* spp. and *Combretum roxburghii.* A thick growth of *Curcuma* spp. and *Zingiber* spp. is a common feature of undergrowth. A large number of ground orchids like *Eulophia* spp., *Habenaria* spp. and epiphytic orchids like *Dendrobium* spp., *Aerides multiflora, Rynchostylis retusa, Vanda* spp. and several ferns and fern allies, including tree ferns, are denizens of these forest.

Tropical moist deciduous forest

These forest are characterised by an open top canopy of a mixture of scattered deciduous species reaching a height of 25 m or more and a combination of deciduous and evergreen smaller trees and shrubs forming the second storey. The presence of evergreen species in the lower storey and a rich undergrowth gives these forest as a whole, a more or less luxurient green look. These are generally found in the hilly areas of Hoshangabad, Balaghat, Seoni, Raipur, Durg, Bastar, Surguja, Raigarh and Mandla districts.

The common tall trees of these forest are *Shorea robusta, Tectona grandis, Pterocarpus marsupium, Terminalia alata, T. bellerica, T. chebula, Lannea coromandelica, Dalbergia paniculata, Haldinia cordifolia, Bombax ceiba, Stereospermum colasis, Garuga pinnata, Soymida febrifuga, Lagerstroemia parviflora,* and *Anogeissus latifolia.* Common small trees and shrubs are *Bridellia squamosa, Cleistanthes collinus, Mallotus philippensis, Diospyros melanoxylon, Buchanania lanzan, Cassia fistula, Schleichera oleosa, Desmodium oojeinensis, Miliusa tomentosa, Careya arborea, Dillenia pentagyna, D. indica, Chloroxylon sweetenia, Helicteres isora, Antidesma ghaesembilla, Gmelina arborea, Grewia tiliaefolia, Breynia vitisidaea, Shrebera swietenioides, Embelica tsjeriam cottam, Ochna obtusata; Casaeria graveolens, Holarrhena pubescens, Semecarpus anacardium, Ficus* spp., *Leea* spp. and *Dendrocalamus strictus.*

The conspicuous climbers and ramblers in these forest are *Milletia extensa, Ventilago denticulata, Bauhinia vahlii, Smilax zeylanica, Celastrus paniculatus, Ichnocarpus frutescens, Combretum roxburghii, Hemidesmus indicus, Olax scandens, Ziziphus oenoplia, Dioscorea bulbifera* and other spp.

The lower most canopy is sparse and not much varied. Some common species are *Eranthemum purpurascens, Perilepta edgeworthiana, Desmodium* spp., *Phoenix acaulis, Curcuma* spp. *Zinziber* spp. etc. Some ground orchids like *Eulophia* spp., *Geodorum densiflorum, Habenaria* spp., *Plantanthera susanae* are also found in well protected forest.

Tropical dry decicuous forest

In these forest entire dominants as well as many lower storeyed trees and shrubs are deciduous. There is an almost leafless period during March-April. They give the whole forest a look of dryness. The top canopy is invariably open and light. The height of this canopy varies between 8-20m. Here woody climbers and epiphytes are few and orchids and ferns are almost absent.

This type of forest is generally found in the northern, western and central western districts of Sidhi, Rewa, Satna, Panna, Chhatarpur, Sagar, Damoh, Vidisha, Guna, Morena, Shivpuri, Gwalior, Datia, Raisen, Mandsaur, Ratlam, Ujjain, Indore, Dhar, East Nimar and Jabalpur.

The common taller trees of these forest are *Terminalia* spp., *Tectona grandis, Pterocarpus marsupium, Cochlospermum religiosum, Soymida febrifuga, Lannea coromandelica, Diospyros melanoxylon, Butea monosperma, Lagerstroemia parviflora, Anogeissus latifolia, A. pendula, Mitragyna parviflora, Phyllanthus emblica, Sterculia* spp., *Boswellia serrata, Bridelia squamosa, Albizia* spp., *Hardwickia binata, Bauhinia* spp., *Cordia obliqua, Aegle marmelos* and *Acacia* spp.

The common smaller trees and shrubs of these forest are *Gardenia* spp., *Grewia* spp., *Helicteres isora, Holarrhena antidysenterica Wrightia* spp., *Casearia elliptica, Carissa* spp., *Alangium salvifolium, Nyctanthes arbor-tristis, Ziziphus* spp., *Capparis zeylanica, Flacourtia indica, Mimosa spp., Securinega virosa, Kirganelia reticulata, Woodfordia fruticosa,* etc. Some slender climbers commonly met in these forest are *Rhynchosia minima, Atylosia scarabeoides, Cocculus hirsutus, Cissampelos pereira,*

Ipomoea spp., *Coccinia indica, Mukia maderaspatana, Diplocyclos palmatus, Momordica dioica, Cryptolepis buchananii, Puereria tuberosa, Marsdenia* spp., *Ziziphus oenoplia, Pergularia daemia* and *Tinospora cordifolia.*

Tropical thorn forest

In these forest the dominants are the low thorny hard leaved evergreen trees and xerophytes on generally very shallow and poor soil. The canopy in most cases is broken and under 10m in height. Species diversity is low. Woody climbers and epiphytes are few. There is an abundant growth of ephimerals during rainy months. Annual rain fall is below 1000mm. In Madhya Pradesh only small patches of such Forest are present in north-west Morena and west Nimar. Some important constituents of these forest are *Acacia* spp., *Ziziphus* spp., *Albizia* spp., *Aegle marmelos, Gardenia* spp., *Randia* spp., *Cordia obliqua, Balanites roxburghii, Prosopis spicigera, Mimosa* spp., *Gymnosporea spinosa, Flacourtia indica* and *Grewia* spp.

The climbers are generally with wiry twining branches and are represented by *Cocculus hirsutus, Cissampelos pareira, Rhynchosia minima, Atylosia scarabaeoides, Abrus precatorius, Ipomoea* spp. and several cucurbits. *Dendrophthoe falcata, Viscum nepalense* and *V. orientale*, all partly parasitic and profusely branched herbs are often found perched on trees.

MONTANE SUBTROPICAL FOREST

These are represented in Madhya Pradesh by only the following kind.

Central Indian subtropical hill Forest

The sites occupied by these forest are the hill tops above 1200m in parts of Pachmarhi and Bailadila hills. These are cooler places, usually well exposed and have poor and shallow soil. Besides, most of these places are easily accessible and under intense biotic pressure. The rainfall is fairly high but the water retention capacity of the soil is limited. Due to these factors even though these Forest contain many evergreen species, the total appearance of these Forest with short boled branchy trees is sometimes that of a inferior kind of forest. Some of the common constituents of these forest are *Michelia champaca, Syzygium cumini, Manilkara*

hexandra, Mangifera indica, Symplocos laurina, Salix tetrasperma, Carallia brachiata, Litsea monopetala, Berberis asiatica, Dillenia spp., *Mallotus philippensis, Toona ciliata, Gnetum scandens, Celtis tetrandra, Calamus* spp. and tree-ferns like *Cyathea gigantea, C. spinulosa* and *Angiopteris evecta.*

AQUATIC PLANTS

Madhya Pradesh has extensive network of rivers, rivulets, streams, drains, ponds and ditches which are home for a large number of aquatic plants. During dry seasons, many such plants survive well in marshes and mud also. These have been broadly grouped into the following categories.

Free floating hydrophytes

Roots of these plants do not touch the ground. They float freely on the surface of water. Some such plants are *Azolla pinnata, Eichhornia crassipes, Lemna perpusilla, Nymphoides hydrophylla, N. indica, Pistia stratiotes, Spirodela polyrrhiza, Trapa natans* var. *bispinosa and Wolffia globosa.*

Suspended submerged hydrophytes

Plants are submerged in water but their roots are not attached to the soil. These are *Ceratophyllum demersum, Utricularia aurea* and *U. exoleta.*

Anchored submerged hydrophytes

Roots of these plants are fixed in soil and plant body remains submerged in water. Some plants of this kind are *Aponogeton crispus, Blyxa aubertii, B. octandra, Cryptocoryne reterospiralis, Hydrilla verticillata, Myreophyllum oliganthum, Najas* spp., *Nechamandra alternifolia, Podostemon wallichii, Polypleurum stylosum, Potamogeton crispus, P. mucronatus, P. pectinatus* and *Vallisneria natans.*

Anchored hydrophytes with floating shoots

Roots of these plants are fixed in the ground. The examples are *Alternanthera philoxeroides, Cyperus platystylis, Hygroryza aristata, Ipomoea aquatica, Ludwigia adscendens* and *Neptunia oleracea.*

Anchored hydrophytes with floating leaves

Roots of these plants are fixed in soil and their flat and comparatively broad leaves float on water surface. Some of these are *Aponogeton natans, Caldesia parnassifolia, Limnophyton obtusifolium, Marsilea minuta, Monochoria hastata, M. vaginalis, Nelumbo nucifera, Nymphae pubescens, N. nouchali, N. rubra, Nymphoides hydrophylla, N. indica, Ottelia alismoides, Potamogeton nodosus, Sagittaria guayanensis subsp. lappula* and *Tenagocharis latifolia.*

Emergent amphibious hydrophytes

These plants are well adapted to moderate condition of water and soil. These plants mostly grow in moist places along banks of the ponds, rivulets, ditches etc. Some important plants of this type are *Acorus calamus, Aeschynomene aspera, Ammania baccifera, Brachiaria reptans, Coix aquatica, Cyperus distans, Echinochloa colona, Eleocharis* ssp., *Eriocaulon* spp. *Fimbristylis* spp., *Hygrophila auriculata, Limnophila* spp., *Lipocarpha* spp., *Ludwigia* spp., *Phragmites karka, Polygonum* spp., *Ranunculus scleratus, Rotala* spp., *Scirpus* spp. and *Typha angustata.*

ANALYSIS OF VEGETATION AND DIVERSITY

In Madya Pradesh there are about 2317 flowering plant species belonging to 955 genera and 165 families. Out of this, the share of monocot and dicot is 654 and 1663 respectively. Larger number of species come from Leguminosae (268), Poaceae (252), Fabaceae (196) Cyperaceae (131), Asteraceae (106), Acanthaceae (105), Euphorbiaceae (96), Scrophulariaceae (69), Convolvulaceae (50) and Malvaceae (40).

Trees

Madhya Pradesh has over 450 tree species which give a definite shape to the vegetation of a place. The state is famous for its *Shorea robusta* (sal) and *Tectona grandis* (teak) trees. Beside this here is a very good representation of larger trees viz. *Terminalia alata, T. arjuna, T. bellirica, Phyllanthus emblica, Diospyros melanoxylon, Anogeissus latifolia, A. pendula, Madhuca longifolia, Cleistanthes collinus, Boswellia serrata, Lannea coromandelica, Schleichera oleosa, Buchanania lanzan, Aegle marmelos, Pterocarpus marsupium, Ziziphus* spp., *Acacia* spp., *Bauhinia* spp., *Butea monosperma, B. superba, Syzygium* spp., *Ficus* spp.,

Dillenia spp. Dense thickets of *Dendrocalamus strictus* and other species of bamboos are abundant in the state. Among smaller trees *Nyctanthes arbor-tristis* and *Holarrhena antidysenterica* are well known and widely distributed.

In Madhya Pradesh several trees species are planted along roadsides. Some of the common trees are *Mangifera indica, Azadirachta indica, Dalbergia sissoo, Pongamia pinnata, Eucalyptus spp. Terminalia arjuna, Parkinsonia aculeata, Acacia auriculiformis, Syzygium cumini, Ficus religiosa, Holoptelea integrifolia, Cassia siamea, Bombax ceiba, Thespesia populnea, Pterocarpus marsupium* etc.

Along the river banks trees of *Terminalia arjuna* and *Syzygium heynianum* are a common sight.

Shrubs and Bushes

A large number of shrubs and bushes found in different kinds of reserved and degraded forest, forest margins, roadsides or wastelands, form an ecologically important and conspicuous part of the vegetation.

Sometimes the dominance of some of the species of this group are useful in subdividing the major vegetation types. In the dense 'sal' (*Shorea robusta*) forest, deep inside or more so on its periphery are found shrubs, undershrubs and bushes of *Eranthemum purpurascens, Perilepta edgeworthiana, Phoenix acaulis, Embelia tsjeriam-cottam, Chloroxylon swietenia, Casearia graveolens, Helicteres isora, Semecarpus anacardium, Indigofera caseoides, Woodfordia fruticosa, Desmodium* and *Leea* spp. etc. In degraded forest and along roadsides bushes of *Abutilon* spp., *Alysicarpus* spp., *Anesomeles indica, Antidesma* spp., *Bidens biternata, Caesalpinia* spp., *Calotropis* spp. *Capparis zeylanica, Datura* spp., *Flacourtia indica, Grewia* spp., *Hyptis suaveolens, Ipomoea carnea, Leonotis nepetaefolia, Ludwigia* spp., *Mimosa* spp., *Pogostemon benghalense* and *Ziziphus* spp. are common. In open and generally in dry areas *Flacourtia indica, Mimosa* spp., *Solanum* spp., *Datura* spp., *Calotropis* spp., *Securinega* spp., *Euphorbia* spp., *Zizphus* spp., *Pogostemon* spp. are common. Beside these, there are certain notorious bushy shrubs which are not indigenous but had been brought to the country during the last century or so. Most of them belong to South American countries. These are expanding alarmingly and posing a serious threat to the indigenous vegetation. *Lantana* is expanding dangerously in degraded

dry deciduous forest. *Ipomoea carnea* is capturing roadsides and agricultural fields where even little water is present. *Prosopis juliflora* is spreading in north-western areas of the state and during last 15-20 years the so called congress grass, *Parthenium hysterophorus* is occuping every open place available to it. It is suspected that pollens of *Parthenium* cause diseases of eye and skin. Once these species occupy a place they make it almost impossible the growth of other indigenous species there. Hence, these exert a harmful impact on the vegetation of the place. At the moment, the only option left to get rid of the problem is to collect and burn them to ashes.

Climbers and Creepers

In Madhya Pradesh, there are approximately 100 species of climbers and creepers. Many of the climbers are so extensive that they almost envelop the supporting trees or shrubs. Some such extensive climbers in the state are *Cocculus hirsutus, Celastrus paniculatus, Hemidesmus indicus, Milletia extensa, Bauhinia vahlii, Acacia sinuata, Combretum roxburghii, Butea superba, Gnetum scandens, Pergularia daemia, Smilax zeylanica, Olax scandens, Ventilago denticulata, Ichnocarpus frutescence and Argyreia* spp. About 10 species of *Dioscorea* are found in the moist deciduous forest. Some widely distributed species are *Dioscorea pentaphylla, D. bulbifera* and *D. hispida* var. *daemona*. Many climbers come from families like Menispermaceae, Cucurbitaceae, Vitaceae, Leguminosae and Asclepiadaceae. A few of them are *Cissampelos pareira* var. *hirsuta, Cocculus hirsutus, Ampelocissus latifolia, Cayratia trifolia, C. rependa, Abrus precatorius, Atylosia scarabaeoides, Mucuna pruriens, Pueraria tuberosa, Rhynchosia minima, Diplocyclos palmatus, Tricrosanthes cucumerina, Momordica dioica, Cryptolepis buchanani, Dregia volubilis, Gymnema sylvestris* and *Pergularia daemia.*

Some creepers like *Lathyrus aphaca, Vicia sativa, Evolvulus nummularia* are common in agricultural fields. Some creepers take the help of their tendrils for climbing and they continue growing on land horizontally till they find a suitable support. Some plants run horizontally in open spaces. They get adequate light here for photosynthesis. Some typical plants of this type are *Phyla nudiflora* and *Evolvulus nummularia.* Families like Cucurbitaceae, Convolvulaceae, Vitaceae, Leguminosae and Poaceae largely contribute to species of such habit.

Herbs

Madhya Pradesh is rich in both annual and perennial herbs. While some of these are forest dwellers, mostly these form the greenery of the open lands, particularly in the monsoon and the post-monsoon periods. A large number of these are extremely important in various ways. Many herbs are medicinal, articles of food or soil binders which check soil erosion. On decomposition they make the soil fertile. The experts use these herbs as parameters in determination of humidity and fertility of soil. The leguminous species fix the atmospheric nitrogen and make soil fertile. Members of Poaceae and Cyperaceae check the soil erosion. Some numbers of Zingiberaceae especially the *species of Curcuma* are variously used. Their rhizomes are source of food, medicine and dye to many ethnic communities. Some species of *Curcuma* bear flowers directly from the rhizomes in the dry summer months, well before the emergence of leaves often providing a beautiful sight in the otherwise parched landscape. Some herbs like *Anisochilus carnosus, Polycarpaea aurea, P. corymbosa* prefer to grow in the crevices of the rocks. The red-violet flowers of *Burmannia* are an eye-catching sight on bare moist rocks. Many species are adapted to grow on the walls of the houses and other buildings. Some of these are *Verbascum chinense, Melochia corchorifolia, Blumea* spp. and *Ficus* spp. *Cyathocline purpurea* which bears scented dissected leaves and purple flowers is restricted to wet places of sal forest. Some grasses like *Oropetium thomaeum* and *Aristida* spp. are useful sand binders. Members of Podostemonaceae such as *Podostemon wallichii* and *Polypleurum stylosum* having extensively branched thalloid stems are found sticking to rocks in running water. Among the smaller plants of the state are the free floating *Wolffia globosa, Lemna perpusila, Spirodela polyrhiza* and *Azolla pinnata*.

Epiphytes

Many species of plants are seen growing on other plants in the semi-evergreen and moist deciduous forest of the state. Most of the epiphytes, except a few like *Cuscuta* spp. which are parasites, synthesize their own food needing only a sheltered footage at some height, moisture and some minerals from the host plant. Some plants like *Dendrophthoe falcata* and *Viscum* spp. grow considerably in size and are harmful to the host plants. But other epiphytes, mostly ferns and orchids are almost harmless to the host plant. *Viscum* spp., *Dendrophthoe falcata*, two species of orchids,

viz. *Vanda tesselleta* and *V. testacea* are found in almost every forest. The majority of other epiphytic orchids and the ferns are found in semi-evergreen and moist deciduous forest.

Insectivorous plants

These are interesting plants which attract the insects, trap them and gradually digest them for food requirements. Such plants are represented in Madhya Pradesh too. Leaves of *Drosera burmanii* and *D. indica* bear mucilaginous glands and insect is caught when it comes in contact with the mucilage. Three species of *Utricularia* grow in water or marshes. Roots of these species bear bladders. There is a small pore and a lid in the bladder. When the insect enters the bladder, the lid closes down. Thus, trapped insect is gradually digested and absorbed by the plant.

Attractive flowers

Madhya Pradesh has nearly 2,317 species of flowering plants. While all of these are equally interesting to an academic botanist, some instantly provide unforgetable eye-catching sights to a common plant lover. The deciduous forest during their leafless period in January-March has a desolate feeling of barrenness everywhere till one comes across large stretches of land with small leafless trees of *Butea monosperma* loaded with bright red flowers or hanging bunches of yellow flowers of *Cassia fistula*, clusters of pink flowers of *Desmodium oojeinensis*, sweetly scented pinkish white flowers of *Nyctanthes arbor-tristis*, the large pink or red flowers of *Bombax ceiba* and yellow, green, red or white globular flower heads of *Acacia* spp., *Albizia* spp. or *Mimosa* spp. Beside these, the flowers of many other plants like *Pterocarpus marsupium, Thespesia lampas, Bauhinia* spp., *Woodfordia fruticosa, Nymphea* spp. and *Nelumbo nucifera* are also a source of pleasure.

Flowers of Araceae have multicoloured, snakehood like flower spathes. Orchid flowers are famous for their beauty. Though not all but many species of Orchidaceae bear beautiful flowers. Some of these are the epiphytic *Dendrobium nobile, Vanda testacea, Rhyncostylis retusa*, and the terrestrial *Geodorum densiflorum, Eulophia flava, E. nuda, E. explanata* and species of *Habenaria*.

Rare/endangered and endemic species

While an exact assessment of such species in any region is not possible due to lacunae in our knowledge of plant distribution data, changing vegetation and floristic composition, plant migration and taxonomic confusions, it is estimated that in Madhya Pradesh about 90 species fall into this group. Some of the rare/endangered species are *Acacia donaldi, Alstonia venenata, Amorphophallus sylvaticus, Andropogon pumilus, Aspidopterys cordata, Berberis* spp., *Bupleurum plantaginifolium, Calpurnea aurea, Cleome felina, Crotalaria notonii, C. vestita, Desmodium rotundifolium, Eragrostiella leioptera, Flemingia grahamiana, Hypericum gaittii, Melhania hamiltoniana, Maytenus rothiana, Nogra dalzelli, N. filicaulis, Oropetium villosulum, Senecio corymbosus, Smithia pycnantha, Theriophonum minutum and Utricularia baouleensis.* Some of the endemic species are *Alysicarpus vasavadae, Andropogon grahamii, Berberis hainesii, Curcuma sulcata, Euphorbia caducifolia, Ficus cupulata, Grewia hainesiana, Hibiscus pachmarhiana, Maytenus bailadillana* and *Polygonum myriophyllum.*

Useful plants

Men always needed certain things for food, housing, clothing, medicine and other items in his day to day life. In the past when there was little transportation facility people were dependent on local vegetation only. "Necessity is the mother of invention," following this man has learnt different uses of plants, etc. on trial and error basis. The fruits of their experience passed on to the future generation. This methodology is still in use in many ethnic communities. Development bridges the distances, the materials of one region reaching the other fairly and easily. But this trend has increased the needs also. During survey trips to Madhya Pradesh, and while talking to local people, several useful plants came into light. While medicinal plants are treated separately, some other useful plants are being given here.

The wood of *Shorea robusta* (sal) and *Tectona grandis* (teak) is the favourite house building material. Madhya Pradesh has widely spread sal Forest. Teak plantations are being raised on large scale. Trade of its wood has now been established as an organized industry. The other timber yielding species are *Azadirachta indica, Mangifera indica, Madhuca longifolia, Eucalyptus* spp., *Acacia* spp., *Albizia* spp., *Dalbergia* spp., *Anogeissus*

spp., *Toona ciliata, Terminalia alata, Michelia champaca, Pterocarpus marsupium, Syzygium cumini* and *Desmodium oojeinsis.*

The forest of Madhya Pradesh house a number of plants of food value. Local people convert many wild species of *Dioscorea* edible by boiling their tubers many times in water. Dried rhizomes of wild *Curcuma* spp. are made into flour by the local people. Roots of *Nelumbo nucifera* and *Nymphea* spp. are used as vegetable. The soft and delicate leaves of several plants, like *Amaranthus* spp., *Cassia tora, Ipomoea* spp. and tender branches of *Dendrocalamus strictus* are used as vegetables. Flowers of *Bauhinia* spp., *Moringa oleifera* and *Madhuca longifolia* are also edible. Some of the plants bearing edible fruits or seeds are *Dillenia pentagyna, Annona squamosa, Buchanania lanzan, Grewia* spp., *Aegle marmelos, Ziziphus* spp., *Moringa oleifera, Pithecelobium dulce, Momordica dioica, Embelia tsjeriam-cottam, Phoenix* spp., *Semecarpus anacardium, Diospyros* spp., *Cordia obliqua, Phyllanthus emblica, Ficus* spp., *Indigofera glandulosa, Vigna* spp., *Bauhinia vahlii, Coix aquatica, Eleusine coracana, Oryza rufipogon, Panicum sumatrensis* and *Paspalum scrobiculatum.*

Beside these, many plants of the state are being used for other purposes viz. *Tamarindus indica* and *Madhuca longifolia* for liquor, *Thysanolaena maxima* for brooms, *Gossypium* spp., *Bombax ceiba* and *Cochlospermum religiosum* for cotton, *Butea monosperma, Nyctanthes arbor-tristis, Mallotus philippensis, Woodfordia fruticosa* and *Curcuma* spp. for dyes, *Bauhinia vahlii, Hibiscus cannabinus* and *Eulaliopsis binata* for rope making fibres, *Sterculia urens, Acacia* spp., *Boswellia serrata* and *Lannea coromandelica* for gums, *Bombax ceiba* and *Boswellia serrata* for match-sticks, leaves of *Madhuca longifolia, Butea monosperma* and *Bauhinia vahlii* for making eating bowls and plates, *Sapindus emarginatus* and *Acacia sinuata* for washing hairs, *Phoenix* spp., *Imperata cylindrica* and *Saccharum* spp. for thatching.

There are many plants which are the main source of raw materials for well established plant-based industries. Some of such plants are *Shorea robusta* and *Tectona grandis* for timber, *Diospyros melanoxylon* for bidi leaves, *Dendrocalamus strictus* for paper pulp, *Schleichera oleosa* for lac growing, *Madhuca longifolia, Pongamia pinnata, Schleichera oleosa, Cochlospermum religiosum, Buchanania lanzan, Azadirachta indica, Cymbopogon martinii, Eucalyptus* ssp. and *Shorea robusta* for oils.

Plant diversity includes agricultural crops too. Paddy, wheat, barley, ragi, pulses, vegetables, linseed, sunflower, *Guizotia abyssinica* and many fruits are being cultivated in suitable areas. Cultivation of *Eleusine coracana and Paspalum scrobiculatum* is on decline. Plants like *Santalum album, Anacardium occidentale, Tectona grandis, Dendrocalamus* spp., *Pongamia pinnata* and *Eucalyptus* are being planted by Forest Department at several places.

Medicinal plants

Madhya Pradesh is well known for medicinal plants. At least 200 plant species are being used variously in Ayurvedic preparations. Beside these, medicinal values and uses of 150-200 species of plants are known but still restricted to ethnic communities.

Some widely distributed plants of the state used in Ayurvedic preparations are *Terminalia chebula, T. bellirica, T. arjuna, Aegle marmelos, Anogeissus latifolia, Helicteres isora, Holarrhena pubescens, Mallotus philippensis, Cassia fistula, Nyctanthes arbor-tristis, Pterocarpus marsupium, Azadirachta indica, Strychnos nux-vomica, Sapindus emarginatus,* etc. Some other medicinally important plants are *Abrus precatorius, Acacia* spp., *Adhatoda vasica, Alstonia scholaris, Argyreia* spp., *Baliospermum montanum, Acorus calamus, Asparagus racemosus, Balanites aegyptiaca, Bauhinia* spp., *Berberis* spp., *Blepharispermum subsessile, Catharanthus* spp., *Celastrus paniculatus, Cissampelos pariera* var. *hirsuta, Chlorodendrum* spp., *Clitoria ternatia, Costus speciosus, Curcuma* spp., *Datura* spp., *Embelia tsjeriam-cottam, Euphorbia* spp., *Gymnema sylvestre, Hemidesmus indicus, Leptadenia reticulata, Mimosa pudica, Ocimum* spp., *Plantago* spp., *Plumbago zeylanica, Pongamia pinnata, Psoralea corylifolia, Rauvolfia serpentina, Semecarpus anacardium, Sida* spp., *Solanum* spp. *Sterculia urens, Tinospora cordifolia, Uraria picta, Urginia indica, Vitex negundo* and *Woodfordia fruticosa.*

CONSERVATION

Madhya Pradesh has a history of large tracts of tropical forests, less population and low industrial activity, particularly in its south eastern region. Its land connections to the semi-arid west, Indo-Gangetic plains, Deccan Peninsula and Eastern Ghats, the hill ranges, a climate varying

from semi-arid conditions in the west to highly humid south eastern regions, a variety of soil, the topography of hills, valleys, deep gorges, plateaus and plains and the various kinds of forests had altogether created an eco-friendly and accomodating environment for plant migration from different phyto-geographical regions. Hardly about a dozen endemic species and the forest forms which are of intermediate kinds between distinct northern and southern tropical forms are an indication that the existing about 2,317 species of flowering plants in Madhya Pradesh are an assemblage of species from different regions. However, Madhya Pradesh is also the limit for distribution of about 100 rare species which might be in the process of disappearance in their original habitats. Together with the necessity of maintenance of forest cover for several environmental considerations this is yet another reason of paramount importance for preservation of forests of Madhya Paradesh. The age-old practice of maintaining forest patches by former rulers of this region as Game sanctuaries, the religious faiths of the local people or their instincts for preservation of forests which provided them with plants of their regular use, the difficult terrain and general inaccessibility to several places all together contributed towards the preservation of forests. Post independence era saw rapid urbanization and industrialization, construction of dams and canals and development of a network of roads for transport, all having some adverse affect on forests. However, some of these adverse affects have been nullified by progressive social and legislative measures undertaken by the central and state governments, large scale plantations and declaration (including proposals) of 11 National Parks and 32 sactuaries in Madhya Pradesh. However, for successful implementation of programs for maintenance of these Nature's conservatories for floristic diversity, public awareness and their wilful commitments to this august purpose is a necessity beyond doubts. The seeds have been sown and the future depends on the coming generations.

FLORISTIC DIVERSITY IN MADHYA PRADESH

Name of the family	Number of genera		Number of species	
	Madhya Pradesh	India	Madhya Pradesh	India
1	2	3	4	5
DICOTYLEDONS				
Ranunculaceae	4	28	9	193
Dilleniaceae	1	3	3	12
Magnoliaceae	2	3	2	24
Annonaceae	5	24	8	120
Menispermaceae	5	22	6	43
Berberidaceae	1	4	3	70
Nymphaeaceae	2	2	4	7
Papaveraceae	2	5	3	27
Brassicaceae	9	64	13	207
Capparaceae	4	7	16	55
Violaceae	2	3	3	41
Bixaceae (including Cochlospermaceae)	2	2	2	2
Flacourtiaceae	3	11	5	39
Pittosporaceae	1	1	1	11
Polygalaceae	2	4	14	31
Caryophyllaceae	6	28	8	126
Portulacaceae	1	2	3	8
Tamaricaceae	1	3	2	16
Elatinaceae	2	2	3	8
Hypericaceae (including Clusiaceae)	1	8	2	82
Theaceae	1	9	1	23
Dipterocarpaceae	1	5	1	30
Malvaceae	13	22	40	93
Bombacaceae	4	6	5	8
Sterculiaceae	10	19	12	68
Tiliaceae	3	8	23	53

1	2	3	4	5
Linaceae	2	4	4	9
Malpighiaceae	3	4	4	25
Zygophyllaceae (including Balanitaceae)	2	8	2	21
Geraniaceae	1	6	1	45
Oxalidaceae (including Averrhoaceae)	3	3	7	21
Balsaminaceae	1	1	3	200
Rutaceae	10	29	16	114
Simaroubaceae	1	8	1	15
Ochnaceae	1	4	2	6
Burseraceae	3	8	3	22
Meliaceae	8	23	9	97
Olacaceae	1	7	2	18
Opiliaceae	2	3	2	3
Celastraceae	3	13	7	67
Rhamnaceae	5	15	13	68
Vitaceae	4	10	6	94
Leeaceae	1	1	5	15
Sapindaceae	8	18	10	50
Sabiaceae	1	2	1	15
Anacardiaceae	7	22	8	71
Moringaceae	1	1	2	2
Fabaceae	61	133	196	973
Caesalpiniaceae	10	19	35	92
Mimosaceae	13	15	37	76
Rosaceae	4	40	4	432
Vahliaceae	1	1	1	2
Crassulaceae	1	10	2	71
Droseraceae	1	2	2	4
Haloragaceae	1	3	2	11
Callitrichaceae	1	1	1	6
Rhizophoraceae	1	8	1	18
Combretaceae	5	8	17	48
Myrtaceae	4	14	9	146

1	2	3	4	5
Lecythidaceae	2	5	2	13
Melastomataceae	4	21	6	150
Lythraceae	6	9	16	51
Punicaceae	1	1	1	1
Onagraceae	1	6	5	49
Trapaceae	1	1	1	3
Turneraceae	1	1	1	2
Passifloraceae	1	3	2	24
Caricaceae	1	1	1	2
Cucurbitaceae	14	39	29	99
Begoniaceae	1	1	2	55
Cactaceae	1	1	2	3
Aizoaceae	1	8	2	11
Molluginaceae	1	1	5	6
Apiaceae	15	72	20	288
Cornaceae	1	7	1	15
Rubiaceae	25	113	52	616
Asteraceae	62	166	106	803
Stylidiaceae	1	1	1	2
Campanulaceae	3	11	7	45
Plumbaginaceae	2	6	3	10
Primulaceae	3	10	6	183
Myrsinaceae	2	12	6	109
Sapotaceae	4	14	5	49
Ebenaceae	1	1	7	51
Symplocaceae	1	1	2	43
Oleaceae	5	10	20	99
Salvadoraceae	1	3	1	4
Apocynaceae	15	47	24	119
Asclepiadaceae	19	57	29	260
Loganiaceae	4	10	6	34
Buddlejaceae	1	1	2	10
Gentianaceae	6	22	17	188
Menyanthaceae	1	3	2	6
Polemoniaceae	1	1	1	1
Hydrophyllaceae	1	2	1	2

1	2	3	4	5
Boraginaceae	8	43	30	209
Convolvulaceae (including Cuscutaceae)	11	28	50	184
Solanaceae	11	17	27	75
Scrophulariaceae	26	62	69	368
Orobanchaceae	2	7	3	32
Lentibulariaceae	1	2	14	36
Gesneriaceae	4	24	4	114
Bignoniaceae	17	20	18	34
Pedaliaceae (including Martyniaceae)	2	2	2	4
Acanthaceae	38	92	103	500
Verbenaceae	18	25	35	145
Lamiaceae	20	72	62	435
Plantaginaceae	1	1	2	12
Nyctaginaceae	4	4	7	15
Amaranthaceae	13	20	27	60
Chenopodiaceae	1	23	3	69
Basellaceae	1	2	1	3
Phytolaccaceae	1	4	1	6
Polygonaceae	4	17	18	163
Podostemaceae	3	9	3	20
Aristolochiaceae	1	5	3	25
Piperaceae	2	3	3	100
Lauraceae	5	17	7	212
Proteaceae	1	2	1	7
Elaeagnaceae	1	2	1	19
Loranthaceae	3	9	7	49
Santalaceae	2	10	2	18
Euphorbiaceae	29	84	96	523
Urticaceae	10	27	17	151
Moraceae	6	13	33	122
Cannabaceae	1	2	1	2
Ulmaceae	3	6	6	22
Casuarinaceae	1	1	1	2
Salicaceae	2	2	2	64

1	2	3	4	5
Ceratophyllaceae	1	1	2	2
MONOCOTYLEDONS				
Hydrocharitaceae	5	9	7	18
Burmanniaceae	1	2	1	8
Orchidaceae	33	184	88	1229
Zingiberaceae	7	23	22	189
Costaceae	1	1	1	2
Marantaceae	1	6	2	14
Musaceae	1	2	1	25
Cannaceae	1	1	1	3
Iridaceae	1	5	1	21
Taccaceae	1	1	1	3
Dioscoreaceae	1	4	15	34
Liliaceae	16	54	34	249
Smilacaceae	1	2	2	33
Pontederiaceae	2	2	2	3
Xyridaceae	1	1	2	6
Commelinaceae	7	14	27	90
Juncaceae	1	2	2	53
Arecaceae	6	24	8	94
Pandanaceae	1	2	1	17
Typhaceae	1	1	1	3
Araceae	11	29	14	126
Lemnaceae	3	4	7	13
Alismataceae	3	6	5	14
Butomaceae	1	1	1	1
Najadaceae	1	1	4	14
Aponogetonaceae	1	1	2	8
Potamogetonaceae	1	1	6	18
Zannichelliaceae	1	1	1	1
Eriocaulaceae	1	1	13	70
Cyperaceae	11	38	131	545
Poaceae (including Bambusoideae)	102	264	252	1291

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Cultivation of sunflower

Dry deciduous forest

Sal mixed moist deciduous forest

Dry deciduous forest, Satna dist
(Courtesy : K.K. Khanna)

Sal forest

Vegetation along the bank of river Narmada

Little fall Panchmarhi : moist deciduous forest
(Courtesy : M.A. Siddiqui).

MAHARASHTRA

S. Karthikeyan
N.P. Singh
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Maharashtra state was part of Bombay Presidency during British Rule, subsequently it formed part of Bombay State. The present State of Maharashtra was formed on 1.5.1960. Its political boundary extends from Bombay to Gadchiroli and Dhule to Sindhudurg districts. It is about 800 km east-west and 700 km north-south, lying between 22° 1' 16° 4' N Latitude and 72° 6' - 80° 9' E Longitude, having an area of 3,07,690 sq km (Anonymous, 1991).

Its limits are Arabian sea on the west whose coast line extends upto 720 km; Goa and Karnataka on the south, Andhra Pradesh on the South-East, Madhya Pradesh on the north and Gujarat on the north-west. It is one of the largest states of Indian Union.

The state has four well demarcated regions viz., Vidarbha- the eastern Maharashtra, Desh or the central plateau of Deccan peninsula situated on the eastern side of Sahyadris (N.W. Ghats), Marathwada and Konkan, the narrow coastal strip to the west of 'Sahyadris'. The state has been divided into 30 districts.

Sahyadris vary in their height between 20-2000 m above m.s.l. from Parner Fort on Daman-Ganga to Bababudan hills in Karnataka through Savantwadi and Goa. They run north to south and are *ca* 750 km in Maharashtra. Desh is separated from Konkan by Sahyadris which is about 50-80 km broad.

The river valley system in 'Desh' are Narmada, Tapi, Purna, Wardha, Penganga, Godavari, Bhima and Krishna. They run from west to east forming four compartments of the state.

The Satmala range starts from Saptashringi hills and extends towards Daulatabad, Aurangabad and Manmad.

The second range of mountain is Balaghat range which starts from Harishchandragad in Ahmednagar district and extends upto Gulbarga through Bidar and Osmanabad.

The third mountain range is Shambu-Mahadev mountains.

The other major rivers in the state are Pravara, Pranahita, Ghatprabha, Damanganga, Tansa, Vaitarna and Ulhas. The principal smaller rivers are Amba, Kundalika, Savitri, Sastri, Vasishthi, Kajali, Muchkundi, Shuk, Gadnadi, Terekhol, etc.

Ninety percent of Maharashtra's geology is made up of Deccan traps, which are the dark rocks seen everywhere in Deccan. Another important formation is the Gondwanas seen in Bhandara, Chandrapur, Wardha, Wardha-Godavari-Pranahita valley and in Konkan. Small areas in Konkan have the Archeans.

Most of the soils are formed from the Deccan traps. They are black, dark brown or reddish in colour. In Nagpur, Bhandara and Chandrapur districts some soils are derived from Vindhyan and Gondwana formation. They form small areas of sandy or loamy soil.

The climate is monsoonal. Rainfall and humidity in Konkan and hill tops in Sahyadris are equable and suitable for plant growth. There is no extremes of hot or cold. It is a little hotter in Vidarbha, and quite hot in summer in Khandesh.

The rainfall is mostly due to S.W. monsoon. The Konkan and coastal regions get regularly about 2540 mm p.a., though much of the water goes to the sea. The highest rainfall in Vidarbha is 1736 mm at Dhanora in Chandrapur District. At Mahabaleshwar the rainfall rises to 6226.3 mm.

The temperature prevalent in Konkan is lowest due to the nearness of Arabian sea. In Highlands and hill tops in Sahyadris also, the temperature is low due to the altitude. The temperature in the whole state at different places normally vary from 10°C - 42.7°C.

All through Maharashtra, the humidity is low. Average mean humidity ranges between 56% - 74%.

The forest area recorded for Maharashtra State is 63,861 sq km which is *ca* 20.3% of its geographical area. The vegetation of Maharashtra can be classified into the following zones, viz.,Konkan strip adjacent to

Arabian sea; Sahyadris or N.W. Ghats; Desh forming a flat plain to east, with side off-shoots of ranges of Sahyadris; Khandesh at the north with low hills of Satpura and Vidarbha (Mahabale, 1987).

The vegetation of these zones differ due to factors like rainfall, temperature, humidity, type of soils and topography. The pattern of vegetation in these places is influenced by the vegetation of adjoining regions also, the plants from the Indo-Ganga plains reach as far as Khandesh, the Tapti and Narmada basins, and those fom Gujarat enter at the North; those from Malabar at the south reach south Konkan. The forests of Andhra Pradesh and Madhya Pradesh adjoin the forests of Chandrapur and Gadchiroli districts and vegetation of Khandesh gets mixed with that the South Gujarat and Madhya Pradesh.

The vegetation of low lying valleys of Sahyadris differ from that of higher altitudes because of climatic and edaphic factors. The flora of Maharashtra is considered to have formed part of ***'Dandakaranya'*** of ancient times.

Major regions of Maharashtra belong to the 'Deccan' as proposed by Hooker and Thomson (1885). The Deccan peninsula of which Maharashtra is a large part - is relatively a dry elevated tableland and it is a part of the most ancient Indian continental land mass - the Deccan peninsula. They have considered Konkan as part of Malabar.

The state of Maharashtra constitutes 30 districts which can be classified as follows

1.	Konkan	Bombay, Raigad*, Ratnagiri*, Sindhudurg* and Thane*.
2.	Desh or Deccan	Ahmednagar*, Kolhapur*, Nasik*, Pune*, Sangli*, Satara* and Sholapur.
3.	Khandesh	Dhule and Jalgaon.
4.	Marathwada	Aurangabad, Beed, Buldhana, Jalna, Latur, Nanded, Osmanabad and Parbhani.
5.	Vidarbha	Akola, Amaravati, Bhandara, Chandrapur, Gadchiroli, Nagpur, Wardha and Yavatmal.

The greater part of Deccan Tableland is nearly 610 m above m.s.l.

* Sahyadris run through these districts starting from Nasik down to Sindhudurg.

VEGETATION

As seen earlier, Maharashtra can be broadly classified into Konkan, Deccan, Marathwada and Vidarbha. Geographically Konkan and Desh can be segregated. The two are separated by Sahyadris which is running almost parallel to the west coast.

Konkan is a narrow strip, 27 - 48 km broad and about 800 km long which starts from Tapi basin down to Goa. It is a botanical subunit of Malabar province of Hooker and Thomson (1885). It is a maritime province, with high humidity throughout the year which is 60-70% at any time of the year. Throughout the year the vegetation is green, though the hills are barren. The average height of Konkan plains is 6-9 m above m.s.l. The higher peaks of adjoining Sahyadris which rise to nearly 1220 m in Mahabaleshwar and Harishchandragad serve as a wall to obstruct the clouds coming with S.W. monsoons and intercept them in 'ghats' or passes from west to east. The rainfall at the foot of Sahyadris on the Konkan side on an average is *ca* 2540 mm but it is less in the coastal region. The coastal strip of 15 17 km is a marshy saline bed due to the incoming of the Arabian sea. Only salt tolerant plants grow here. Konkan plains are full of cultivable lands where rice, ragi and other crops and vegetables are cultivated. Wherever rich alluvial deposits are found, Coconut, Arecanut, Mango, Nutmeg, Cashew, etc., are grown.

On the western side of Sahyadris, marshy conditions prevail only during monsoons, as soon as the rains are over, the soil becomes nearly dry because it is lateritic and the water flows away towards the sea.

But on the eastern side i.e. towards the Deccan side of the Sahyadris, the slope is gentle and ravines are deep. Small and large rivers bring rich detritus material from the traps to the valleys. Through the valleys, the rain water flows enriching the river banks and valleys. Consequently, the lateral spurs of Sahyadris having high humidity and good drainage have developed 'Shola' like vegetation. These are known as 'Mavals'.

As mentioned already, 'Konkan' comprises five districts viz., Bombay, Thane, Raigad, Ratnagiri and Sindhudurg. Konkan is part of Hooker's Malabar. The flora of Konkan has been studied by Hooker, Dalzell, Nairne, Cooke, Blatter, McCann, Almeida, Santapau, etc.

The flora of north Bombay is richer than that of S. Bombay. The flora of S. Ratnagiri has more humid species as in Goa, North Kanara and Malabar (Kulkarni, 1988). Dalgado (1896) has described the flora of Savantwadi. The flora of Raigad (Kothari and Moorthy, 1993), Ratnagiri (Almeida, S.M. 1983-86), Thane (Billore, 1972) and Savantwadi (Almeida, 1990) have been thoroughly explored.

The major rivers of Konkan region are Ulhas, Vashishthi, Kundalika, Shastri, Urali, Gad, Ter, etc. As they deposit rich alluvium on the banks and depressions, Coconut, betelnut and mangoes grow well here.

All along the coast line, there are tidal swamps and mudflats mostly covered by mangroves. *Avicennia marina*, *A. officinalis*, *Rhizophora mucronata* and *Sonneratia alba* are the common mangrove species. The associate species are *Acanthus ilicifolius*, *Aegiceras corniculatum*, *Avicennia alba*, *Bruguiera cylindrica*, *B. gymnorrhiza*, *B. parviflora*, *Cerbera manghas*, *Ceriops tagal*, *Excoecaria agallocha*, *Kandelia candel*, *Lumnitzera racemosa*, *Rhizophora apiculata*, *Sonneratia apetala*, *S. caseolaris*, etc. Behind them sandbinders and strand vegetation occur. Wherever the soils are sandy and the coast is not muddy *Aeluropus lagopoides*, *Cressa cretica*, *Cyperus bulbosus*, *Pandanus tectorius*, *Pedalium murex*, *Spinifex littoralis*, *Tribulus terrestris*, etc. occur.

There are semi evergreen forest pockets interspersed with *Tectona grandis*. There are a few pockets of evergreen forest in Sindhudurg but they are not continuous.

The strand vegetation present behind the tidal swamps, is in patches. Trees and shrubs such as *Calophyllum inophyllum*, *Clerodendrum inerme*, *Colubrina asiatica*, *Pandanus tectorius*, *Pongamia pinnata*, *Premna corymbosa*, *Thespesia populnea*, etc. are common. The commonly found climbers in these patches are *Canavalia virosa*, *Derris trifoliata*, *Ipomoea pes-caprae*, etc. The herbs prevalent here are *Cyperus squarrosus*, *Launaea procumbens*, *Neanotis rheedii*, *Perotis indica*, *Tricholepis glaberrima*, *Vernonia cinerea*, *Zoysia matrella*, etc.

Groves of *Cocos nucifera* fringe behind the coast line. *Hyphaene dichotoma* is found in patches in places like Alibag and Vasai. *Phoenix sylvestris* and *Areca catechu* are found in Thane, Uran, etc.

Plateau Vegetation at Lower Elevations or Plains

Vegetation is sparse in the undulating rocky plateaus in various places in 'Konkan'. *Acacia chundra, Buchanania lanzan, Carissa congesta, Flacourtia indica, Holarrhena pubescens, Maytenus senegalensis, Woodfordia fruticosa*, etc. occur here.

On low hills and slopes *Borassus flabellifer* is found in groups. Occasionally, *Crotalaria lutescens, Elephantopus scaber, Ixora coccinea, Sida rhomboidea*, etc. are intermixed. *Abrus precatorius, Aspidopterys cordata, Derris scandens, Gloriosa superba, Gymnema sylvestris, Hemidesmus indicus, Ichnocarpus frutescens, Wattakaka volubilis*, etc. are found to be climbing over some of these elements.

The most common species found along the riparian flora on the river banks of stony, sandy or alluvial soils are, *Barringtonia acutangula, B. racemosa, Homonoia riparia, Rotula aquatica, Tamarix dioica, T. ericoides, Vetiveria zizanioides*, etc.

Hydrophytes

About 279 species of hydrophytes occur along streams, ponds, lakes and other water sources in Maharashtra (Karthikeyan *et al.* 1982). Some of the common species are *Aeschynomene aspera, Bergia ammannioides, Cryptocoryne retrospiralis, Eriocaulon sharmae, Ludwigia adscendens, Monochoria vaginalis, Neptunia oleracea, Nymphaea pubescens, Oryza rufipogon. Rotala densiflora. Trapa natans* var. *bispinosa, Vallisneria spiralis*, etc.

Grasslands

Grasslands occur from Raita near Kalyan, Bhivandi to Palghar, Dahanu and Umbargaon. Poaceae is the dominant family. The common grasses are *Arthraxon hispidus, Bothriochloa pertusa, Capillipedium huegelii, Dichanthium annulatum, Echinochloa colonum, Heteropogon contortus, Iseilema laxum, Jansenella griffithiana, Saccharum spontaneum* and *Themeda cymbaria*, etc.

Weeds

In the cultivated fields, a large number of weeds are found. Some of the common weeds are *Ageratum conyzoides, Coldenia procumbens, Dentella repens, Goniogyna hirta, Vernonia cinerea,* etc.

Scrub forest

Along foot hills and lower elevations where the soil is usually lateritic and gravelly, scrub jungles thrive. *Maytenus senegalensis* is the prominent species here.

The common species occurring in this type are *Acacia chundra, A. nilotica, Barleria prionitis, Capparis divaricata, Dichrostachys cinerea, Eranthemum roseum, Flacourtia indica, Hemigraphis latebrosa, Justicia diffusa, Rungia repens,* etc.

Dry deciduous forest

With altitudes going higher up and improved soil type which retains more moisture, there is a perceptible change in the vegetation and the scrub jungles yield to elements of dry deciduous type. Trees start appearing. *Tectona grandis* grows luxuriantly. *Acacia chundra, Anogeissus latifolia, Bombax ceiba, Cassia fistula, Dalbergia latifolia, Gmelina arborea, Haldina cordifolia, Holarrhena pubescens, Lagerstroemia parviflora, Lannea coromandelica, Mitragyna parvifolia, Terminalia chebula, T. crenulata, T. paniculata, Wrightia tinctoria, Ziziphus mauritiana,* etc. are the common small and large trees.

Shrubs and climbers are also represented abundantly. Some common species are *Abrus precatorius, Aspidopterys cordata, Carissa congesta, Celastrus paniculatus, Derris scandens, Dioscorea bulbifera, Helicteres isora, Ichnocarpus frutescens, Maytenus rothiana, Wattakaka volubilis, Woodfordia fruticosa, Ziziphus oenoplia,* etc.

The most common herbs and undershrubs include, *Apluda mutica, Cymbopogon martinii, Dichanthium annulatum, Digitaria ciliaris, Elephantopus scaber, Eragrostis unioloides, Flemingia strobilifera, Heteropogon contortus, Naregamia alata, Schima nervosum, Themeda triandra,* etc.

Tropical moist deciduous forest

Still higher elevations coupled with better and richer soil and rainfall create conditions suitable for tropical moist deciduous forest. The common trees occurring here are *Albizia chinensis, Canthium dicoccum, Catunaregam spinosa, Dillenia pentagyna, Ficus racemosa, Glochidion hohenackeri, Hymenodictyon obovatum, Macaranga peltata, Mallotus philippensis, Meyna laxiflora, Syzygium cumini,* etc.

In many places distinct communities of *Ligustrum perrottetii* and *Wendlandia thyrsoidea* have been found to occur.

The common shrubs include *Callicarpa tomentosa, Canthium rheedii, Grewia abutilifolia, Leea asiatica,* etc.

Some of the climbers which occur commonly here are *Clematis gouriana, Combretum ovalifolium, Jasminum malabaricum, Mucuna monosperma, Stephania japonica, Ziziphus rugosa,* etc.

The herbs and undershrubs prevalent here include *Adenostemma lavenia, Alysicarpus bupleurifolius, Carvia callosa, Crotalaria retusa, Desmodium laxiflorum, Ecbolium ligustrinum,* etc.

Some common epiphytes met with include, *Aerides crispum, Drynaria quercifolia, Eria microchilos, Impatiens acaulis, Oberonia recurva, Vanda tessellata,* etc.

Parasites, saprophytes and insectivorous plants are also abound in these forest. Some of them are *Aeginetia indica, Balanophora fungosa* ssp. *indica, Dendrophthoe falcata, Drosera indica, Tolypanthus lageniſer, Utricularia caerulea, U. graminifolia, U. reticulata, U. striatula, U. uliginosa, Viscum articulatum,* etc.

Montane subtropical evergreen forest

The evergreen forest that occur in the N.W. Ghats of Maharashtra are not typical evergreen forest, (Qureshi, 1965). As the trees tend to be dwarfish without any tiers, or canopies of tropical elements they are classified as montane subtropical evergreen forest.

The common trees found in these forest are *Actinodaphne angustifolia, Elaeocarpus serratus, Garcinia indica, Holigarna grahamii, Knema attenuata, Lagerstroemia microcarpa, Litsea stocksii, Memecylon umbellatum, Mesua ferrea, Neolitsea cassia, Persea macrantha, Polyalthia fragrans, Prunus ceylanica, Symplocos racemosa, Syzygium laetum, Vitex altissima*, etc.

Small trees or shrubs such as *Actephila indica, Blachia denudata, Dichapetalum gelonioides, Euodia lunu-ankenda, Euonymus indicus, Ixora nigricans, Meiogyne pannosa, Pavetta tomentosa, Psychotria dalzellii*, etc. are commonly found.

Some of the climbers or scandent shrubs occurring here are *Ancistrocladus heyneanus, Arnicratea grahamii, Dalbergia volubilis, Elaeagnus conferta, Embelia viridiflora, Luvunga eleutherandra, Naravelia zeylanica, Paramignya monophylla, Toddalia asiatica, Ventilago madraspatana*, etc.

Some epiphytes are *Aerides dalzelliana, Aeschynanthus perrottetii, Bulbophyllum fimbriatum, Cymbidium aloifolium, Dendrobium barbatulum, Hoya wightii, Piper trichostachyon, Porpax jerdoniana*, etc.

Some of the common parasites are *Dendrophthoe trigona, Helicanthus elastica, Helixanthera wallichiana, Macrosolen capitellatus, Scurrula philippensis, Taxillus cuneatus, Viscum angulatum, V. monoicum*, etc.

The herbaceous flora is highly rich. Some of these are *Anisomeles heyneana, Costus speciosus, Delphinium malabaricum, Exacum bicolor, Flemingia congesta, Gynura cusimbua, Impatiens kleinii, Leucas ciliata, Neanotis calycina, Pecteilis susannae. Thalictrum dalzellii, Urena lobata*, etc.

Ensete superbum grows in the screes.

Ferns and Fern-Allies

Lycopodium hamiltonii grows on trees along with *Selaginella delicatula, S. panchganiana*, etc. Some of the other common ferns are *Adiantum philippense, Asplenium indicum, Athyrium hohenackerianum, Cheilanthes albomarginatus, Leucostegia immersa, Microsorium membranaceum, Pteris biaurita, P. quadriaurita, Tectaria macrodonta*, etc.

Flora of Deccan or 'Desh'

The region to the east of Sahydris lying between rivers Krishna, Bhima, Sina and Godavari is known as 'Desh' or Deccan, comprising seven districts viz., Kolhapur, Sangli, Satara, Pune, Nasik, Ahmednagar and Sholapur. The area of 'Desh' is approximately 565 sq km. Climate is hot and dry and the rainfall is irregular. Consequently the vegetation is of dry deciduous type.

The highest peaks of Sahyadris such as, Kalsubai (1646 m) (Lakshminarasimhan and Sharma, 1991) Harishchandragad (1424 m) and Mahabaleshwar (1438 m) (S.D. Deshpande *et al.* 1993 and 1995) are in Deccan. In Radhanagari, Kolhapur, the vegetation is 'semi evergreen' Trees like *Amoora lawii, Cinnamomum zeylanicum, Elaeocarpus oblongus, Ficus glomerata, Garcinia indica, Holigarna grahamii, Lagerstroemia parviflora,* etc. occur. Shrubs such as *Cnidia glauca, Crotalaria retusa, Leea macrophylla, Maytenus rothiana,* etc. are found. Grasses such as *Apluda mutica, Aristida adscensionis, Brachiaria reptans, Chrysopogon fulvus, Dichanthium annulatum, Dinebra retroflexa, Eragrostis unioloides, Ischaemum pilosum, Leptochloa cinensis, Ophiuros exaltatus, Panicum psilopodium, Setaria pumila, Themeda quadrivalvis,* etc. are common. *Capparis moonii, Clematis gouriana* and *Gnetum ula* are some of the common climbers of these areas. *Calamus pseudotenuis, Calycopteris floribunda, Piper hookeri,* etc. are also found. Some of the common herbs include *Abelmoschus manihot* ssp. *tetraphyllus, Ammannia baccifera, Boerhavia diffusa, Caesulia axillaris, Cardamine trichocarpa, Cleome viscosa, Corchorus aestuans, Cyperus rotundus, Echinops echinatus, Euphorbia hirta, Heliotropium indicum, Impatiens balsamina, Lavandula bipinnata, Lepidagathis cristata, Ludwigia perennis, Melochia corchorifolia, Polygala arvensis, Portulaca oleracea, Sida mysorensis, Solanum surattense, Sopubia delphinifolia,* etc.

'Dev-Rais' or sacred groves

These are relics of conserved natural forests, generally composed of trees and are found in Western ghats, thanks largely to the faith and reverence man has got for God (Gadgil and Vartak, 1976, 1981), Vartak (1983), Vartak and Gadgil (1981) and Sharma and Kulkarni (1980). The removal of any plant material or killing any animal from the sacred grove is taboo. The climax type of vegetation here exhibits a diversity in species. There are *ca* 250 such 'Dev-Rais' all along the Western Ghats. Most

of them contain a small number of montane subtropical evergreen, moist deciduous and some dry deciduous elements which are rare or threatened.

Flora of Marathwada

The region covered by the districts, Aurangabad, Beed, Buldhana, Jalna, Latur, Nanded, Osmanabad and Parbhani is known as 'Marathwada' This region is more dry than Deccan. The rainfall is uncertain and is for a short duration. The flora has got elements which are available in adjoining Nasik district and also from Telengana of Andhra Pradesh which forms the border on the eastern side. The vegetation is of dry deciduous type, characterised by *Anogeissus latifolia, Boswellia serrata, Dalbergia latifolia, Tectona grandis, Terminalia chebula,* etc. Presence of *Capparis horrida, Cochlospermum gossypium, Flacourtia montana,* etc. also show that the region is quite dry and hot.

There are low hills along the Ajantha caves, which are famous for their paintings. However, they are also covered by only dry deciduous flora. Herbaceous flora is more. Trees such as *Anogeissus latifolia, Dalbergia latifolia, D. paniculata, Haldina cordifolia, Spermadictyon suaveolens, Terminalia arjuna, T. chebula, T. paniculata,* etc. are sporadic.

The common herbs include *Achyranthes aspera, Aeschynomene indica, Alysicarpus bupleurifolius, Argemone mexicana, Bergia ammannioides, Celosia argentea, Chrozophora prostrata, Cleome simplicifolia, Commelina benghalensis, Fimbristylis dichotoma, Glossocardia bosvallea, Hemigraphis latebrosa, Justicia prostrata, Kyllinga tenuifolia, Leucas aspera. Martynia annua. Polygala persicariaefolia. Polygonum plebeium. Sida acuta, Triumfetta rhomboidea, Zeuxine strateumatica,* etc. Grasses like *Alloteropsis cimicina, Aristida adscensionis, Brachiaria ramosa, Cenchrus ciliaris, Chrysopogon fulvus, Dichanthium foveolatum, Dinebra retroflexa, Eragrostis viscosa, Ischaemum rugosum, Panicum repens,* etc. are also found here.

The characteristic plants of this region are *Balanites aegyptiaca, Cadaba fruticosa, Capparis divaricata, Commiphora wightii, Erythroxylon monogynum, Ficus virens, Hardwickia binata, Leea asiatica, Litsea monopetala, Phyllanthus reticulatus, Prosopis cineraria, Smilax ovalifolia, Ventilago denticulata, Ziziphus nummularia,* etc.

Flora of Vidarbha

Akola, Amaravati, Bhandara, Chandrapur, Gadchiroli, Nagpur, Wardha and Yavatmal are the districts which form 'Vidarbha' The major rivers of this region are Wardha, Penganga, Katepurna and Purna. The vegetation is dry deciduous with occasional patches of moist deciduous species. *Tectona grandis* plantations are found in almost all districts. *Anogeissus latifolia* and *Haldina cordifolia* occur throughout (Karthikeyan and Anandkumar, 1993). In Chandrapur and Gadchiroli the vegetation is comparatively rich as the flora of Bastar district influence it. The growth of teak is luxuriant.

Nagpur is famous for its oranges throughout India. The climate of this region is hot and dry (Kamble and Pradhan, 1988). The common trees of this region are *Acacia leucophloea, Aegle marmelos, Anogeissus latifolia, Bombax ceiba, Boswellia serrata, Bridelia retusa, Buchanania lanzan, Diospyros melanoxylon, Phyllanthus emblica, Lagerstroemia parviflora. Madhuca longifolia* var. *latifolia. Mallotus philippensis, Mitragyna parvifolia, Nyctanthes arbor-tristis, Semecarpus anacardium, Soymida febrifuga, Strychnos potatorum, Tectona grandis, Terminalia alata. T. arjuna. T. bellirica*, etc.

Small trees include *Acacia pinnata, Bauhinia purpurea, Butea monosperma, Cassia fistula, Cassine glauca, Chloroxylon swietenia, Eriolaena hookeriana, Morinda pubescens, Wrightia tinctoria* ssp. *rothii, Ziziphus mauritiana, Z. xylopyrus*, etc.

Some common shrubs and undershrubs of this region are *Abutilon indicum, Aeschynomene indica, Baliospermum montanum, Barleria prionitis, Calotropis gigantea, Crotalaria hirta, Dichrostachys cinerea, Echinops echinatus, Grewia abutilifolia, Maytenus senegalensis, Mimosa hamata, Sida mysorensis*, etc.

Some of the common climbers, both herbaceous and shrubby consist, *Basella rubra. Butea superba. Cajanus platycarpus. Canavalia virosa, Capparis zeylanica, Cardiospermum halicacabum, Cayratia trifolia, Cissus vitiginea, Clitoria ternatea, Coccinia grandis, Cocculus hirsutus, Ctenolepis garcinii, Dioscorea bulbifera, Diplocyclos palmatus, Gloriosa superba, Hemidesmus indicus, Ipomoea hederifolia, I. obscura, I. pestigridis, Jacquemontia paniculata, Momordica dioica, Mucuna pruriens, Mukia maderaspatana, Paracalyx scariosa, Pergularia daemia, Rivea*

hypocrateriformis, Teramnus labialis, Tinospora cordifolia, Trichosanthes cucumerina, Vigna aconitifolius, etc.

The herbs which occur frequently are *Acalypha malabarica, Ammannia multiflora, Andrographis paniculata, Biophytum sensitivum, Boerhavia diffusa, Caesulia axillaris, Cyathocline purpurea, Desmodium gangeticum, Dicliptera verticillata, Emilia sonchifolia, Evolvulus alsinoides, Exacum pedunculatum, Fimbristylis complanata, Indigofera cordifolia, Polygonum glabrum, Rungia elegans, Sida spp., Tridax procumbens, Vicoa indica*, etc. *Neanotis lancifolia, N. montholoni* and *Orthosiphon pallidus* occur sparsely (Malhotra and Moorthy, 1992). Grasses occur in plenty here. Some representatives are *Alloteropsis cimicina, Andropogon pumilus, Apluda mutica, Aristida redacta, Arthraxon hispidus, Brachiaria eruciformis, B. reptans, Chionachne koenigii, Chloris virgata, Chrysopogon fulvus, C. polyphyllus, Coix lacryma-jobi, Cymbopogon martinii, Cynodon dactylon, Dactyloctenium aegyptium, Dichanthium annulatum, Eragrostis japonica, Heteropogon contortus, Ischaemum rugosum, Melanocenchris jacquemontii, Oryza rufipogon, Panicum psilopodium, Sehima nervosum, Thelepogon elegans, Urochloa panicoides, Vetiveria zizanioides*, etc.

Cuscuta reflexa and *Dendrophthoe falcata* are common parasites.

A variety of cereals (*Hordeum vulgare, Oryza sativa, Setaria italica*, etc.), pulses (*Cajanus cajan, Lablab purpureus, Pisum sativum, Vigna* spp. etc.), oil seeds (*Arachis hypogoea, Brassica* spp., *Sesamum*, etc.) and a host of vegetables (*Brassica* spp.), condiments (*Phyllanthus emblica*), narcotics (*Nicotiana tabacum*), fruits and *Saccharum officinarum* are being cultivated here.

Consequently we find a lot of weed species in these cultivated fields. Mention may be made of *Acalypha indica, Biophytum sensitivum, Celosia argentea, Digera muricata, Euphorbia prostrata, Gomphrena celosioides, Hyptis suaveolens, Indigofera trita, Justicia prostrata, Kohautia aspera, Leucas aspera, Mollugo pentaphylla, Neanotis lancifolia, Oxalis corniculata, Psoralea corylifolia, Rungia repens, Saccharum spontaneum, Tribulus terrestris, Vaccaria pyramidata*, etc.

There are a number of rivers, tanks, rivulets, freshwater ponds and marshy areas in this region where a number of aquatic species grow. The most common species are *Aeschynomene indica, Bacopa monnieri*.

Caesulia axillaris, Dopatrium junceum, Eclipta prostrata, Fuirena wallichiana, Glossostigma diandrum, Hygrophila auriculata, Iseilema laxum, Justicia quinqueangularis var. *peploides, Ludwigia perennis, Monochoria vaginalis, Paspalum scrobiculatum, Rotala indica, Schoenoplectus litoralis, Typha angustifolia, Utricularia caerulea,* etc.

Interesting plants recorded from Vidarbha

Acalypha lanceolata, Alectra parasitica, A. thompsoni, Allmania nodiflora var. *dichotoma, Ampelocissus tomentosa, Arthraxon lanceolatus* var. *echinatus, Brachiaria remota, Bridelia montana, Canscora sessiliflora, Chlorophytum arundinaceum, Chrysanthellum indicum, Cleome aspera, C. felina, Crotalaria acicularis, C. hirta, C. laburnifolia, Datura ferox, Dentella serpyllifolia, Desmodium brachystachyum, Dimeria connivens, Distemon indicum, Eragrostis coarctata, Fimbristylis sieberiana, Flemingia nana, Hedyotis coerulea, H. ovalifolia, H. umbellata, Heliotropium strigosum, Indigofera constricta, Ipomoea petaloidea, I. sindica, Lasia heterophylla, Mnesithea laevis, Orthosiphon rubicundus, Osbeckia zeylanica, Pancratium longiflorum, Paspalum distichum, Schoenoplectus litoralis, Scleria parvula, Themeda laxa, Theriophonum minutum, Uraria alopecuroides* and *Utricularia scandens.*

FLORISTIC DIVERSITY

The comprehensive Flora of Maharashtra as such has not been compiled so far. The most important work available dealing with Flora of Maharashtra is Cooke's Flora of the Presidency of Bombay (1901-1908). Talbot (1909 and 1911) also has studied the region thoroughly and supplemented Cooke's work.

The major lacuna in Cooke's Flora is that some regions of present day Marathwada and Vidarbha have not been included. He has described 147 families, 999 genera, 2513 species and 162 varieties. The former Bombay Presidency included parts of Gujarat, Maharashtra, Goa, Karnataka and Sind. Even up to 1978, 7 genera, 715 species, 4 subspecies, 104 varieties and 5 forma have been added to Cooke's Flora (Karthikeyan, *et al.* 1981). It has been estimated that at present the Flora of Maharashtra is composed of 181 families, 1082 genera and 3225 species which occur in wild. About 827 cultivated species have been recorded from the state. Of these 3225 wild species, 963 are monocots (Lakshminarasimhan, 1996).

The statistical analysis of the Flora of Maharashtra is presented in table I below, wherein the number of genera and species in Maharashtra are furnished familywise and are also compared with those of India. This table also shows that there are 42 families with one genus and 1 species only, 37 families with one genus and varying number of species i.e., from 2-40, 27 families with 2 genera and species varying from 2-9, 6 families with 3 genera and 3-26 species, 11 families with 4 genera and 4-26 species, 10 families with 5 genera and 6-36 species, 4 families with 6 genera and 7-17 species, 5 families with 7 genera and 10-46 species, 5 families with 8 genera and 9-24 species, 4 families with 9 genera and 17-34 species, another 4 families with 10 genera and 12-28 species, one family with 11 genera and 21 species, 3 families with 12 genera and 24-34 species, another 3 families with 14 genera and 17-29 species, 2 families with 15 genera and 57-61 species, another 2 families with 16 genera and 22-69 species and the remaining 12 families have both genera and species varying from 8-110 and 39-376 respectively.

Table I
Floristic Analysis

Name of the family	No. of genera in		No. of Species in	
	India	Maha-rashtra	India	Mahar-rashtra
DICOTS				
Ranunculaceae	28	4	193	11
Dilleniaceae	3	1	12	3
Magnoliaceae	3	1	24	1
Annonaceae	24	8	120	13
Menispermaceae	22	8	43	10
Nymphaeaceae	2	1	7	3
Nelumbonaceae	1	1	1	1
Papaveraceae	5	1	27	1
Fumariaceae	5	1	67	1
Brassicaceae	64	8	207	9
Capparaceae	7	5	55	28
Resedaceae	3	1	5	1

Name of the family	No. of genera in		No. of Species in	
	India	Maha-rashtra	India	Mahar-rashtra
Violaceae	3	2	41	2
Bixaceae (Incl. Cochlospermaceae)	2	1	2	1
Flacourtiaceae	11	5	39	11
Pittosporaceae	1	1	11	2
Polygalaceae	4	2	31	9
Xanthophyllaceae	1	1	4	1
Caryophyllaceae	28	10	126	12
Portulacaceae	2	2	8	4
Tamaricaceae	3	1	16	3
Elatinaceae	2	2	8	6
Clusiaceae	8	5	82	12
Theaceae	9	1	23	1
Dipterocarpaceae	5	2	30	2
Ancistrocladaceae	1	1	4	1
Malvaceae	22	15	93	61
Bombacaceae	3	1	5	2
Sterculiaceae	19	11	68	21
Tiliaceae	8	5	53	36
Elaeocarpaceae	2	1	33	9
Linaceae	4	3	9	3
Erythroxylaceae	1	1	6	1
Malpighiaceae	4	3	25	7
Zygophyllaceae (incl. Balanitaceae)	8	4	21	6
Geraniaceae	6	2	45	3
Oxalidaceae	3	2	21	9
Tropaeolaceae	1	1	1	1
Balsaminaceae	1	1	200	24
Rutaceae	29	14	114	20

Name of the family	No. of genera in		No. of Species in	
	India	Maha-rashtra	India	Mahar-rashtra
Simaroubaceae	8	2	15	3
Ochnaceae	4	2	6	4
Burseraceae	8	4	22	4
Meliaceae	23	14	97	17
Dichapetalaceae	1	1	5	1
Olacaceae	7	2	18	3
Opiliaceae	3	1	3	1
Icacinaceae	12	2	22	2
Aquifoliaceae	1	1	25	1
Celastraceae	13	10	67	21
Rhamnaceae	15	8	68	24
Vitaceae	10	4	94	26
Leeaceae	1	1	15	5
Sapindaceae	18	8	50	12
Staphyleaceae	2	1	4	1
Sabiaceae	2	1	15	1
Anacardiaceae	22	10	71	13
Moringaceae	1	1	2	1
Connaraceae	4	2	14	4
Leguminosae (*s.l.*)	167	72	1141	345
Rosaceae	40	2	432	4
Vahliaceae	1	1	2	1
Crassulaceae	10	2	71	8
Droseraceae	2	1	4	2
Haloragaceae	3	1	11	2
Rhizophoraceae	8	5	18	8
Combretaceae	8	6	48	17
Myrtaceae	14	1	146	13
Lecythidaceae (incl.Barringtoniaceae)	5	2	13	3

Name of the famiiy	No. of genera in		No. of Species in	
	India	Maha-rashtra	India	Mahar-rashtra
Melastomataceae	21	4	150	10
Lythraceae	9	5	51	25
Sonneratiaceae	2	1	4	2
Onagraceae	6	1	49	7
Trapaceae	1	1	3	1
Turneraceae	1	1	2	1
Passifloraceae	3	1	24	1
Cucurbitaceae	39	18	99	39
Begoniaceae	1	1	55	7
Datiscaceae	2	1	2	1
Cactaceae	1	1	3	2
Aizoaceae	8	4	11	5
Molluginaceae	1	2	6	6
Apiaceae	72	9	288	17
Araliaceae	17	2	69	3
Alangiaceae	1	1	7	2
Mastixiaceae	1	1	7	1
Rubiaceae	113	38	616	92
Asteraceae	166	60	803	143
Goodeniaceae	1	1	2	1
Campanulaceae (incl. Lobeliaceae)	11	4	45	7
Sphenocleaceae	1	1	1	1
Plumbaginaceae	6	2	10	2
Primulaceae	10	1	183	2
Myrsinaceae	12	4	109	6
Sapotaceae	14	7	49	10
Ebenaceae	1	1	51	12
Symplocaceae	1	1	43	2

Name of the family	No. of genera in		No. of Species in	
	India	Maha-rashtra	India	Mahar-rashtra
Oleaceae	10	6	99	14
Salvadoraceae	3	2	4	2
Apocynaceae	47	16	119	22
Asclepiadaceae	57	27	260	68
Loganiaceae	10	4	34	7
Buddlejaceae	1	1	10	1
Gentianaceae	22	7	188	27
Menyanthaceae	3	1	6	4
Hydrophyllaceae	2	1	2	1
Boraginaceae	43	9	209	34
Convolvulaceae	28	16	184	69
Cuscutaceae	1	1	15	6
Solanaceae	17	7	75	26
Scrophulariaceae	62	25	368	71
Orobanchaceae	7	4	32	5
Lentibulariaceae	2	1	36	14
Gesneriaceae	24	4	114	7
Bignoniaceae	20	6	34	7
Pedaliaceae	2	2	4	3
Martyniaceae	1	1	1	1
Acanthaceae	92	45	500	149
Verbenaceae (incl. Avicenniaceae and Symphoremataceae)	25	14	145	29
Lamiaceae	72	23	435	76
Plantaginaceae	1	1	12	1
Nyctaginaceae	4	2	15	6
Amaranthaceae	20	12	60	34
Chenopodiaceae	23	5	69	9
Basellaceae	2	1		1

Name of the family	No. of genera in		No. of Species in	
	India	Maha-rashtra	India	Mahar-rashtra
Phytolaccaceae	4	1	6	1
Polygonaceae	17	3	163	26
Podostemaceae	9	5	20	6
Aristolochiaceae	5	2	25	3
Piperaceae	3	3	100	5
Myristicaceae	5	2	25	3
Lauraceae	17	9	212	19
Hernandiaceae	3	1	9	1
Thymelaeaceae	14	1	23	1
Elaeagnaceae	2	1	19	1
Loranthaceae	9	7	49	18
Viscaceae	4	1	21	5
Santalaceae	10	2	18	2
Balanophoraceae	3	1	8	3
Euphorbiaceae	84	37	523	118
Ulmaceae	6	3	22	6
Urticaceae	27	12	151	24
Cannabaceae	2	1	2	1
Moraceae	13	5	122	29
Salicaceae	2	1	64	2
Ceratophyllaceae	1	1	2	2
MONOCOTS				
Hydrocharitaceae	9	6	18	9
Burmanniaceae	2	1	8	3
Orchidaceae	184	35	1229	114
Zingiberaceae	23	10	189	28
Costaceae	1	1	2	1
Marantaceae	6	2	14	2

Name of the family	No. of genera in		No. of Species in	
	India	Maha-rashtra	India	Mahar-rashtra
Musaceae	2	2	25	3
Taccaceae	1	1	3	2
Agavaceae	2	1	18	1
Dioscoreaceae	4	1	34	10
Liliaceae (incl. Hypoxidaceae and Amaryllidaceae)	54	15	249	57
Smilacaceae	2	1	33	3
Pontederiaceae	2	2	3	3
Xyridaceae	1	1	6	2
Commelinaceae	14	7	90	46
Flagellariaceae	1	1	1	1
Juncaceae	2	1	53	1
Arecaceae	24	7	94	15
Pandanaceae	2	1	17	2
Typhaceae	1	1	3	2
Araceae	29	12	126	27
Lemnaceae	4	3	13	5
Alismataceae	6	4	14	5
Butomaceae	1	1	1	1
Aponogetonaceae	1	1	8	5
Potamogetonaceae	1	1	18	4
Najadaceae	1	1	14	3
Zannichelliaceae	1	1	1	1
Ruppiaceae	1	1	1	1
Eriocaulaceae	1	1	70	40
Hydatellaceae	1	1	1	1
Cyperaceae	38	22	545	169
Poaceae	264	110	1291	376

A family wise list of cultivated species in Maharashtra is furnished (Table II), while the 10 largest families according to number of genera and species is given in Table III and IV respectively.

Table II
Cultivated species

Family	Species	Family	Species
Dicots		Oxalidaceae	1
Ranunculaceae	1	Averrhoaceae	2
Magnoliaceae	1	Rutaceae	13
Annonaceae	5	Meliaceae	5
Menispermaceae	1	Celastraceae	1
Papaveraceae	1	Rhamnaceae	2
Brassicaceae	10	Vitaceae	1
Capparaceae	1	Sapindaceae	4
Violaceae	2	Anacardiaceae	1
Bixaceae	1	Moringaceae	1
Flacourtiaceae	2	Fabaceae	37
Pittosporaceae	1	Caesalpiniaceae	31
Polygalaceae	1	Mimosaceae	16
Caryophyllaceae	3	Rosaceae	19
Portulacaceae	3	Hydrangeaceae	2
Clusiaceae	3	Crassulaceae	2
Theaceae	2	Combretaceae	4
Malvaceae	21	Myrtaceae	32
Bombacaceae	2	Lythraceae	2
Sterculiaceae	11	Sonneratiaceae	1
Linaceae	1	Punicaceae	1
Erythroxylaceae	1	Onagraceae	2
Malpighiaceae	5	Passifloraceae	9
Zygophyllaceae	1	Caricaceae	1
Geraniaceae	1	Cucurbitaceae	16

Family	Species	Family	Species
Begoniaceae	3	Chenopodiaceae	2
Cactaceae	4	Polygonaceae	4
Aizoaceae	1	Aristolochiaceae	5
Apiaceae	11	Piperaceae	5
Araliaceae	5	Myristicaceae	1
Caprifoliaceae	2	Lauraceae	1
Rubiaceae	18	Proteaceae	2
Asteraceae	66	Euphorbiaceae	21
Lobeliaceae	1	Urticaceae	2
Plumbaginaceae	2	Moraceae	13
Myrsinaceae	2	Casuarinaceae	2
Sapotaceae	4	**Monocots**	
Oleaceae	9		
Apocynaceae	22	Zingiberaceae	4
Asclepiadaceae	8	Heliconiaceae	2
Periplocaceae	2	Strelitziaceae	1
Buddlejaceae	2	Bromeliaceae	1
Boraginaceae	3	Marantaceae	1
Convolvulaceae	15	Cannaceae	3
Solanaceae	35	Musaceae	1
Scrophulariaceae	9	Hypoxidaceae	1
Gesneriaceae	9	Amaryllidaceae	6
Bignoniaceae	23	Agavaceae	13
Pedaliaceae	1	Alliaceae	3
Acanthaceae	23	Liliaceae	5
Verbenaceae	24	Commelinaceae	3
Lamiaceae	17	Arecaceae	41
Plantaginaceae	3	Araceae	9
Nyctaginaceae	3	Cyperaceae	1
Amaranthaceae	3	Poaceae	57

Table III
Ten largest families of flowering plants
According to number of Genera

Sl.No.	Family	No. of genera
1.	Poaceae	110
2.	Fabaceae (Leguminosae)	72
3.	Asteraceae	60
4.	Acanthaceae	45
5.	Rubiaceae	38
6.	Euphorbiaceae	37
7.	Orchidaceae	35
8.	Asclepiadaceae	27
9.	Scrophulariaceae	25
10.	Lamiaceae	23

Table IV
Ten largest families of flowering plants
According to number of species

Sl.No.	Family	No. of species
1.	Poaceae	376
2.	Fabaceae (Leguminosae)	345
3.	Cyperaceae	169
4.	Acanthaceae	149
5.	Asteraceae	143
6.	Euphorbiaceae	118
7.	Orchidaceae	114
8.	Rubiaceae	92
9.	Lamiaceae	76
10.	Scrophulariaceae	71

PHYTOGEOGRAPHY

The flora of Maharashtra is heterogeneous in composition. The Deccan traps continue into Madhya Pradesh and Gujarat through Khandesh. The flora of regions such as Nag-region formed by Nagpur, Bhandara, Chandrapur and Gadchiroli ditricts, the plateau of Vidarbha composed by Wardha, Amaravati, Yavatmal, Akola and Buldhana districts and the ten districts of Maharashtra such as Raigad, Ratnagiri, Sindhudurg, Thane, Ahmednagar, Kolhapur, Nasik, Pune, Sangli and Satara with some part of Sahyadris, and the long, narrow, coastal strip of Konkan running through the districts of Bombay, Thane, Raigad, Ratnagiri and Sindudurg differ because the physiography, climate and soil conditions are different.

The flora of Malabar is met with in coastal Konkan. The plants from the Vindhyan and Indo-Gangetic plains meet those in Khandesh and in Narmada basin. There is similarity between the plants of Maharashtra, Madya Pradesh and South Gujarat.

The rainfall and humidity progressively increase towards south and west. As a result, Sahyadri regions in Karnataka have a rich vegetation of moist deciduous species and some evergreen species which do not occur in Maharashtra.

There is a strange resemblance between the flora of Assam and flora of Maharashtra as illustrated by grasses. One of the reasons for this, is, because of soils and due to migration of species along Garo hills, Vindhyas, Satpuras down to Malabar through Sahyadris. This forms a route for migration of species from Malaya - Burma - Assam - Garo - Vindhyan - Satpuras - Konkan - Malabar (Mahabale, 1987). This is evidenced by the occurrence of species like *Lilium nilgirense*, which grow in E. Himalayas as well as Nilgiris. The Satpura Hypothesis explains the migration of species across the continent of India from East to West and from there to South through Satpuras. The Junagadh hills, Girnar Parvat and Barda - dongar have species akin to those in dry parts of Deccan of Maharashtra. The flora of Saurashtra resemble the flora in deciduous forests of Deccan and that in drier parts of Konkan like Deogad.

The flora of Khandesh is comparable to South Gujarat and Madhya Pradesh.

ENDEMIC PLANTS

It has been estimated that nearly 24 genera (2.2%) and 605 taxa (18.8%) of plants which are endemic to India are occurring in Maharashtra, of which 7 genera and 169 taxa are found to occur only in Maharashtra. A list of such endemic genera, species and infraspecific taxa of Maharashtra only is given below

RANUNCULACEAE

Delphinium malabaricum var. *malabaricum*
D. malabaricum var. *ghaticum*
Thalictrum obovatum

XANTHOPHYLLACEAE

Xanthophyllum bombayanum

MALVACEAE

Abutilon ranadei

CELASTRACEAE

Salacia brunoniana

RHAMNACEAE

Rhamnus purandharensis
Ventilago madraspatana var. *fructifida*
Zizyphus horrida
Z. rugosa var. *glabra*

VITACEAE

Cissus woodrowii

SAPINDACEAE

Allophylus concanicus

FABACEAE

Alysicarpus luteovexillatus
Crotalaria decasperma
C. naikiana
Desmodium ritchiei
Flemingia rollae
Galactia tenuiflora var. *latifolia*
G. tenuiflora var. *minor*
Indigofera deccanensis
I. santapaui
I. trifoliata var. *duthiei*
I. trita var. *purandharensis*
Smithia agharkarii
S. oligantha
Vigna khandalensis
V. trilobata var. *pusilla*
V. vexillata var. *sepiaria*

LYTHRACEAE

Rotala floribunda

CUCURBITACEAE

Cucumis setosus

BEGONIACEAE

Begonia phrixophylla

APIACEAE

Heracleum dalgadianum
Pimpinella rollae
P. tomentosa

I *PINDA*

Pinda concanense

RUBIACEAE

Neanotis carnosa
N. sahyadrica

ASTERACEAE

Blumea venkataramanii
Cyathocline purpurea var. *alba*
C. purpurea var. *bicolor*
Phyllocephalum hookeri
Senecio gibsonii

APOCYNACEAE

Beaumontia jerdoniana
Tabernaemontana heyneana

ASCLEPIADACEAE

Bidaria khandalense
Brachystelma malwanense
Ceropegia evansii
C. huberi
C. jainii
C. lawii
C. maccannii
C. mahabalei
C. media
C. noorjahaniae
C. oculata
C. panchganiensis
Ceropegia rollae
C. sahyadrica
C. santapaui
C. vincaefolia

II. *FREREA*

Frerea indica
Heterostemma deccanense

III. *SESHAGIRIA*

Seshagiria sahyadrica

GENTIANACEAE

Canscora concanensis
C. stricta

CONVOLVULACEAE

Argyreia boseana
Ipomoea salsettensis
Operculina tansaensis

SCROPHULARIACEAE

Lindernia estaminodiosa
L. quinqueloba

ACANTHACEAE

Asystasia mysorensis
Barleria gibsonioides
B. prattensis
B. sepalosa
Dicliptera ghatica
D. nasikensis
Dyschoriste dalzellii
Hygrophila anomala
Hypoestes lanata
Justicia santapaui

Lepidagathis bandraensis
Nilgirianthus reticulatus

IV. *SUPUSHPA*

Supushpa scrobiculata

LAMIACEAE

Leucas deodikarii
Pogostemon benghalense var. *glaberrima*

AMARANTHACEAE

Achyranthes coynei
Amaranthus caturus

EUPHORBIACEAE

Euphorbia concanensis
E. katrajensis
E. khandalensis
E. panchganiensis
Phyllanthus scabrifolius

ORCHIDACEAE

Habenaria foliosa var. *foetida*
H. panchganiensis

ZINGIBERACEAE

Curcuma inodora
C. purpurea
Hitchenia caulina

AMARYLLIDACEAE

Crinum brachynema
C. eleonorae
C. woodrowii
Pancratium sanctae-mariae

LILIACEAE

Camptorrhiza indica
Chlorophytum glaucoides
Dipcadi concanense
D. maharashtrensis
D. minor
D. saxorum
D. ursulae
Drimia polyphylla
D. razii
Iphigenia stellata
Protasparagus karthikeyanii
Scilla viridis

ARACEAE

Amorphophallus konkanensis
Arisaema caudatum
A. sahyadricum
Cryptocoryne cognata

APONOGETONACEAE

Aponogeton bruggenii
A. satarensis

ERIOCAULACEAE

Eriocaulon bolei
E. rouxianum
E. santapaui
E. sedgwickii
E. sharmae
E. tuberiferum

HYDATELLACEAE

Trithuria konkanensis

CYPERACEAE

Cyperus decumbens
C. pentabracteatus
Fimbristylis unispicularis
F. woodrowii
Mariscus blatteri
M. konkanensis
Pycreus bolei
P. lancelotii
P. malabaricus

POACEAE

Arthraxon hispidus var. *junnarensis*
A.hispidus var. *santapaui*
A. lanceolatus var. *raizadae*
Coelachne minuta
Dichanthium armatum
D. compressum
D. jainii
D. maccannii
D. panchganiensis
D. woodrowii
Dimeria blatteri
D. stapfiana
Garnotia arborum
Glyphochloa ratnagirica
Heteropogon polystachyos
Isachne bicolor
I. borii
I. swaminathanii
Ischaemum bolei
I. bombaiense
I. diplopogon
I. huegelii
I. impressum
I. raizadae
I. santapaui
Panicum deccanense
P. paianum
P. paianum var. *minor*
P. phoiniclados

V. *POGONACHNE*

Pogonachne racemosa

VI. *PSEUDODICHANTHIUM*

Pseudodichanthium serrafalcoides
Sacciolepis indica var. *intermedia*

VII *TRIPLOPOGON*

Triplopogon ramosissimus
Tripogon polyanthus

THREATENED PLANTS

Nearly 153 (4.7%) species of flowering plants are under varying degrees of threat.

There are 5 species which have probably become extinct, 19 species are endangered, 11 species are vulnerable and nearly 118 species are rare. These threatened plants have been listed category wise below.

Extinct species

Cryptocoryne cognata, Drimia polyphylla, Eriocaulon rouxianum, Habenaria caranjensis and *Ipomoea salsettensis*.

Endangered species

Abutilon ranadei, Barleria gibsonioides, B. sepalosa, Ceropegia evansii, C. huberi, C. lawii, C. mahabalei, C. odorata, C. panchganiensis, C. sahyadrica, C. vincaefolia, Dipcadi maharashtrensis, Frerea indica, Glyphochloa santapaui, Hygrophila anomala, Lepidagathis bandraensis, Pogostemon stocksii, Salacia brunoniana and *Scilla viridis*.

Vulnerable species

Aponogeton satarensis, Belosynapsis vivipara, Capparis rheedei, Cryptocoryne cognatoides, Dichanthium maccannii, D. woodrowii Dipcadi saxosum, Iphigenia magnifica, I. stellata, Nogra dalzellii and *Rotala ritchiei*.

Rare species

Achyranthes coynei, Allophylus concanicus, Amorphophallus sylvaticus, Arisaema caudatum, A. murrayi, Arthraxon lanceolatus var. *meeboldii, Arundinella tuberculata, Begonia phrixophylla, Bhidea burnsiana, Bidarta cuspidata, B. khandalensis, Canscora concanensis, Ceropegia attenuata, C. fantastica, C. jainii, C. maccannii, C. media, C. noorjahaniae, C. oculata, C. rollae, C. santapaui, Chlorophytum borivilianum, C. glaucum, Coelachne minuta, Commelina hasskarlii, C. kotschyi, C. paleata, Crinum eleonorae, Crotalaria lutescens, C. priestleyoides, Cyanotis cerifolia, C. fasciculata, C. pilosa, C. tuberosa, Cyathocline lutea, Danthonidium gammiei, Decaschistia trilobata, Dendrobium microbulbon, Derris thothathrii, Dichanthium armatum, D. compressum, D. oliganthum, D. panchganiensis, D. paranjpyeanum, Dimeria blatteri, D. hohenackeri, D. stapfiana, D. woodrowii, Dipcadi minor, D. ursulae, Drimia polyantha, D. razii, Elaeocarpus munronii, Erinocarpus nimmonii, Eriocaulon fysonii, Eulophia ramentacea, Euphorbia katrajensis, E. panchganiensis, E. sebastinei, Flemingia gracilis, Garnotia arborum, Glyphochloa acuminata, Habenaria panchganiensis, Heracleum aquilegifolium, Heteropogon polystachyos,*

Heterostemma deccanense, H. urceolatum, Hoya alexicocca, Hygrophila pinnatifida, Hypoestes lanata, Indopoa paupercula, Ipomoea clarkei, Isachne lisboae, Ischaemum bombaiense, I. raizadae, I. ritchiei, I. santapaui, I. thomsonianum, I. travancorense, I. tumidum, Kalanchoe olivacea, Lepidagathis lutea, Murdannia crocea ssp. *ochracea, M. dimorpha, M. versicolor, Nanothamnus sericeus, Neanotis carnosa, N. montholoni, N. rheedii, Ophiuros bombaiensis, Oropetium roxburghianum, Paracaryopsis malabarica, Pogonachne racemosa, Pogostemon salicifolius, Polyzygus tuberosus, Pseudodichanthium serrafalcoides, Pseudoxytenanthera ritcheyi, Psilotrichum sericeum, Pterospermum reticulatum, Rungia crenata, R. linifolia, Scleria psilorrhiza, Scurrula stocksii, Senecio dalzellii, Seshagiria sahyadrica, Smithia agharkarii, Sorghum deccanense, Spehenostylis bracteata, Theriophonum dalzellii, Trilobachne cookei, Tripogon capillatus, T. jacquemontii, T. lisboae, Triplopogon ramosissimus, Typhonium bulbiferum, Vepris bilocularis, Vigna khandalensis* and *Wiesneria triandra.*

ECONOMIC USES

Many of the forest trees of Maharashtra are useful from various angles such as timber used in construction activities and making furniture, preparing plywood etc. (*Tectona grandis, Albizia chinensis, Chloroxylon swietenia, Chukrasia tabularis, Dalbergia paniculata,* etc.). Species like *Acacia leucophloea, Albizia amara, Anogeissus latifolia, Bauhinia purpurea, Bridelia retusa,* etc. are useful in making agricultural implements. *Haldina cordifolia* wood is useful in making panelling for railway carriages. The wood of *Acacia nilotica, Acronychia pedunculata, Aegle marmelos, Allophylus cobbe, Gmelina asiatica,* etc. are useful in making charcoal.

The Bamboos such as *Bambusa arundinacea, Dendrocalamus strictus* and *Pseudoxytenanthera ritcheyi* are in great demand for various rural industries and is a valuable raw material for paper, pulp and rayon production. These are important next only to *Tectona grandis.*

Grasses such as *Andropogon pumilus, Apluda mutica, Aristida* spp., *Heteropogon contortus,* etc. are useful for fodder, both for grazing as well as cut and dried, thatching, fibre, distillation of oil, etc.

The root fibres of *Vetiveria zizanioides* (Khas) are made into scented mats.

Cymbopogon citratus, C. martinii and *C. nardus* yield oils. The stems and roots of *Acacia leucophloea, Butea monosperma, Grewia tiliaefolia, Helicteres isora, Thespesia populnea,* etc. provide useful fibre.

The bark of *Acacia nilotica, Anogeissus latifolia, Bridelia retusa, Caesalpinia sepiaria, Cassia fistula, Emblica officinalis, Lagerstroemia parviflora, Terminalia chebula, Wrightia tinctoria,* etc. yield tannin.

Dyes are obtained from the bark of species like, *Acacia nilotica, Artocarpus heterophyllus, Morinda pubescens, Terminalia crenulata,* etc. The heartwood and underground portions of *Santalum album* possess the famous and expensive Sandalwood oil.

Hitchenia caulina provides starch. The leaves of *Acacia nilotica, Aegle marmelos, Albizia lebbeck, Haldina cordifolia, Hardwickia binata,* etc. provide fodder. The leaves and branches of *Borassus flabellifer, Butea monosperma,* etc. are useful in thatching of huts.

Auctioning of the leaves of *Diospyros melanoxylon* yield a sizable revenue to the Maharashtra State Government. These are used in bidi making.

The fruits of *Annona squamosa, Phyllanthus emblica, Mangifera indica, Spondias pinnata, Syzygium cumini,* etc., are edible.

The seeds of *Actinodaphne hookeri, Garcinia indica, Madhuca longifolia* var. *latifolia,* etc. yield oil. The fibres of *Bombax ceiba* are used in stuffing pillows and mattresses.

Gums are extracted from *Acacia nilotica, Anogeissus latifolia, Boswellia serrata, Pterocarpus marsupium, Sterculia urens,* etc.

Cereals and Pulses

Cajanus cajan, Cicer arietinum, Echinochloa frumentacea, Hordeum vulgare, Oryza sativa and many other crops are being cultivated.

Vegetables

Abelmoschus esculentus, Allium cepa, Brassica spp., *Daucus carota, Luffa acutangula* and many other vegetables are being cultivated.

VULNERABILITY AND MAJOR THREATS

The plant diversity of Maharashtra is increasingly affected by various factors, both biotic and abiotic. The threats in the former category include over exploitation of natural resources, habitat destruction due to urbanisation of increased population and forest land grab for more cultivation, felling of forests, overgrazing, dam construction and hydro-electric projects and pollution of environment including industrial and otherwise, mining, etc. To name a few, some of the recent projects like the Enron Power Project located in a remote village, Dabhol on the Konkan coast, the Konkan Railway Project, a Rail line along the west coast covering *ca* 760 km stretch from Roha in Maharashtra to Mangalore in Karnataka, Sahara Lake city complex under construction in Lonavala, Pune district, the Dimbhe Dam, meant to irrigate the area, etc. have caused ripples and has generated a lot of heat and public controversy. The Western Ghats in Maharashtra have been subjected to intensive developmental activity resulting in the denudation of the hills. The natural threats include earthquakes, dissimilar rainfall pattern in various regions like Konkan, Marathwada etc., floods, droughts, extreme temperatures in dry areas sometimes causing famine conditions, landslides, soil erosion, diseases, forest fires and pressure from weeds and aliens, etc. Besides, the hydrological conditions at sea affect the mangrove vegetation in the coastal regions.

CONSERVATION MEASURES

The above said various threats affecting the phytodiversity should be taken care of to conserve it. Developmental activities are inevitable in any developing society but efforts should be made to make use of the ecosystems in a sustainable manner, which means a balance has to be achieved between the two.

The hill chain of Western Ghats has been recognised as one of the World's 18 biodiversity hot spots, i.e. region of high levels of biodiversity under threat of rapid loss. Maharashtra has a large number of sacred groves ('Dev rais'), which represent relict type of vegetation and conserve many rare and threatened plants. Earlier these were protected due to the fear of the ruling deity but due to education, belief in the supernatural is diminishing and so these have to be managed properly by educating and creating awareness among people. The Government has also declared 5 National Parks and 24 Wild Life Sanctuaries which is an essential part of

conservation. These also should be managed effectively. Besides this *in situ* conservation, *ex-situ* measures have also to be adopted through biotechnology and multiplication in botanical gardens, etc. Sincere Non Governmental Organisations have also to be roped in to educate the masses, for proper and effective conservation of plant diversity.

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Carvia callosa, and *Nilgirianthus reticulatus* on the upper slopes and *Glochidion ellipticum, Ixora brachiata* and *Olea dioica* in the foreground at Konkankada, Ahmednagar dist.

A view of dry deciduous forest on the banks of Penganga river Yavatmal dist. showing *Terminalia arjuna, Madhuca longifolia* var. *latifolia* and *Tectona grandis,* etc.

A tree of *Capparis decidua* in bloom

Firmiana colorata in flowers

Pinda concanensis : a close up of flowers

MANIPUR

A. S. Chauhan

The state of Manipur with a geographical area of about 22,347 sq km in North eastern part of India, lies between 23° 47' - 25°41' N Latitude and 93°61' 94°48' E Longitude. The state is nature's paradise for its wild fauna and flora in general and rich heritage of wild orchids in particular. The botany of state attracted the attention of many British explorers like G. Watt, 1881-82; C.B. Clarke, 1885; A. Meebold, 1906 - 07; Sir Anandale, 1921; D.C. Kaith, 1932; N.L. Bor, 1938, 1942, 1948 and 1960 and Kingdon Ward, 1927, 1935 and 1945. Later, U.N. Kanjilal, the then forest officer with Govt. of Assam made extensive collections from Manipur for the publication of Flora of Assam.

Manipur, a small land locked hilly state, lying just north of tropic of cancer is bounded on the north by Nagaland, on the south by Mizoram and Chin hills of Myanmar, on the east by Chindwin district of Myanmar and on the west by Cachar and north Cachar district of Assam. It has a large central valley covering an area of about 1,545 Sq km with high hills surrounding the valley. The State has an elevation of 550-3600 m msl.

The main rivers of Imphal valley are Imphal, Iril, Thoubal, Nambu and Nambol. The first three are rising in the hills to the north, flow eastward to the Loktak and do not fall into it, while the other two rise in north and north-west and fall into the Loktak lake. The hill river Barak and its tributaries, on the Western park of the state are perennial, very deep and swift.

The Loktak is the largest lake, having an area of *ca* 100 sq km and is one of the chief and the most striking feature of Manipur. The surface of water is everywhere dotted with floating islands, composed of matted rots of aquatic plants, which are used by the local people for fishing.

The minimum temperature ranges from 1 - 3° C, rarely it goes down to -1° C, at whereas in the minimum temperature remains a little high. The monthly mean temperature rises steadily and reaches highest 32 - 38° C during the month of August and September then goes down and reach minimum in January.

The annual rainfall at Imphal is 2040 mm, at Kungpokpi 1600 mm, at Ukhrul 1780 mm, at Tamenglong 1602 mm, at Moreh 2010 mm, at Chandel 3230 mm, at Churechandpur 3055 mm, and at Jiribam 3430 mm. The humidity at Churachandpur remains highest throughout the year, while at other places e.g. Tamenglong, Senapati and sometimes at Jiri and Moreh it goes down and varies from 80% - 92 % depending upon the other factors. Generally, it has been observed that humidity goes down to the lowest during March (45 %). The low humidity combined with an east wind, which often reaches the force of a gale results in a period during which grassland and deciduous forest dry up and forest fire becomes a common feature at this time of the year.

VEGETATION

The climate of Manipur ranges from that of tropical plains to temperate and sub alpine hills and is characterised by high rainfall and humidity. The soil too ranges from new alluvial, old alluvial to laterite and in general is rich in organic matters, iron content but very low or sometimes deficient in Boron, Calcium and Zinc. The pH of soil usually ranges from 4.5 - 5.5. Due to these various factors, the state represents one of the richest botanical treasure house of the country. Phytogeographically, C.B. Clarke (1889) classified the whole of north-eastern region in two distinct regions i.e. Assam and Eastern Himalaya. Sir J.D. Hooker (1906) in his phytogeographical divisions of India, placed Manipur in subzone Northern Myanmar of his 8th division, which includes the Garo, Khasi, Jaintia, Naga, Patkoi and Manipur hills. Besides, he made sporadic mention about the plants of Manipur in his monumental work "Flora of British India" Chatterjee (1962) followed Clarke and treated Assam as an area distinct from the Eastern Himalaya because of its unique flora. Ridley (1942) is of the opinion that a definite conclusion can not be drawn till the full knowledge of plant distribution of the present and the past are not fully understood. However, the forests of the Manipur have been classified by different authors based on various criteria. Kaith (1936) classified the forest of Manipur into four major types. Deb (1961) also classified the forest depending upon the Clementsan system. These earlier workers have laid more emphasis on floristic compositon in their clasifications. Singh (1971) has classified the forest of Manipur into (i) Tropical wet evergeen (ii) Tropical moist deciduous (iii) Sub tropical broad leaved (iv) Sub tropical pine and (v) Montane wet temperate forest. There is usually a distinct correlation between altitude and vegetation. From this point of view, vegetation of the whole north-eastern region can be

classified into three major types, *viz.* (a) Tropical (b) Temperate and (c) Alpine with their intermediate types. Sahni (1969, 1981) while highlighting the floral wealth of Eastern Himalayas the following forest types viz (i) Tropical evergreen (2) Sub tropical (3) Temperate (4) Sub alpine and (5) Alpine to arctic. Based on previous works on classification of the vegetation types and observations made, the forest of Manipur can be classified into the following types

1. Tropical moist and dry deciduous forest,
2. Tropical evergreen and semi evergreen forest,
3. Sub tropical mixed forest,
4. Sub tropical pine forest,
5. Sub tropical and temperate grasslands.
6. Temperate forest, and
7. Sub alpine vegetation etc.

1. Tropical moist and dry deciduous forest

The tropical moist and dry deciduous forest are confined up to an altitude of 900 m. Besides the Imphal valley, such forest are also met at Tamenglong, Senapati in north-west, at Vangoi, Bishenpur in south west, at Jiri and Tipaimukh areas in west and at Moreh and Chandel in south east Manipur. It is imperative to mention here that typical natural deciduous forest do not occur any where in the state of Manipur but are only sub climax or man made forest. These forest are characterised by seasonal leaf shedding and profuse flowering of the trees. The man made deciduous forest are much extensive in their distribution and include many economically important tree species like *Albizia lebbeck, A. procera, Artocarpus chama, Anthocephalus chinensis, Bischofia javanica, Bombax ceiba, Dipterocarpus tuberculatus, Duabanga grandiflora, Gmelina arborea, Haldina cordifolia, Kydia calycina, Lagerstroemia parviflora* var. *reginae, Spondias pinnata, Salmalia malabarica, Sterculia villosa, Tectona grandis* and *Tetrameles nudiflora*, etc.

The second storey is composed of *Aglaia hiernii, Bauhinia purpurea, B. variegata, Callicarpa arborea, Canarium strictum, Careya arborea, Chukrasia tabularis, Cryptocarya amygdalina, Dalbergia sissoo, Dysoxylum alliarium, Melia dubia, Persia villosa,* and *Turpinia pomifera*, etc. The shrubby layer is often gregarious and forms an impenetrable thicket during rainy season. The major components are *Allophyllus cobbe, Buddleja asiatica, Clerodendrum kaempferi* and *Desmodium* spp., etc.

Lianas are fewer but scandent shrubs viz. *Aspidopteris*, *Bridelia*, *Combretum*, *Entada*, *Hiptage*, *Mussaenda*, *Phanera*, *Spatholobes*, *Tinospora*, etc. along with the species of Vitaceae and Menispermaceae. The undergrowth of these forest vary from place to place according to changes in rainfall and soil composition. In most of the places species of *Desmodium*, *Licuala*, *Phlogacanthus*, *Impatiens*, *Mimosa*, *Oxalis*, etc., form dominant undergrowth. In open areas, *Chromolaena*, *Eupatorium*, *Lantana* and *Mikania* grow profusely without any competition. Bamboo thickets are also found everywhere in these forest as succssional vegetation in jhum abandoned areas. Avenue trees viz. *Acacia melanoxylon* and *Parkia atimoriana* are commonly seen on the both side of roads in the valley, especially Imphal - Ukhrul road. The young fruits of *Parkia* are eaten as vegetable and 'Chatani' also.

2. Tropical Evergreen and semi evergreen forest

The tropical evergreen and semi evergreen forest are confined upto an elevation of *ca* 1200 m with an average annual rainfall of 3000 - 4000 mm coupled with high relative humidity. Due to the effect of physiographic, edaphic and other exogenous factors, these forest seldom form continuous belts in the state, but harbour rich species diversity. Such forest are now restricted to inacessible hills as well as near catchment areas unsuitable for cultivation or to areas protected as reserved forest. These forest display a close canopy of trees with a dense and rather impenetrable herbaceous growth. The bewildering wealth of species of these forest are not often common to all these areas, even the dominant species also differ from area wise.

The top canopy vegetation is composed of trees like *Aglaia hiernii*, *Ailanthus integrifolia* ssp. *calcina*, *Anthocephalus chinensis*, *Artocarpus heterophyllus*, *Canarium strictum*, *Castanopsis castanicarpa*, *C. tribuloides*, *Cinnamomum glaucescens*, *Dipterocarpus tuberculatus*, *Duabanga grandiflora*, *Elaeocarpus floribundus*, *E. prunifolia*, *E. varunua*, *Mesua ferrea*, *Stereospermum colais*, *Terminalia bellirica*, *T. citrina*, *T. myriocarpa*. The middle storey which is almost obscure is comprised of *Alstonia scholaris*, *Bischofia javanica*, *Dillenia indica*, *D. pentagyna*, *Dysoxylum binectariferum*, *D. gobara*, *Garcinia cowa*, *Magnolia griffithii*, *Mangifera sylvatica*, *Michelia champaca*, *Phoebe goalparensis*, *Pterospermum lancifolium*, *Sapium baccatum*, *Schima wallichii* and *Syzygium cumini*, etc. The lower most storey of trees in these forest is represented by *Alangium barbatum*, *A. chinense*, *Antidesima*

bunius, Brassiopsis glomerulata, Callicarpa arborea, Cinnamomum glaucescens, Goniothalamus sesquipedalis, Litsea cubeba, Macaranga denticulata and *Macropanax undulatus*. Of the various large shrubs or small trees which inhabit these forest, the prominent ones are *Acacia decurrens, Aralia armata, Boehmeria macrophylla, Camellia kissii, Canthium angustifolium, Coffea khasiana, Leea edgeworthii, Maesa indica, Microtropis discolor, Murraya paniculata, Phlogacanthus curviflorus*, etc. The conspicuous lianas intertwining the trees in these forest are *Acacia pennata, Beaumontia grándiflora, Cayratia japonica, Cissus assamica, Dioscorea* spp., *Entada rheedei, Hodgsonia macrocarpa, Paederia foetida, Tetrastigma* spp. and *Thunbergia grandiflora*, etc.

The ground in these forest is dark and moist due to lofty trees with thick canopy and has a thick layer of undisturbed humus and has fleshy fungi as well as saprophytic flowering plants. The common herbs in these forest are *Costus speciosus, Curcuma* spp., *Glycosmis arborea, Hedychium* spp., *Panax pseudoginseng* and species belonging to the families Acanthaceae, Asteraceae, Balsaminaceae, Begoniaceae, Fabaceae, Lauraceae, Oxalidaceae and Poaceae, etc. Besides, *Galeola lindelyana, Paphiopedilum spicerianum, Phaius flavus, P. tankervilliae, Tropidia* spp., etc. are scattered in the ground layer.

Epiphytes and other climbers are *Aeschynanthes bracteatus, A. superba, Agapetes variegata, Pipper* spp., *Pothos cathcartii, P. scandens, Rhaphidophora decursiva, R. lancifolia*, etc. and the stem parasites viz. *Cuscuta reflexa, Dendrophthoe falcata, Helixanthera ligustrina, Scurrula gracilifolia, S. parasitica* and *Taxilus* spp., etc. The tree trunks these forest are moss laden and hosting multitudes of epiphytic orchids, ferns, fern allies, bryophytes and lichens.

3. Sub tropical mixed forest

Sub tropical mixed forest are confined at the altitude from 1000 - 1800 m. Rainfall also varies from 200 - 3500 mm or more in certain areas. Such forest are spread over in different parts of the state, with a quite varied floral constituents from place to place based on the local climatic and edaphic conditions. The climatic climax forest are seen scattered and never form a continuous stretch of vegetation not only in Manipur but also whole of the north eastern region. The trees are generally dwarf and of a bushy appearance as compared with that of the tropical zone. Plant buttresses are rare in these forest. Shrubs and herbaceous layer are

well marked and form impenetrable thickets at certain places. The trees height in general are upto 20 m high with evergreen to semi evergreen appearance depends on the multitude of rainfall, temperature, soil in that area. The major components in these open forest are, *Alnus nepalensis, Albizia chinensis, Betula alnoides, Corylopsis himaleyana* and species of *Artocarpus, Dysoxylum, Elaeocarpus, Magnolia, Michelia, Schima, Terminalia*, etc. The second storey is composed of *Acer oblongum, Albizia odoratissima, Bischofia javanica, Brucea mollis* and *Anneslea fragrans*, etc. Besides, the common shrubby species are *Debregeasia longifolia, Eurya nitida, Maesa indica, Mussaenda glabra, Neillia thyrsiflora, Toddalia asiatica* and various species of Acanthaceae, Araliaceae, Myrsinaceae and Verbenaceae, etc. Usually tree trunks have luxuriant epiphytic growth.

4. Sub tropical Pine forest

Such forest occur at an elevation of 900 - 1800 m, in the moderate rainfall areas of the state. These pine forest are interspread by a few tree species such as *Engelhardtia spicata, Quercus griffithii, Schima wallichii* var. *khasiana*, etc. *Pinus kesiya* (Khasi Pine) occurs in pure patches with undergrowth of broad leaved species e.g. *Daphne papyracea, Myrsine semiserrata, Rubus ellipticus, Rhus* spp. and *Viburnum* spp., etc. *Pinus kesiya*, being one of the fast growing trees of this region, the state forest department has introduced it at high altitude at suitable climatic conditions. The floor with a thick carpet of pine needles is devoid of any plant growth except in small clearings where *Anemone rivularis, Artemisia nilagirica, Crotalaria ferruginea, Desmodium heterocarpum, Smithia blanda*, etc., add to the nitrogen content of the soil in these forest. Most of the herbaceous flora either killed or lie dormant during winter. The orchid species belonging to *Bulbophyllum, Cymbidium, Dendrobium, Erta, Luisia, Otochilus, Pholidota, Vanda*, etc., are quite common in these forest. Several terrestrial and epiphytic ferns also form gregarious patches, some of them are *Dicranopteris linearis, Lepisorus excavatus, L. thunbergianus, Lycopodium clavatum, Selaginella chrysocaulis, Blechnum orientale, Cyclophorus flacculsum, Pteridium aquilinum, Pyrosia mannii* and *P. mollis*. Grasslands or savannas that occuring in ripahran flats and slopes are not of a climax type. These grasslands have developed only as a result of removal of original forest cover. At some places *Rhododendron* spp. are also seen sporadically.

5. Sub tropical and temperate grassland

The grassland where ever present are a biotic climax due to removal of original forest cover. The rolling grasslands around Lamatol, Chingmairong, Mao, Shugnu, Litan, Ukhrul, Thoubal and Chandel areas can be seen sporadically. The effect of denuding of forest is every where, and large herd of cattle is common feature of this area. The most of the rounded hillocks within Imphal valley rise up exposing their barren red dry heads, which on closure inspection are seen to bear the stumps of old pine trees, ruthlessly chopped down for fuel wood, followed by excessive grazing transformed into barren land, which is totally devoid of forest cover. The dominant grasses in these areas are *Arundinella bengalensis, Chrysopogon aciculatus, Imperata cylindrica, Saccharum* spp. and *Thysanolena maxima*, etc. In some other areas, the association of *Agrostis micrantha, Brachypodium sylvaticum, Coelorachis striata, Cymbopogon khasianus, Ergrostis nigra*,etc. are seen. These grasses are associated with sedges like *Carex speciosa, C. phacota, Cyperus rotundus* and species of Burmaniaceae, Eriocaulaceae, Liliaceae and Zingiberaceae, etc. The species of Asteraceae, Balsaminaceae, Malestomaceae and Polygonaceae, etc. are also poorly represented in these areas. Besides, the insectivorus plants viz. *Drosera peltata* and *Utricularia* spp. also grow in the grassland. A rare and endemic species of Liliaceae i.e. *Lilium mackliniae* is found growing profusely on the top of the Sirohee Hills amongst the rolling grassland in the Ukhrul district of Manipur and shows a restricted range of distribution. Recently, this species has also been collected from the Dzukou valley.

6. Temperate forest

The temperate vegetation is usually found at an elevation of 1500 - 2500 m and confined to small pockets at Ukhrul, Chingsaw, Mao, Koupru, Japvo, and Saramati areas in the Manipur. These are close evergreen forest of medium height trees and the trees more than 20 m in height are rarely met within these forest. Large and old trunks are festooned with mosses, ferns and other epiphytic growth. At lower elevation, the forest show a intermixing of elements from tropical and sub tropical zone and species composition changes gradually with the increase in the altitude. It is pertinent to point out that sub-tropical vegetation and temperate vegetation sometimes appear side by side, under apparently similar environmental conditions where sub tropical and temperate zones are not well defined as in other parts of north eastern region. The dominant species in this

zone are *Acer oblongum, Alnus nepalensis, Betula alnoides, Castanopsis armata, Cinnamomum bejolghota, Elaeocarpus braceanus, Engelhardtia spicata, Exbucklandia populnea, Lithocarpus dealbatus, Magnolia insignis, Pinus kesiya, Prunus cerasoides, Quercus griffithii, Rhododendron arboreum, R. johnstoneanum, R. triflorum* and *Symplocus* spp., etc.

At some other places, species of *Albizia, Cinnamomum, Juglans, Magnolia, Michelia, Persea, Quercus, Rubus,* etc., along with *Helicia nilagirica, Ilex khasiana, I. embelioides* and *Viburnum* spp. are present. There is a gradual change in the composition of species diversity with the increase of altitude. At higher elevation, *Rhododendron* spp., predominate with *Prunus, Rubus, Spirea* and other members of Rosaceae. The mountain bamboo brakes *Arundinaria maling* are found throughout the moist temperate forest.

In the shrubby layer predominate taxa are *Celastrus paniculatus, Eurya acuminata, E. nitida, Illicium griffithii, I. manipurense, Macropanax oriophyllum,* etc. The herbaceous layer in this zone comprises of *Galium rotundifolium, Hedyotis scandens, Ophiopogon dracaenoides, Pilea hookeriana, Piperomia pelludosa* and *Begonia* spp., etc. The other fascinating group of plants because of their long lasting ornamental flowers is Orchids, which include many highly ornamental species belonging to the genera, viz. *Aerides, Bulbophyllum, Coelogyne, Cymbidium, Dendrobium, Paphiopedilum, Phaius, Renanthera,* and *Vanda,* etc.

The ferns and fern allies like *Asplenium laciniatum, Athyrium drepanopterum, Lycopodium clavatum, Selaginella chrysocaulis, Lygodium japonicum, Pteris biaurita, Pleopeltis* spp., *Plegiogyria* spp. and *Microsorium* spp., etc are predominating. Besides, the other herbaceous species belonging to Ranunculaceae, Rosaceae, Begoniaceae, Asteraceae and Poaceae, etc. are commonly seen. *Sapria himalayana,* an interesting root parasite on *Cissus elongata* could also be collected from temperate forest of Koupru hills of Manipur.

7. Sub alpine vegetation

The subalpine vegetation occurs at an altitude of 2500 m and above in Chingnaw, Japvo, Koupru, Sirohee and Sorma hill ranges of Manipur, where the vegetation changes from temperate to sub alpine type. It is

characterised by a typical dense growth of small crooked gnarled and stunted trees and shrubs. The dominant species are *Aconitum elwesii*, *A. nagarum*, *Agapetes nitrarioides*, *Berberis manipurana*, *B. sublevis* var. *sublevis*, *B. sublevis* var. *microcarpa* , *Corydalis chaerophylla*, *Hypericum monanthemum*, *Mahonia manipurensis*, *M. roxburghii*, *Rhododendron elliottii* , *R. macabeanum*, *R. maddeni* ssp. *crassum*, *R. wattii*, *Selinum striatum*, *Spiraea callosa* and *Carex manipurensis*, etc. Two species of rare and interesting gymnosperms i.e. *Cephalotaxus griffithii* and *Cephalotaxus mannii*, have also been collected from this state. Besides, other economically important plants e.g. *Gaultheria*, *Gentiana* and *Swertia* spp. also occurring in this zone. The forest floor is covered by a few herbaceous members of the families Ranunculaceae, Caryophyllaceae, Papaveraceae, Fumariaceae, Brassicaceae, Rosaceae, Primulaceae, Gentianaceae, Polygonaceae, Asteraceae and Saxifragaceae, etc., as small or sometimes stunted clumps.

FLORISTIC DIVERSITY

Hooker (1906) recognized the following ten as the most dominant families of flowering plants in India, based on the total number of species, Orchidaceae, Leguminosae (*s. l.*), Poaceae, Asteraceae, Rubiaceae, Acanthaceae, Euphorbiaceae, Lamiaceae, Cyperaceae and Scrophulariaceae. In comparision to this, the first ten families in the Manipur state are Orchidaceae (*ca* 226 species), Poaceae (*ca* 200 species), Leguminosae (*ca* 168 species), Rubiaceae (*ca* 84 species), Asteraceae (*ca* 83 species), Euphorbiaceae (*ca* 52 species), Acanthaceae (*ca* 50 species), Cyperaceae (*ca* 49 species), Rosaceae (*ca* 46 species) and Lamiaceae (*ca* 43 species) (Table I - III). The largest genera are *Dendrobium* (41 spp.), *Polygonum* (23 spp.), *Impatiens* (17 spp. and 4 varieties), *Ficus* (17 spp.), *Coelogyne* (16 spp.), *Carex* (15 spp.), *Crotalaria* (14 spp.), *Cyperus*, *Cymbidium* and *Jasminium* (13 spp.) each. About 2376 species belonging to 1052 different genera spread over 203 families are found. The ratio of dicot and monocot species is 2.56: 1, while the ratio of dicot and monocot genera is 4.97 : 1. In the state the dicot flora is spread over 169 families. Not a single angiosperm family is endemic to this state. The dicot families Nelumbonaceae, Bixaceae, Tamaricaceae, Actinidiaceae, Geraniaceae, Tropaeolaceae, Erythropalaceae, Connaceae, Morgaceae, Saxifragaceae, Rhizophoraceae, Sonneratiaceae, Punicaceae, Trapaceae, Caricaceae, Datiscaceae, Aizoaceae, Nyssaceae, Dipsacaceae, Sphenocleaceae, Pyrolaceae, Monotropaceae, Sarcospermaceae,

Polemoniaceae, Hydrophyllaceae, Pedaliacaceae, Cuscutaceae, Basellaceae, Phytolacaceae, Podostemaceae, Rafflesiaceae, Saururaceae, Proteaceae, Elaeagnaceae, Buxaceae, Cannabaceae, Myricaceae, Salicaceae, Ceratophyllaceae are represented by a single genus having a single species each. Some of the other poorly represented are Lardizabalaceae, Schizandraceae, Pittosporaceae, Portulacaceae, Crassulaceae, Cactaceae, Alangiaceae, Buddlejaceae, Menyanthaceae, Plantaginaceae and Chloranthaceae, which have been represented by a single genus and two species each. Each of the families Simaroubaceae, Droseraceae, Hamamelidaceae, Molluginaceae, Orobanchaceae, Aristolochiaceae, Juglandaceae and Betulaceae have been represented by two genera and two species each.

Table I
Dominant Families of phanerogams by number of species

Sl.No	Family	Genera	Species
1.	Orchidaceae	66	226
2.	Poaceae	87	200
3.	Leguminosae (*s. l.*)	65	168
4.	Rubiaceae	35	84
5.	Asteraceae	63	83
6.	Euphorbiaceae	25	52
7.	Acanthaceae	22	50
8.	Cyperaceae	10	49
9.	Rosaceae	14	46
10.	Lamiaceae	32	43

Table II
Dominant Dicot families by number of species

Sl.No	Family	Genera	Species
1.	Leguminosae (*s. l.*)	65	168
2.	Rubiaceae	35	84
3.	Asteraceae	63	83

Sl.No	Family	Genera	Species
4.	Urticaceae	21	80
5.	Euphorbiaceae	25	52
6.	Acanthaceae	22	50
7.	Rosaceae	14	46
8.	Lamiaceae	32	43
9.	Lauraceae	10	39
10.	Scrophulariaceae	18	36

Table III
Dominant families of Monocot by number of species

Sl.No	Family	Genera	Species
1.	Orchidaceae	66	226
2.	Poaceae	87	200
3.	Cyperaceae	10	49
4.	Zingiberaceae	12	29
5.	Liliaceae	14	27
6.	Araceae	12	25
7.	Commelinaceae	8	17
8.	Arecaceae	9	16
9.	Dioscoreaceae	1	8
10.	Smilacaceae	2	18

The herbaceous family Ranunculaceae is well represented in this state with endemic species like *Aconitum elwesii*, *A. nagarum* and *Clematis apiculata* along with other nine species of *Clematis*, etc. Primitive families viz. Annonacee, Chloranthaceae, Hamamelidaceae, Lardizabalaceae, Lauraceae, Magnoliaceae and Schisandraceae, etc., show their maximum concentration in the state along with neighbouring states of north eastern region of India. *Berberis* and *Mahonia* are also well represented. Besides, the *Dipterocarpus* (Dipterocarpaceae), an important timber yielding plant is now confined only in the north eastern part of the country.

The family Balsaminaceae has been represented by 17 species and four varieties, out of *ca* 200 species reported from India. Several species of *Impatiens* like *Impatiens gibbisepala, I. laevigata, I. longirama, I. odontosepala, I. spissiflora*, etc., are endemic to this region. The family Rosaceae is well represented by the species of *Agrimonia, Docynia, Fragaria, Neillia, Photinia, Potentilla, Prunus, Pyrus, Rosa, Rubus, Sorbus* and *Spiraea*, etc. The family Begoniaceae is represented by eight species and a few species of *Begonia* are also endemic. Similarly, the family Cucurbitaceae has been represented by over 30 species and family Rubiaceae by 84 species. The family Ericaceae including Vacciniaceae are also well represented with showy flowers of different colours and attractive foliage of *Rhododendron*, a few species of which are endemic to this region (Sastry and Hajra, 1983). Families Fagaceae, Moraceae and Urticaceae are also very well represented in this state.

In the state the monocots are represented by 34 families. The family Orchidaceae is the largest one, not only amongst the monocots but also among the phanerogams as a whole. This is followed by Poaceae and Cyperaceae. The family Zingiberaceae is represented by 29 species. The genus *Hedychium* has been represented by 9 species, out of which a few are endemic. Several genera of this family e.g *Amomum, Curcuma, Hedychium, Kaempferia* and *Zingiber* are of great medicinal value. The family Arecaceae is represented by 16 species, of which *Areca, Borassus, Calamus, Caryota, Licuala, Phoenix, Pinanga* and *Wallichia*, etc., are prominant. Some poorly represented families are Costaceae, Bromeliaceae, Taccaceae, Xyridaceae, Pandanacee, Typhaceae and Butomaceae, which have been represented by a single genus and a single species each. Burmaniaceae, Cannaceae, Najadaceae and Potamogetonaceae are having a single genus and two species each, while families like Juncaceae and Eriocaulaceae have also been represented by a single genus and three species each. Iridiaceae, Pontedariaceae, Smilaceae and Stemonaceae have two genera each, Alismataceae, Amaryllidaceae, Hypoxidaceae, Limnaceae and Marantaceae are the families with three genera each. Hydrocharitaceae with five genera, Commelinaceae with eight genera, Araceae with twelve genera and Cyperaceae with ten genera are found in the state. The family Liliaceae is well represented by fourteen genera of great horticultural value.

Primitive angiosperms: The Manipur state also harbours a good number of primitive flowering plants. According to Takhtajan (1969), the north eastern region with the maximum number of primitive

flowering plants is to be considered the centre of origin of angiosperms. If this view is accepted, one has to beleive that the flora of this region is quite primitive and indigenous. Smith (1970) considered the countries bordering pacific ocean as the centre of origin of angiosperms based on the presence of few primitive families, along the shores of the pacific ocean countries. He is of the opinion that the south east Asain flora which is part of the Gondwana land have been brought through the Burmese and Malaysian portion of Indian block joining with the Asian main land and the inaccessible terrain of Himalayas helped in the preservation of the remanants of a few primitive families. In view of this it would be appropriate to consider south east Asian plexus with numerous folds of mountains a "refugium" and not a "Cradle of flowering plants" as considered by Takhtajan.

Primitive Flowering plants

Name of the Species	Family	Distribution
Actinodaphne angustifolia	Lauraceae	North East India and Indo - Malaya
A. obovata	Lauraceae	North East India, Easatern Himalayas and Bengladesh
Alseodaphne sikkimensis	Lauraceae	North East India, Sikkim
A. owdenii	Lauraceae	North east India, Sikkim and Bhutan
Artabotrys cubittii	Annonaceae	Manipur, Assam, Meghalaya and Myanmar
A. hexapetalus	Annonaceae	North East India and Myanmar, Malaesia
Beilschmiedia assamica	Lauraceae	Manipur, North East India and Myanmar
B. fagifolia	Lauraceae	Manipur, North East India
B. roxburghiana	Lauraceae	Manipur, North East India

Name of the Species	Family	Distribution
Betula alnoides	Betulaceae	Himalayas, North East India and Myanmar
Chloranthus elatior	Chloranthaceae	Manipur, North East India Himalayas, Andaman and Indo - Malayas
C. glaber	Chloranthaceae	North East India, Indo Malaya
Corylopsis himalayana	Hamamelidaceae	North East India and Indo China
Cryptocarya amygdalina	Lauraceae	North East India, E. Himalayas and Andamans
Desmos longiflorus	Annonaceae	North East India and Indo-Malaya
Exbucklandia populnea	Hamamelidaceae	North East India, Eastern Himalaya and Sumatra
Fissistigma bicolor	Annonaceae	North East India, W. Bengal Myanmer
F. polyanthum	Annonaceae	North East India, Bhutan and Bangladesh
Goniothalamus sesquipedalis	Annonaceae	North East India, Indo-Myanmar
Holboellia latifolia	Lardizabalaceae	North East India
Horsfieldia amygdalina	Myristicaceae	North East India, Bangladesh and Myanmar
Illicium griffithii	Illiciaceae	North East India, E. Himalaya and Myanmar
I. manipurense	Illiciaceae	Endemic to Manipur
I. simonsii	Illiciaceae	North East India, E. Himalaya and China
Kadsura heteroclita	Schisandraceae	North East India, Eastern Himalayas and Bengladesh
K. wattii	Schisandraceae	Endemic to Manipur

Name of the Species	Family	Distribution
Knema erratica	Myristicaceae	North East India
K. linifolia	Myristicaceae	North East India, Bangladesh Myanmar and Malaysia
K. tenuinervia	Myrsticaceae	North East India, Eastern Himalaya, Myanmar and Thailand
Magnolia campbellii	Magnoliaceae	North East India, E. Himalya, Myanmar and China
M. griffithii	Magnoliaceae	Endemic to North East.India
M. hodgsonii	Magnoliaceae	North East India, E. Himalaya and Bangladesh
M. hookeri	Magnoliaceae	North East India and Myanmar
Manglietia insignis	Magnoliaceae	North East India, E. Himalaya
Michelia cathcartii	Magnoliaceae	Manipur, Meghalaya, Nagaland and Sikkim
M. doltsapa	Magnoliaceae	North East India and Eastern Himalayas
M. glabra	Magnoliaceae	Endemic to N.E. India and Himalaya
M. punduana	Magnoliaceae	Endemic to North East India and Eastern Himalayas
M. velutina	Magnoliaceae	North East India, West Bengal and Nepal
Polyalthia jenkinsii	Annonaceae	North East India and Indo Malaya

Name of the Species	Family	Distribution
Tetracera sarmentosa	Dilleniaceae	North East India, West Bengal, Andamans, Myanmar and Malaysia

BAMBOOS

The state of Manipur has also large population of bamboos, which are well known for their multipurpose economic uses. Bamboos are used in house making, preparation of baskets, brooms, mats, hats, poles, fencing, water pipes, bows and arrows as well as in other cottage industries. It is even used for preparation of salt. Besides, the tender shoots are eaten as vegetable by the local inhabitants. Out of 126 taxa of bamboos reported from India, over 40 species (*Arundinaria ca* 7 species, *Bambusa ca* 15 species *Chimnobambusa* 1 species, *Dendrocalamus ca* 8 species, *Dinochloa* 1 species,*Melocanna* 1 species, *Schizostachyum ca* 7 species and *Thyrsostachys* 1 species, are known from Manipur. Some of the important bamboo species of common uses are *Arundinaria clarkei, A. maling, A. rolloana, Bambusa balcooa, B. burmanica , B. griffithiana, B. pallida, B. tulda, B. vulgaris, Chimonobambusa khasiana, Dendrocalamus giganteus, D. hamiltonii, D. strictus , Melocanna baccifer, Schizostachyum dullooa , S. fuchsianum S. mannii, S. pallidum* and *Thyrsostachys oliveri*

ORCHIDS

People, generally are very much fascinated by orchids because of their beautiful long lasting ornamental flowers. The state of is prolific in many epiphytic and terrestrial orchids of immense horticultural value. Some of these are progenitors of the modern commercial hybrids and deserve multiplication and protection for future hybridisation programme. About 226 species belonging to 66 different genera of the family orchidaceae have been reported from the state. Some of the major components of this highly ornamental group of plants are as follows *Dendrobium* 41 species, *Coelogyne* 16 species, *Cymbidium* 13 species, *Bulbophyllum* 12 species, *Eria* and *Habenaria* 8 species each, *Calanthe, Liparis, Oberonia* and *Vanda* 7 species each, *Pleione* 4 species and other interesting orchids viz. *Anoectochilus, Ascocentrum, Epigeneium, Galeola, Phaius* and *Vanilla*.

Some of the important ornamental species which are prized all over the world are *Aeridis multiflora, A. odorata, Anoectochilus grandiflorus, Arundina graminifolia, Calanthe densiflora, C. massuca, Coelogyne barbata, C. flaccida, Cymbidium cyperifolium, C. devonianum, C. elegans, C. iridioides, C. mastersii, Dendrobium bensoniae, D. chrysanthum, D. chrysotoxum, D. densiflorum, D. devonianum, D. fimbriatum, D. nobile, Hygrochilus* sp., *Paphiopedilum spicerianum, Phaius flavus, P. mishmensis, Pleione humilis, P. praecox, Renanthera imschootiana, Rhynchostylis retusa, Schoenorchis fragrans* and *Vanda coerulea*, etc. Due to over exploitation, most of the orchids have already been depleted considerably and some of them are seen only in orchidaria.

Primitive cultivars and land races

Manipur also abounds a rich gene pool of primitive cultivars and land races. There are enormous gene pool of rice, maize, coix, etc. Besides these crops, there are numerous wild relatives of cultivated plants, mention may be made of *Alpinia, Alocasia, Amomum, Mucuna, Pyrus, Prunus,* and *Rubus*, etc. The genus *Dioscorea* is represented by 8 species and *Piper* with *ca* 21 species. Several wild species of banana viz. *Ensete glaucum , Musa cheesmanii, M. nagensis, M. paradisiaca*, etc., have been recorded from this state and some of them being endemic to North eastern region. The genus *Citrus* is represented by *Citrus aurantium, C. maxima, C. hystrix,. C. medica* and their varieties, etc. So far the fibre crops are concerned, mention may be made of *Bauhinia, Butea, Canabis, Corchorus, Crotalaria, Sesbania, Sida* and their varieties Other important taxa like, *Costus, Curcuma, Hedychium, Lilium, Saccharum* and *Zingiber*, etc., show great diversity.

PHYTOGEOGRAPHY

Though the flora of Manipur exhibits an Indo Malayan affinity, the floral elements of other parts of India, the neighbouring and far off countries have also contributed to its richness and diversity. These affinities are best illustrated by an enumeration of some of common elements. The genera found in Tibet, China, Bhutan and Nepal are *Acanthopanax, Actinidia, Anthocephalus, Arisaema, Berberis, Bulbophyllum, Camellia, Cymbidium, Eulalia, Epigenetum, Helwingia, Kadsura* and *Mahonia*, etc. Of the Malayan elements occurring in this state are genera like *Balanophora, Engelhardtia, Exbucklandia, Millusa, Rubus, Vaccinium*, etc. Besides, some of the common species having the affinities with those of

Sikkim and Tibet are *Arisaema tortoosum, Apocopsis puleacea , Luzula effusa, Saccharum procerum, Trachycarpus martiana. Helwingia himalaica* and species of *Anemone, Agapetes, Globba, Hypoxis, Holbolia, Maesa, Ophiopogon, Smilacina, Tupistra*, etc. *Desmodium griffithianum, Bauhinia glauca* ssp. *temiflora, Ardisia virens, Aerides odorata* var. *alba, Coelogyne dayana, Dendrobium bensoniae* var. *xanthinum, D. linguella, Gastrochilus bellinus, Luisia antennifera* and *L. jonesii* show their range of distribution through Philippines and Thailand to Borneo and Indonesia. The floristic elements of peninsular India are *Dillenia indica, D. pentagyna; Eurya acuminata, Mahonia pycnophylla, Helicia nilagirica, Habenaria malintana , Nervilia prainiana*, etc. The African elements met within are *Elatostema sessile, Phoenix humilis, Melinis minutiflora* and species of *Eragrostis, Eleusine* and *Digitaria*, etc. The American elements in Manipur are not very common. They are exhibited generally by weeds of agricultural lands e.g. *Chromolaena odorata, Eichornia crassipes. Eupatorium adenophorum, Lantana camara, Mikania micrantha*, etc. While *Mangifera sylvatica* and *Nauclea griffithii* show their range of distribution up to Andamans. The taxa like *Aeschynanthes superba, Ardisia khasiana, A. virens, Chirita brevipes , Callicarpa psilocalyx, Justicia khasiana, Senecio linifolius, Prunus jenkinsii, Rubus burkillii, Cinnamomum pauciflorum, Polysolenia wallichii, Strobilanthes acrocephalus* and *Synotis nagenstum*, etc. occur only in the neighbouring states of north eastern India.

Besides, a number of exotics have been introduced on the Indian soil and have become permanent denizens. Some of them have not only masked the native elements, but have also replaced them probably because of their allelopathic effects. To name a few of them are *Abelmoschus moschatus, Abrus precatorius, Acacia melanoxylon , Asclepias curassavica, Argemone maxicana, Cleome viscosa, brugmansia suaveolens , Dombeya mastersii, Eupatorium* spp., *Euphorbia prostrata, Kadsura heteroclita , Peperomia pallucida*, etc.

ENDEMISM

The term ' endemic' is generally applied to taxon viz. species, genus or other group confined to a small area. Some authors designate even the species restricted to larger areas as endemics. These endemics may be of two types i.e. paleo-endemics and neo-endemics. When a taxon is the survivor of widely distributed group of the past that is now in the process of gradual extinction is known as paleoendemic e.g., *Ginkgo*

biloba, while neoendemics is a taxon which is new or recent forms of gradual extending group, e.g *Orchid, Primula*, etc. The factors responsible for the creation of endemic species are mutation, natural crossing over amongst allied species, isolation, etc. That's why the oceanic Islands are having a higher percentage of endemic flora. For example 82 % of species in Hawaii Islands, 72 % in Newzealand and 50 % in Fiji Islands are endemic. The state of Manipur, although having the dominance of Malayan elements and some floristic elements of other contiguous as well as far off places, has also a good number of endemic elements. Chatterjee (1940) has emphasized the richness of the flora of the Eastern Himalaya and North eastern India, including British Burma and estimated that 3169 out of a total 6850 endemics in India are endemic to this region. But, later on several species which were described as endemic to this region have also been collected from other parts of the country as well as neighbouring countries. Even then several species appear to be endemic to Manipur and adjacent states of the north eastern India. A list of some of the endemic species is given below

Name of the Species	Family	Distribution
Aconitum elwesii	Ranunculaceae	Manipur,Nagaland and Arunachal Pradesh
A. nagarum	Ranunculaceae	Manipur, Nagaland and Arunachal Pradesh
Actinodaphne obovata var. *wattii*	Lauraceae	Manipur
Agapetes lobbii	Vacciniaceae	Manipur,Meghalaya and Nagaland
A. mannii	Vacciniaceae	Manipur, and N.E. India
Arisaema wattii	Araceae	Manipur
Artabotrys cubittii	Annonaceae	N.E. India and Myanmar
Aster ageratoides	Asteraceae	Manipur
A. trinervius ssp. *trinervius* var. *wattii*	Asteraceae	Manipur and Nagaland

Name of the Species	Family	Distribution
Asystasia pusilla	Acanthaceae	Manipur and Nagaland
Begonia obversa	Begoniaceae	Manipur
Baliospermum suffruticosum	Euphorbiaceae	Manipur
Beaumontia longituba	Apocynaceae	Manipur
Berberis manipurana	Berberidaceae	Manipur
B. sublevis	Berberidaceae	Manipur
Carex manipurensis	Cyperaceae	Manipur
Clematis apiculata	Ranunculaceae	Manipur and Meghalaya
C. wattii	Ranunculaceae	Manipur
Colguhounia elegans	Lamiaceae	Manipur
Craibiodendron stellatum	Ericaceae	Manipur
Dalbergia wattii	Fabaceae	Manipur
Dischidia micholitzii	Asclepiadaceae	Manipur
Elatostema ciliatum	Urticaceae	Manipur
Elaeagnus loureirii	Elaeagnaceae	Manipur
Epipremnum meeboldii	Araceae	Manipur
Euphorbia serrulata	Euphorbiaceae	Manipur
Garcinia loniceroides	Clusiaceae	Manipur and Nagaland
Gleadovia banerjiana	Orobancaceae	Manipur
Hedychium greenii var. *urophyllum*	Zingiberaceae	Manipur
H. speciosum	Zingiberaceae	N.E. India
H. wardii	Zingiberaceae	N.E. India
Ilex embelioides	Icacinaceae	Manipur and Meghalaya
I. khasiana	Icacinaceae	N.E. India
I. wattii	Icacinaceae	Manipur
Illicium manipurense	Illiciaceae	Manipur

Name of the Species	Family	Distribution
Impatiens gibbisepala	Balsaminaceae	Manipur
I. longirama	Balsaminaceae	Manipur
I. rubro-lineata	Balsaminaceae	Manipur
I. spissiflora	Balsaminaceae	Manipur
I. teneriflora	Balsaminaceae	Manipur
Iris bakeri	Iridaceae	Manipur
I. wattii	Iridaceae	Manipur
Justicia anfractuosa	Acanthaceae	Manipur
Kalanchoe rosea	Crassulaceae	Manipur
Mahonia feddei	Berberidaceae	Manipur
M. magnifica	Berberidaceae	Manipur
M. manipurensis	Berberidaceae	Manipur
Mantisia saltatoria	Zingiberaceae	Manipur and Mizoram
Musa ittinerans	Musaceae	Manipur
Phacellaria compressa	Santalaceae	Arunachal Pradesh and Manipur
Pilea minuta	Urticaceae	Manipur
Pimpinella flaccida	Apiaceae	Manipur and Nagaland
Piper aurorubrum	Piperaceae	Manipur
P. gamblei	Piperaceae	Manipur, Mizoram and Nagaland
P. kapruannum	Piperaceae	Manipur
P. lainatakanum	Piperaceae	Manipur
P. makruense	Piperaceae	Manipur
P. meeboldii	Piperaceae	Manipur
P. muneyporensis	Piperaceae	Manipur
P. nagense	Piperaceae	Manipur and Nagaland
Polygonum stellato-tomentossum	Polygonaceae	Manipur

Name of Species	Family	Distribution
Potentilla manipurensis	Rosaceae	Manipur
Prunus wattii	Rosaceae	Manipur
Pyrus wattii	Rosaceae	Manipur
Rosa clinopylla var. *parvifolia*	Rosaceae	Manipur
Spodiopogon lacei	Poaceae	Manipur
Strychnos nux-blanda	Loganiaceae	Manipur
Swertia wattii	Gentianaceae	Manipur and Nagaland
Synotis rhabdos	Asteraceae	Manipur and Nagaland
Vaccinium lamellatum	Vacciniaceae	Manipur
V. manipurensis	Vacciniaceae	Manipur and Arunachal Pradesh
Vernonia clivorum	Asteraceae	Manipur
V. cylindriceps	Asteraceae	Manipur and Nagaland
Zanthoxylum pseudoxyphyllum	Rutaceae	Manipur

ECONOMIC USES

Manipur has always served as a store house of medicinal and aromatic plants. The local tribals inhabiting in different parts of the state solely depend upon these plants for the cure of diseases. In spite of the influx and encroachment of modern civilisation and missionary activities to provide modern medical facilities to these people, the rural folk to a great extent have their faith in the indigenous type of medication. Mention may be made of some important medicinal plants such as *Abroma augusta, Acorus calamus, Alpinia nigra, Amomum* spp., *Aquilaria malaccensis, Berberis* spp., *Brucea mollis, Clerodendron colebrooktanum, Costus speciosus, Dioscorea* spp., *Equisetum diffusum, Lycopodium* spp., *Paedaria foetida, Podophyllum hexandrum* and *Valeriana jatamansii*, etc., the leaves, petioles and young shoots of *Euryale ferox, Houttuynia cordata, Ipomea aquatica, Persicaria hydropiper Sesbania sesban* and *Stellaria media*, etc., are eaten either cooked or raw.

The plants like *Ceratophyllum demarsum, Hydrilla verticellata* and *Myriophyllum tuberculatum* are used for covering fishes and other collected aquatic plants in basket during transport to market. The grasses e.g. *Apluda mutica, Cynodon dactylon, Dichanthium annulatum, D. caricosum, Echinochloa colonum, Isachne albens, I. globosa*, etc., are good fodder species, while *Eulaliopsis binata* is an important grass used for the paper industry. The leaves of *Imperata cylindrica* and *Saccharum spontaneum* are used for thatching by local people. *Melinis minutiflora* a rare grass of Manipur has strong odour of cumine, the smell and vicious hairs on the leaves are stated to have insecticidal and mosquito-repellant properties. A few other ethnobotanically important plants are *Acacia oxyphylla* the extract of bark and fruits are used for dendruff, *Bambusa tulda* young shoots after crushing are applied to care dandruff and leaf extract of *Mussaenda forndosa* mixed with milk is given in jaundice.

Some other interesting plants e.g. *Iris bakeri* (locally called Konbirei) the flowers of this plant are considered sacred and very much associated in the local festivals. The mature stems of *Schoenoplectus lacustrus* and *S. mucronatus* ssp. *mucronatus*, etc. are used for making mats and mattresses.

RARE AND THREATENED TAXA

The rich plant diversity of the Manipur state is in great danger of alteration and depauperisation due to several biotic as well as abiotic factors. To some extent the climatic fluctuations, evolutionary changes and the introduction or extinction of species, etc. have contributed the depletion of the flora. But major threat for the depletion of flora and vegetation is the drastic environmental change brought about by man himself in these forest. By far the most important cause of destruction is the increased pressure on land for jhum cultivation Shifting cultivation. Over grazing, excessive use of fuel wood, forest fire and various socio-economic developmental activities are also bringing about the destruction of natural forests at a great pace. The biotic pressure due to population explosion, the period of jhum cycle reduced to 4 - 6 years, provide practically no chance for natural regeneration of soil fertility. Jhumias prefer the secondary growth of bamboos over primary or secondary wooded forests, as these can be cut, dried and finally burnt easily thereby getting plenty of ashes rich in potassium suitable for a better and healthy growth of crops. But with shorter jhum cycle, obnoxious weeds like *Chromolena, Eupatorium, Lantana, Mikania*, etc., spread widely if soil profile is rich

and it tends to check the growth of *Imperata cylindrica* which is commenly found everywhere. In certain places, the soil has been eroded completely, thereby making these areas barren and unproductive waste lands. Recently, introduction of cash crops like Cardamum, Coffee, Rubber, Tea, Tapioca, etc. at different altitudes have also contributed a lot towards fast deforestation. Now in the afforestation programmes, emphasis has been given either to monoculture or to mixed forests, comprising mostly exotic species. As a result primary forests are dwindling and close canopied indigenous tree are being replaced by straight boled *Alnus, Cryptomeria, Eucalyptus, Pinus,* etc. Similarly, under water management programme initiated by different organisations, a number of exotics have been prefered over native species due to their known high productivity and better nutritional value. All these factors have caused in major qualitative as well as quantitative changes in the flora of the state. Consequently, many taxa of the Manipur state, viz., *Acer laevigatum, Aconitum elwesii, Aconitum nagarum, Alangium* spp., *Anneslea fragrans,Anoectochilus tetrapterus, Aquilaria malaccensis, Aldrovanda vasiculosa, Ascocentrum ampullaceum, Begonia obversa, Canarium strictum, Clematis apiculata, Dalhausea bracteata, Dendrobium bensonae, D. draconis,D. wardianum, Epigeneium amplum, Hedychium greenii, H. marginatum, Ilex embelioides, I. khasiana, Lilium maklinae, Ophiorrhiza wattii, Phoebe hainsiana, Sapria himalayana, Sheflera shweliensis, Psychotria symplocifolia* and *Trachelospermum auritum,* etc., are facing threat of survival in their natural habitats, probably few of them have already been extinct by now.

CONSERVATION

The importance of conservation of tropical rain forests and bio diversity for the survival of the humanity is now widely recognised, so much so that the UNCED (United Nations Conference on Environment and Development) has met at Rio in Brazil during June, 1992, to discuss global policies on environment and development in general and conservation of the tropical forest of the globe in particular. But the goal still remains a far cry, especially in the under and undeveloped countries in the tropical belt, where forest are considered to be nothing more than a revenue earning source even after imposing several Forest Conservation Acts. So far, the conservation is concerned, the biodiversity can be conserved by two apporaches i.e. *in-situ* and *ex-situ*. The conservation of genetic resources through their maintenance within natural ecosystems in which they grow, is the most ideal system as this permits natural evolution to take place, safeguarding ecological integrity. Accordingly,

Keibul Jamjao National Park has been declared for the protection of brow antlered deer, the most threatened deer species in the world. Besides, Manipur Zoological garden and Sirohed Hill, Dzukou valley declared as National Parks by the Forest Department, Govt. of Manipur are the appropriate for the conservation of the rich flora and fauna. However, it is not feasible to institute gene sancturies for every economic or threatened species. So far the Biosphere Reserve is concerned, it is unpleasent to say that not a single potential site has so far been identified in the state till date. It is very much relevant to say that forest area of *ca* 15,154 Sq km constitute 67 % of the total geographical area of the state (22347 sq km). Viewing the richness and diversity of flora and fauna, such reserves can be established at Dzukou valley and Sirohee - Kharasom areas of Manipur, as these sites are still harbouring pristine vegetation with minimum human interference. Due to speedy development of the state, it is not feasible to conserve all such areas where rare, threatened and endemic taxa grow. Therefore, it is suggested that rare and threatened species should also be rehabilitated to similar micro climatic niches in the restoration zone of the reserves.

Another viable means for preservation of selected taxa is their *ex-situ* conservation in botanical/experimental gardens, where they can be rehabilitated not only for future research but also for multiplication and commercial exploitation. That the Government of Manipur is planning to develop a botanical garden so that the flora of the state can be rehabilitated and preserved. Besides, seed gene banks, cryopreservation, pollen storage, genetic gardens and tissue culture techniques, etc. have also been used successfully for preservation of certain species. The one disadvantage in this kind of conservation is that only a small number of individuals representing a small fraction of the total genetic variability can only be preserved.

The Botanical Survey of India the apex organisation concerned with floristic resources of the country and it is actively engaged in an exhaustive inventorisation of the plants of the state and its conservation. Several rare and threatened species from Manipur have been brought under cultivation in experimental gardens at Wood lands Shillong and Barapani. The role of N.G.O's for formulating effective conservation strategy and involvement local people in joint Forest Management Programmes should be encouraged to safe guard the genetic wealth of the state. Only the judicious exploitation of bioresources will help us in the long run in improving the welfare of humanity and at the same time it will also facilitate to conserve this green heritage for posterity.

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Papilionanthe teres

Dendrobium wardianum

Mantisia saltatoria : dancing girl

Lilium mackliniae : a rare and endemic species of Manipur.

MEGHALAYA

K. Haridasan

Meghalaya, one of the seven north eastern states (formerly undivided Assam) is well reputed for its floristic richness (Hooker 1904; Rao 1974; Rao 1994; etc.). Its location, physiographical features and rich ethnic interactions have all contributed very favourably towards this richness and large scale endemism. This rich flora had been the centre of attraction for many botanists starting from Buchanan Hamilton (1820-24) to this date. Wallich (1820), Griffith (1848), Hooker (1854), Gustavman (1863-81), Bor (1942), Kanjilal *et al* (1934-40), Rao (1961), Rao (1974), Hajra (1974), Joseph (1982), Balakrishnan (1981), Neogi (1981), Myrthong (1982), Haridasan and Rao (1985), Rao and Varma (1982), Kataki (1973) and many other later botanists like Hajra, Dam, K. P. Singh, D. K. Singh, Hynniewta, Yogendra Kumar, Kharkongor, Jain, Kataki, Joseph. Deori and others added in many ways for the better understanding of the flora of Meghalaya. The establishment of the Eastern circle headquarter of the Botanical Survey of India at shillong, had a very favourable impact on our understanding of the flora of North-East India. As a result of all these, the flora of Meghalaya, is perhaps the best known in north east India. This does not exclude the prospect of further studies and explorations. There are still lacunae in our understanding of the lower plants, floristic changes, due to increased biotic interferance, flora of remote areas, plants and indigenous knowledge systems, etc.

The paper attempts to put in a nutshell, the information available at present.

LOCATION AND PHYSIOGRAPHIC FEATURES

Meghalaya has an area of 22549 sq km and lies between 25°00' and 26°10' N latitude and 89°45' and 92°45' E longitude and consists of 7 districts viz. East Garo hills, West Garo hills, East Khasi hills, West Khasi hills, Jaintia hills, South Garo hills and Ri Bhoi. It has a forest area of 15714 sq km as per Forest Survey of India report 1995. It is a predominantly hilly state sorrounded by the Assam and Bangladesh plains. The hills rise abruptly in south, while it is gradual in north. The hills in general have an east west orientation. The altitudinal variation range from 50-1950 m with the Shillong plateau at the crest. True to its name

Meghalaya is an abode of clouds and thus increased moisture conditions prevail. These hills are dissected and drained by a number of rivers and rivulets draining to north and south. In Garo hills, there are some westward flowing rivers. Some of the important rivers of Meghalaya are Umiam, Mawphlang, Umgnot, Simsang, Mahadeo, Rongkai, Kolkongkini, Daru, Drong, Kynshi Ildek, Dudnai, Didak, Jinjiram, Khri, Umtrew, Umkhen, Kupli, etc. The Shillong plateau is perhaps the oldest in the north east India.

The soil of Meghalaya differs greatly over different places. They are lateritic in origin and vary from sandy loam, red loam to clayey loam. They are grouped under laterite soil, ferruginous red soil (old or alluvium) Mountain and hill soil.

Meghalaya enjoys a very salubrious climate. However, the western part covering Garo hills is more hot and oppressive, while the Khasi and Jaintia hills are more cooler. Meghalaya receives high rain fall. Annual average ranging from 2800 mm to 4000 mm. Incidentally, the highest rainfall receiving areas in the world viz. Mawsynram and Cherrapunji are also in this state.

The maximum average temperature in summer is about 26°C in hills and 35°C in lower regions while the minimum is about 18 and 28°C respectively. In winter the maximum and minimum temperatures are 15°C - 22°C and 4°C - 8°C respectively. In the higher reaches winter frosts are a common feature. The relative humidity too is usually high never registered below 55%.

Over all, it can safely be said that the physical environmental features of Meghalaya are quite condusive to a wide ranging vegetation types harbouring rich flora.

VEGETATION

Due to favourable environmental factors, physiographical features, geographical location, biotic influence, human interaction, etc. the vegetation of the state is very rich and diverse. They could be conveniently, broadly grouped based on altitudinal difference as tropical, subtropical and temperate types. These could be further divided into types and subtypes depending upon the locality factors. Though the vegetation is intact in many pockets, a large portion of it is disturbed and resulted in secondary types.

Tropical Forest

These forest are met within areas up to an elevation of 900m and with an average rainfall of about 200 cm. They are more inportant from economic point of view and are the source of many of our useful plants yielding timber, fuel, fodder, medicine, aromatics and other non timber forest produce.

The major types of forest met with under this group of forest are Tropical evergreen forest, Tropical semi-evergreen forest, and moist deciduous forest.

Tropical Evergreen Forest

These forest usually occur in more wet slopes and valleys. These seldom form continuous belts due to various exogenous factors. They are complex in structure and rich in species diversity. They exhibit definite zonation and have an impenetrable herbaceous undergrowth, particularly during rainy seasons. The tier-wise distribution of species is as follows.

Top canopy : *Sapium baccatum, Castanopsis indica, C. tribuloides, Dysoxylum* spp., *Xerospermum glabratum, Cynometra polyandra, Elaeocarpus* sp., Syzygium spp., etc. Some of the emergent tree species here are deciduous and are represented by *Firmiana colorata, Tetrameles nudiflora, Pterygota alata,* etc.

Second storey/subcanopy : This layer is almost obscure from the previous one and has trees like *Garcinia pedunculata, G. paniculata, Syzygium operculata, Sarcosperma griffithii, Turpinia pomifera, Heritiera macrophylla, Ostodes paniculata, Knema linifolia, Chisocheton paniculatus* and many other species.

In many instances, a third storey would be discernible and the trees consist of *Oreocnide integrifolia, Alcornea tiliaefolia, Antidesma bunius, Ixora subsessilis, Prismatomeris tetrandra, Trevesia palmata, Saprosma ternatum,* etc.

The ground flora of undershrubs and herbs includes *Dracaena elliptica, Leea edgeworthia, Phlogacanthus* sp., various Acanthaceous, Rubiaceous, Balsaminaceous, and Asteraceous sp. According to the season these herbaceous plants vary in their dominance.

Climbers and lianas form a characteristic species composition of these forest. To mention a few are *Hodgsonia macrocarpa, Beaumontia grandiflora, Gnetum scandens, Ventilago, Cayratia, Entada, Schefflera, Chonemorpha, Phanera, Ampelocissus, Combretum, Lasiobaema,* etc. In addition, at some places one can see climbing bamboos and species of Rattan (Cane).

The forest structure is incomplete without the mention of epiphytes. Many trees are perched with this group of plants belonging to Ferns, Orchids, Gesneriads, Piper, Aroids, Mosses and many others. The prevalence of stem clasping climbers are remarkable.

Tropical Semi-Evergreen forest

This type of forest occupy the north and north eastern slopes of the state. Like the former, the forest are much complex and stratified. However, there is a preponderance of deciduous tree species along with evergreen species compared to the former type. *Tetrameles, Dillenia pentagyna, Acrocarpus, Terminalia, Careya* are some such deciduous species. In this type of forest there is a lesser representation of epiphytes. The ground flora is also much seasonal with a greater representation of gregarious growth of Zingiberaceous species like *Curcuma,* ferns, etc. This is also a treasure house of economically important species.

Tropical Moist and dry deciduous forest

This is a very prominent vegetation of Meghalaya covering larger areas in, the east and west Garo hills, Ri-Bhoi, etc. The rainfall in this forest belt is slightly lower than the previous vegetation areas. Temperature too is higher. These forest are characterised by seasonal leaf shedding and profuse flowering. They are much valued for their economically important species like *Shorea robusta, Terminalia myriocarpa, Lagerstroemia parviflora, Gmelina arborea, Artocarpus chaplasha, Morus laevigata* and *Vitex peduncularis.* Other important associated species seen are *Schima wallichii, Toona ciliata, Bridelia retusa, Albizia lebbeck, Terminalia* sp., *Albizia lucida, Dillenia pentagyna,* etc. Most of these trees are canopy forming.

The forest, as is expected in a tropical forest, have a complex tiered structure.

The middle storey trees seen just below the canopy are *Aporusa roxburghii, Croton roxburghii, Careya arborea, Rhus accuminata, Micromelum integerrimum, Piliostigma malabarica, Glochidion lanceolarium, Mallotus tetragonum, Meyna laxiflora, Grewia* spp., *Polyalthia* sp., etc.

The shrubby layer is more gregarious and prominent. This stratum is represented by the species of *Phlogacanthus, Leea, Desmodium, Flemmingia, Holarrhena, Glycosmis, Allophyllus, Licuala, Costus, Stachetarpheta,* and *Eupatorium* (mostly near open areas).

The common climbers and lianas seen here are *Combretum* spp., *Mussaenda* sp., *Hiptage, Aspidopteris, Ventilago, Gouania, Phanera, Entada, Spatholobus, Chonemorpha, Toddalia, Cayratia* and others.

The epiphytic flora as expected is comparatively lesser here. However, those seen include *Dendrobium, Cymbidium, Papilionathe, Rhynchostylis.,* etc from Orchidaceae, *Pseudodrynaria, Asplenium, Microsorum* etc. from ferns, *Hoya* from Asclepiadaceae, etc.

Most of the deciduous forest fall under the sal forest which are infact man-made in nature. The composition of trees as well as the herbaceous flora vary much from place to place.

Subtropical Pine Forest

The pine forest are seen above the tropical zone and are confined to the higher reaches of the Shillong plateau in Khasi and Jaintia hills. The altitudinal range is from 900 m - 1500 m. The pine forest unlike the tropical forest are less complex in structure and comparatively poorer in respect of species richness when seen with tropical types. The canopy trees obviousely are of pines which tend to grow gregariously and in pure stands. The main species is *Pinus kesiya.* However, in certain places the pines are associated with a few broad-leaved species like *Schima wallichii, Myrica esculenta, Erythrina arborescence, Rhus javanica, Lyonia ovalifolia, Rhododendron arboreum, Quercus* sp. etc. Most of them are subcanopy species or Middle storey species. There is, however not much stratification seen.

The shrubby layer is of *Rubus, Osbeckia, Spirea, Neillia, Artemesia,* etc. The ground flora is seasonal and attractive flowering plants like

Chrysanthemum, Aster, Hypochaeris, Prunella, Plectranthus, Desmodium, Ranunculus, Anemone, Potentilla, Clinopodium, Polygonum, Elsholtzia are common. They appear during summer/rainy season. An exotic species *Eupatorium adenophorum* is characteristic. There is paucity of epiphytic and climbing flora, though they are scantily represented by orchids, ferns and *Clematis*.

The pine forest are a climatic subclimax and are maintained at that level through recurring annual fires.

Subtropical Broad Leaved Forest

In the same altitudinal zone with more wet areas, the very dense and complex structured broad leaved, forest appear. Though, the tierwise dispersal of trees is not distinct, the canopy trees are *Lithocarpus fenestratus, Castanopsis kurzii, Michelia, Schima wallichii, Rhus javanica, Photinia arguta, Symplocos glomerata, Elaeocarpus prunifolius, Betula alnoides, Alnus nepalensis, Engelhardtia spicata, Castanopsis tribuloides, Quercus griffithii*, etc.

This layer is followed by a number of smaller tree species like *Macropanax, Schefflera, Lyonia, Ardisia, Camellia, Eurya, Ligustrum, Wendlandia, Myrsine, Viburnum, Symplocos*, etc. A very strong shrubby layer can be seen in these forest. The main species seen in this layer are *Neillia thyrsiflora, Spirea, Osbeckia, Rubus, Diflugossa colorata, Viburnum, Maesa, Plectranthus* spp., *Symplocos* spp., *Clerodendrum* spp., *Solanum* spp., etc. There are many species in this belt which are common with the temperate type.

The herbaceous ground flora is indeed different in different seasons. *Polygonum, Drymaria, Galinsoga, Ageratum, Osbeckia, Desmodium, Smythia, Prunella* and many others belonging to Asteraceae, Lamiaceae, Scrophulariaceae, Caryophyllaceae, Acanthaceae, Ranunculaceae are the usual representatives.

Temperate Forest

The temperate forest in Meghalaya are confined to some high altitude pockets, particularly the sacared grooves. Though, these are not in

the actual altitudinal zones of temperate forest, the species composition suggests their temperate nature, rather they could be termed subtemperate types.

These forest are seen above 1500 m. A special feature is the high rainfall associated with these areas. The trees seen in the canopy are *Lithocarpus fenestratus, Castanopsis kurzii, Quercus griffithii, O. semiserrata, Schima khasiana, Myrica esculenta, Symplocos glomerata, Photinia arguta, Ficus nemoralis, Manglietia caveana, Acer* sp., *Exbucklandea populnea, Englehardtia spicata, Betula alnoides, Rhododendron arboreum.* etc. The canopy is quite thick and dense.

A well developed shrub layer can be seen in these forest. The dominant species include *Mahonia pycnophylla, Daphne papyraceae, Polygala arillata, Camellia caudata, Neillia thyrsiflora, Lyonia ovalifolia, Rubus* spp. Most of the herbaceous plants in this layer are seasonal and provide a spectacular change in the floral composition.

The epiphytic flora is exceptionally rich and comprise of Ferns, Lichens, Mosses, Orchids, Zingibers, Aroids, Gesneriads, etc. *Loxogramme involuta, Pyrossia* spp., *Pleione praecox, Coelogyne punctata, Agapetes obovata, Vaccinium donianum, Aeschenanthus* sp., *Hoya* sp., are worth mentioning.

Climbers are less frequent but those seen include *Kadsura heteroclita, Hedera nepalensis Codonopsis javanica, Holboelia latifolia, Clematis loureriana,* etc. Very good accounts of the sacred grooves are provided by Bor (1942) Raju (1968) and Hajra (1975).

Secondary Forest

Due to various adverse factors, the climax forest give way to secondary types. These factors could be shifting cultivation, urbanisation, settlements, over exploitation, etc. Once the forest are removed, various successional stages of vegetation takes place and the secondary types like bamboo forest, grasslands or degraded forest result. The bamboo forest appear uniform and gregarious without much undergrowth. The main bamboo species are *Dendrocalamus hamiltonii* and *Melocanna bambusoides* which are the most common ones. Some other species found less frequently are *Bambusa pallida, Bambusa tulda, Chimonobambusa khasiana,* etc. These are the preferred ones for cultivation. Bamboos

also could be seen in forest gaps in the lower reaches and in degraded forest.

Grasslands : An interesting feature of the vegetation is the vast stretches of rolling grasslands. They are more prevalent in higher altitudes and are the results of removal of once occupied pristine forests, the relics of which could be seen amidst these grasslands as sacred grooves. The grasses belong to genera like *Panicum, Paspalum, Imperata, Axonopus, Neyraudia, Sporobolus, Saccharum, Chrysopogon, Oplisminus* and others along with sedges, dicotyledonous herbs like *Eriosaema, Polygonum, Trifolium, Smythia*, etc. In warmer areas a few scattered trees like *Glochidion, Callicarpa, Mallotus, Ficus*, etc. amidst grasses make it a "savanna"

Degraded Forest

This type of vegetation develops in jhum fallows which have long interval period between consecutive cultivation. Though the trees develop, but they are mostly pioneers and of inferior quality. There is poor species diversity compared to the original vegetation. Some species of trees include *Macranga, Mallotus, Glochidion, Bridelia, Grewia, Dillenia*, etc. along with the bamboo *Dendrocalamus hamiltonii.*

Thus, it could be seen that though there is not much altitudinal variation as compared to the himalayan states but there occurs a wide variety of vegetation type. This vegetation harbours one of the worlds' richest flora and biodiversity.

FLORISTIC DIVERSITY

The flora of Meghalaya has long been recognised as one of the richest in India, perhaps in Asia as well, (Hooker 1872-97, 1904). Subsequent botanical surveys and studies like Kanjilal *et al.* (1934-40) Balakrishnan (1981), Joseph (1982), Kataki (1983), Baishya and Rao (1982) Haridasan and Rao (1985) have all strengthened this view. A visit to any part of the state will make the visitor astonished to see the amazing variety and diversity of the flora that can be expected in a small unit area, whether it is climax forest, secondary forest or any other type of vegetation. The state is also the home for many interesting and curious plant groups. The most spectacular among them are the insectivorous plants (Joseph and Joseph 1986). The floristic richness is attributed to the favourable ecological and

environmental factors and to the specific geographical position and topographic features. Its sub-himalayan existence and the abrupt raising of hills over the vast plains that surround the state all around has, resulted in rich endemism. It is evident from the fact that a number of specific epithets (over 68) for Indian plants originate from Meghalaya place names (Table I). The flora is also a unique assemblage of economic and useful plants which yield timber, fuel, fodder, resin, medicinal plants, aromatics, oils, spices, bamboos, canes, etc. They have been variousely used by the people inhabiting the state from time immemmorial. This interaction has resulted in evolution of plant species. Due to the prevalence of many primitive species among the states flora, Takhtajan has rightly pointed out the north east region as the centre of origin of some of our crop plants.

Table I
Plant names with specific epithets originating inMeghalaya

Name of the species	Family
Aglaia khasiana	Meliaceae
Agrostophyllum khasianum	Orchidaceae
Anisadenia khasiana	Linaceae
Antidesma khasianum	Euphorbiaceae
Argostemma khasiana	Rubiaceae
Arundinella khasiana	Poaceae
Arundinaria khasiana	Poaceae
Aquilaria khasiana	Thymeleaceae
Alseodaphne khasiana	Lauraceae
Bambusa khasiana	Poaceae
Beaumontia khasiana	Apocynaceae
Calamus khasianus	Arecaceae
Campanula khasiana	Campanulaceae
Carum khasianum	apiaceae
Cheilotheca khasiana	Monotropaceae
Chimonobambusa khasyana	Poaceae
Claoxylon khasianum	Euphorbiaceae
Coelorachis khasiana	Poaceae

Name of the species	Family
Cymbopogon khasianus	Poaceae
Daphne shillong	Thymelaceae
Dischidia khasiana	Asclepiadaceae
Epilobium khasianum	Onagraceae
Euphorbia khasiana	Euphorbiaceae
Fagraea khasiana	Loganiaceae
Germania khasiana	Poaceae
Glochidion khasicum	Euphorbiaceae
Habenaria khasiana	Orchidaceae
Hierochloa khasiana	Poaceae
Illigera khasiana	Hernandiaceae
Ilex khasiana	Aquifoliaceae
Impatiens khasiana	Balsaminaceae
Ixonanthus khasiana	Ixonanthaceae
Justicia khasiana	Acanthaceae
Litsea khasiana	Lauraceae
Macropanax meghalayensis	Araliaceae
Mallotus khasianus	Euphorbiaceae
Melodinus khasianus	Apocynaceae
Melaxis khasiana	Orchidaceae
Microstylis khasiana	Orchidaceae
Nepenthes khasiana	Nepenthaceae
Panicum khasianum	Poaceae
Parophiorrhiza khasiana	Rubiaceae
Phanera khasiana	Caesalpinioideae
Pentanura khasiana	Asclepiadaceae
Piper khasianum	Piperaceae
Plectocomia khasiana	Arecaceae
Premna khasiana	Verbenaceae
Prenanthus khasianus	Asteraceae
Poa khasiana	Poaceae
Pyrus khasiana	Rosaceae

Name of the species	Family
Rhus khasiana	Anacardiaceae
Rubus khasianus	Rosaceae
Rungia khasiana	Acanthaceae
Sabaea khasiana	Loganiaceae
Schima khasiana	Theaceae
Scutellaria khasiana	Lamiaceae
Senecio jowaiensis	Asteraceae
Silene khasiana	Caryophyllaceae
Solanum khasianum	Solanaceae
Sonerila khasiana	Melastomataceae
Stenosiphonium khasianum	Acanthaceae
Tainia khasiana	Orchidaceae
Thelasis khasiana	Orchidaceae
Tournefortia khasiana	Boraginaceae
Trachyspermum khasianum	Apiaceae
Trichodesma khasiana	Boraginaceae
Zanthoxylum khasianum	Rutaceae

(Nomenclatural changes not excluded)

The states flora is estimated to contain a minimum of 3000 species. Considering the smaller geographical area this is a very significant number. As per previous literature the largest ten families are given below (Table II).

Table II
Ten dominant families

Sl.No.	Family	Meghalaya		India	
		Genera	Species	Genera	Species
1.	Orchidaceae	98	352	184	1229
2.	Poaceae	121	284	264	1291
3.	Fabaceae	40	130	167	1141

Sl.No.	Family	Meghalaya		India	
		Genera	Species	Genera	Species
4.	Rubiaceae	52	119	113	616
5.	Cyperaceae	17	107	38	545
6.	Euphorbiaceae	38	90	84	523
7.	Asteraceae	42	86	166	803
8.	Acanthaceae	24	77	92	500
9.	Rosaceae	18	60	40	432
10.	Lamiaceae	32	55	72	435

It is interesting to note that as many as 52 families of flowering plants in Meghalaya have only one genus in the state. Of these 33 have one species only, 10 have 2 species, 3 have 3 species and so on. Famlies having one genus with one species; Bombacaceae, Opiliaceae, Ixonanthaceae, Moringaceae, Erythroxylaceae, Rhizophoraceae, Malpighiaceae, Barringtoniaceae, Averrhoaceae, Sonneratiaceae, Ochnaceae, Crypteroniaceae, Tetramelaceae, Salicaceae, Dipsacaceae, Hydrocharitaceae, Stylidiaceae, Musaceae, Nepenthaceae, Cannaceae, Daphniphyllaceae, Bromeliaceae, Bischofiaceae, Amaryllidaceae, Cannabaceae, Taccaceae, Myricaceae, Stemonaceae, Corylaceae, Pontederiaceae, Sparganiaceae, Butomaceae, Potamogetonaceae; with two species Staphylaceae, Valarianaceae Buddlejaceae, Chloranthaceae, Elaeagnaceae, Juglandaceae, Burmanniaceae, Marantaceae, Xyridaceae, Pandanaceae; with three species Pittosporaceae, Aceraceae, Hernandiaceae; with four species Hypericaceae, Lobeliaceae, Aristolochiaceae; with five species Saurauiaceae; with seven species Eriocaulaceae, with eight species Aquifoliaceae, Leeaceae; with nine species Ebenaceae, Dioscoreaceae; with ten species Symplocaceae.

The top ten families have in themselves lot of diversity and variation in terms of their habits, habitat preferences, utilization, etc. The following paragraphs highlight such diversity in these families.

Acanthaceae

Acanthaceae in Meghalaya is represented by 24 genera, and 77 species. They have a greater preference to the tropics and sub-tropics. The family has mostly herbs and shrubs The habitatwise they can be seen in

open areas, shades and wetlands. There is a remarkable diversity in their infloresence and flowers which are of various colour.

Asteraceae

This family has greater representation in Meghalaya with its features of diversity. In every type of habitat they could be seen ranging in size and habits from the smaller herb to even trees like *Vernonia volkamerifolia.* There are scandent ones like *Senecio.* However, a majority of them are herbs and shrubs. Due to their characteristic adaptations and effective seed dispersal mechanism either through floating pappus or sticking hairs, they appear mostly gregarious in distribution. Being able to survive in adverse and harsh conditions they appear as pioneers and early colonisers (*Eupatorium odoratum, E. adenophorum, Mikania macrantha, Ageratum conyzoides Crassocephalum crepidioides)* often reckoned as weeds. Many such species in Meghalaya are exotics. *Senecio jowaiensis* is an endemic species.

From the economic point of view, a few of them are ornamenatals like *Tithonia diversifolia Chrysanthemum cinerarifolium, Hypochaeris radicata, Senecio* spp., as ethnomedicine for blood clotting like *Ageratum, Eupatorium, Mikania;* for tooth, *Spilanthes* while *Crassocephalum* is used as vegetable, *Helianthus* is used as source of oil.

Cyperaceae

This family has 17 genera and 107 species in the state. Like Poaceae they are widely seen sharing the same habitats and conditions. But they are all herbs prefering marshy or shady habitats. A few like *Carex* are of wide occurrence. They have a few genera with substantial species composition. Some larger genera of Cyperaceae in Meghalaya are *Carex, Cyperus* and *Fimbristylis.*

Euphorbiaceae

This is a phenomenally diverse family with wide ranging habits and habitat choices. They can be seen as small herbs, shrubs, trees or twiners. They are also seen as succulents like *Euphorbia nerifolia.* Due to their adaptive features they may be seen in tropical dry areas, mesic and xeric localities. The members of this family are of ornamental value for their variously coloured inflorescence, foliage (*Jatropha, Poinsettia*). Plants like

Euphorbia are known for their medicinal values. *Emblica* is good source of vitamin 'C' through its fruits and is an ingredient of different drug preparations. *Souropus* is a vegetable. *Heveae braziliensis*, the rubber yielding plant and *Aleuritis fordii* are plantation crops. *Ricinus communis* (Castor), a plant known for its oil yielding fruits, is also used for Eri silk worm rearing. Fruits of *Breynea* yield a bluish dye. Thus the family has a great diversity in terms of utilization. Further some genera like *Euphorbia, Phyllanthus,* etc. show great diversity in their habits ranging from herbs to subwoody plants. They also show great tolerance to wide ranging habitat conditions too.

Fabaceae

In Meghalaya this family is quite diverse in many aspects. In habits, they have representatives of herbs (*Smythia*) shrubs (*Moghania*), trees (*Milletia*) and climbers (*Apios*). Their morphological features too are diverse. Their leaves are particular in that a few have simple leaves but others may have trifoliate, paripinnate, imparipinnate or decompound. Their fruit/pods could be ranging from a few millimeter to quite large with over 30 cm in length. In terms of habitat preferences the family members could be seen in all types of habitats either tropical marsh or tropical deciduous or high altitude, forest and as under growths in poor light conditions. Like wise they can thrive in very degraded soils and harsh conditions to fertile lands in Climax forest. They are peculiar with their ability to fix nitrogen in soil with their root nudules. From the utilization point of view, Fabaceae is a very important family to mankind as they are the source of pulses, which are the protein source for us. Apart from this proteinaceous diet, they are having tubers of food value (*Moghania* sp.) edible flowers (*Sesbania),* edible fruits (*Lathyrus, Dolichos, Vigna*) edible leaves (*Vigna*), medicinal plants (*Peuraria*), poisonous ones (*Milletia, Derris,* etc.) allergic types (*Mucuna)* and fodders (*Trifolium).* It has also some of the important timber species like *Dalbergia sissoo.* Further, the family has representation of genera which have only one species like *Parochetus communis, Apios carneae* to some with many species like *Desmodium, Dalbergia,* etc. Indeed, it is a large family which has 40 genera and 130 species in Meghalaya and is full of diversity and adaptability.

Lamiaceae

This family with over 32 genera and 55 species is common throughout the state in alomost all types of vegetational zones. Mostly they are

herbs like *Leucus, Coleus* and *Plectranthus*. But some like *Leucosceptrum* are small tree. They could be seen in exposed open grass lands as represented by *Prunella, Leucas*, etc. and in shades as undergrowth in forest as *Plectranthus*. Some like *Coleus* are ornamental. *Leucus* is medicinal. A few are used as vegetable too. Its efficient seed dispersal mechanism has helped the family to colonise all over the state.

Orchidaceae

This is the largest family in Meghalaya. It is a family with immense diversity and variations. Though, there is no tree habit in this family but there are plants ranging from ephimerals (*Epipogeum*) to perennials, (*Vanda, Dendrobium*, etc). They are also met with as saprophytes, or normal plants in wide ranging habitats like terrestrial, lithophytic or epiphytic in tropical to tempertate habitats. Some saprophytes seen in humid forest are species of *Epipogeum, Gastrodia, Galeola*, etc. Ground orchids of *Cymbidium, Arundina, Phaius* are frequent. Epiphytic ones belonging to genera *Vanda, Dendrobium, Papilionanthe, Rhynchostylis, Pleione, Coelogyne* are important. *Geleola, Dendrobium moschatum* are larger ones, *Pleione* and some species of *Bulbophyllum* are smaller. Some like *Teniophyllum* do not even have leaves, reducing their shoot to root like structures.

As orchids are known for their flowers, it is worth considering the differences and diversity in flowers. In size they range from very small and insignificant ones like that of *Oberonia* to large and pretty ones like *Vanda coerulea, Paphipedilum, Papilionanthe*, etc. A wide range of colours could be noticed from dull white, yellow, orange, pink, blue, white etc. and in various combinations which add to their ornamental value. The flowers also last from a few hours (*Epipogium*) to over a month as in *Paphiopedilum*. Their long lasting nature make it ideal for cut flowers. Apart from their ornamental value, a few orchids are medicinal too. While most orchids do not emit smell some like *Cymbidium munronianum* are fragrant. Orchids like *Vanilla* are source of essence.

Poaceae

Poaceae are ubiquitous and unique with their near uniform habits. They are adapted to wider habitat conditions from tropical marsh to temperate grass lands. They range in size from a few centimeters to many

meters as seen in the section Bambusae, the bamboos. They are either trailing grass or tufted clump forming ones. They may also range from seasonal to perennial types living up to over 100 years as in *Bambusa vulgaris*. Grasses are known for their edible grains as in *Oryza* but young shoots of some bamboos and stems of sugarcane are also edible. They are either with hollow or solid stems. They are good fodder, construction material, industrial raw materials, handicraft items, soil conservation plants, etc. Many genera of grasses are with numerous species as seen in *Poa, Bombusa* etc. while others have one, two or three species. The family has 121 genera and 284 species in Meghalaya.

Rosaceae

The family, though not represented in the top ten families of India but has a dominance in Meghalaya with over 60 species. This is mainly due to the sub-tropical and temperate elements. The family is quite diverse in that it has representation of plants of herbaceous to arboreal nature. Quite a few of them are stragglers. They differ in terms of armature as prickly, thorny or unarmed and in leaves ranging from simple trifoliate to pinnate types. They may be of single flowers or inflorescence of cymes, umbels, racemes or panicles. The flowers are quite attractive and vary in colour from white yellow or pink.

Edible fruits are obtained from *Pyrus,. Prunus, Rubus* etc. *Rosa*, is known for its flowers. The genus *Rubus* is remarkable with a lot of variation in their leaves from single lobed to trifoliate and pinnate. This family in Meghalaya is represented by 18 genera and 60 species with exotics (*Prunus, Pyrus*) and indigenous (*Rubus, Docynia* etc.) species.

Rubiaceae

This family in Meghalaya is diverse in its habit and habitat preferences. They range in habit from small herbs like *Oldenlandia* to trees like *Hymenodictyon, Mitragyna, Adina,* etc. Climbers are represented by *Uncaria*. Within one genus itself there is diversity from herbs to shrubs or even trees. *(Hedyotis, Mussaenda,* etc.) There is observable variation in case of inflorescence from cymes (*Saprosma*) panicles (*Wendlandia*) fascicles (*Coffee*) and even head like compact infloresence (*Uncaria*), etc. There is also a number of modification like petalloid sepal, Petalloid bract, thorny stipules, stipular hooks etc, as seen in *Mussaenda, Hymenopogon,*

Uncaria, etc. Their flowers are very minute as in *Borreria* (*Spermacoce*) to magnifiscent large like those of *Luculia*. As a matter of fact they are often horticulturally important as ornamentals. Some others are ethnobotanically popular *(Paederia* 'medicinal as well as vegetable) *Rubia cordifolia* is a source of dye in the north east for their hand woven clothes.

This family is also ubiquitous in Meghalaya with representation in all types of forest and agroclimates. However, their maximum representation is in the tropics.

PHYTOGEOGRAPHY

The flora of Meghalaya has affinities to different phytogeographical realms of the world and to the phytographical regions of India. Balakrishnan (1981) provides a very good account of the phytogeography of Meghalaya in his Flora of Jowai. As expected, the flora is largely Indo-Malayan in nature. There are good representation of Sino-Himalayan species, owing to its subhimalayan existence. Many floristic elements show disjunct distribution with western ghats, thus pointing towards the peninsular Indian affinities. The flora also shows some affinities with the American, African, European and Australian flora to some extent.

The Gondwana land origin, transmigration of plants, the geographical locations, the early British presence and the selection of Shillong as their headquarters for N.E. region, migration of people from all over India, the flow of large rivers like Brahmaputra originating from China and the annual wind movement patterns, all have contributions to the floristic inter mixing and phytogeographical affinities.

To cite a few examples of plants showing different affinities are *Nepenthes, Vaccinium, Macrosolen, Balanophora,* etc. (Malayan), *Corylopsis, Kadsura, Camellia, Mahonia,* etc. (sino-himalayan), *Deeringia, Holoragis,* etc. (Australian), *Boeschneakia, Pyrularia, Zanthoxylum, Salomonia, Cuphea,* etc. (American New world) *Ochna, Meyna, Heritiera* (African) *Leea, Munronia, Xanthophyllum, Helicia* (Peninsular Indian). It is indeed remarkable to have such wider affinities.

Despite having such strong phytogeographical affinities, the state has a flora of its own too. There are quite a few new species and endemics from Meghalaya.

ECONOMIC USES

The rich and diverse flora of Meghalaya come into the life of the people of the state in many ways. The people of the state being tribal have intimate knowledge of the flora surrounding them and indigenous ways of using it. The indigenous knowledge system is well rooted and has strong ramifications. Apart from the use of plants as timber, fuel, etc. there are a host of other ways by which different plants are used in Meghalaya. The main timber species are *Shorea robusta, Schima wallichii, Lagerstroemia parviflora, Dysoxylum* spp., *Artocarpus chaplasha, Amoora wallichii, Toona ciliata, Duabanga grandiflora, Gmelina arborea, Chukrasia velutina, Pinus kesiya, Tectona grandis* and many others. For fuel and charcoal the species like *Legerstroemia speciosa, Pterospermum acerifolium, Stereospermum chelonoides, Vatica lancifolia, Castanopsis, Quercus* spp. etc are preferred. *Bauhinia* spp., *Stereospermum, Artocarpus, Ficus, Villebrunea* are utilised as fodder.

Edible fruits are obtained from tree species like *Dillenia indica, Myrica esculenta, Terminalia chebula, Spondias axillaris, S. pinnata, Elaeocarpus floribundus, etc.* Other plants like *Rubus, Elaeagnus, Garcinia, Syzygium, Emblica, Docynia* are also recognised as sources of edible fruits in wild.

Deeringia, Diplazium esculentum, Pouzolzia, Sarchochlamys, Mussaenda, Zanthoxylum, Houttuynia, Spilanthus, etc. yield leafy vegetable. The young shoots of *Dendrocalamus hamiltonii* (the common bamboo) is a delicacy in Meghalaya too as in other parts of the north eastern region.

Zanthoxylum armatum, Paedaria foetida, Hedyotis scandens, Rauvolfia serpentina, Rhus javanica, Houttuynia cordata, Acorus calamus, Ageratum conyzoides, Holarrhaena pubescens, Adhatoda zeylanica, Plumbago zeylanica, Clerodendrum colebrookianum, Abroma augusta, Panax pseudoginseng, Berberis sp., are a few of the many medicinal plants of the state.

Moutia puya, Sterculia villosa, Trema orientalis, Boehmeria etc. yield fibres for different use. *Rubia cordifolia, Bixa orellana* are known for their natural dyes. *Pinus kestya, Canarium stricum,* etc. are source of resins.

Millettia, Aesculus, Zanthoxylum are used as piscicidal plants for capturing fish. Many orchids, like *Vanda, Dendrobium, Rhyncostylis, Papilionanthe, Paphiopedilum, Coelogyne, Pleione,* etc. and ferns like *Asplenium, Lycopodium, Nephrolepes* and other plants like *Rhododendron, Begonia, Chirita, Primula, Aeschenanthus, Hoya, Phlogacanthus, Thunbergia* are used as ornamentals. The ethnobotany of Meghalaya is fairly well known through the works of Rao (1981a, 1981b), Rao and Neogi (1980) Rao and Sanpru (1981), Kumar *et al.* (1982) Joseph and Khankongor (1981).

ENDEMISM

As is true to the Indian flora, Meghalayan flora has a good representation of endemics. There are more than 50 endemics reported from here (Table III). The wide separation of the Meghalayan hills by the large plains of Brahmaputra valley and Surma valley and ridges might have contributed to this feature. Balakrishnan (1981).

Table III
Endemic Taxa

Name of the species	Family
Aphyllorchis vaginata	Orchidaceae
Adindra griffithii	Theaceae
Aechmanthera leiosperma	Acanthaceae
Alsodeia racemosa	Violaceae
Anacolosa ilicioides	Olacaceae
Baliospermum micranthus	Euphorbiaceae
Calliandra griffithii	Mimosaceae
Callicarpa psilocalyx	Verbenaceae
Camellia caduca	Theaceae
Ceropegia angustifolia	Asclepiadaceae
Citrus latypes	Rutaceae
Corybas purpureus	Orchidaceae
Cynanchum wallichii	Asclepiadaceae
Dactylicapnos torulosa	Fumariaceae

Name of the species	Family
Daphne shillong	Thymelaeaceae
Eria ferrugineae	Orchidaceae
E. pusilla	Orchidaceae
Eriobotrya angustissima	Rosaceae
Gastrodia exilis	Orchidaceae
Glochidion thomsonii	Euphorbiaceae
Goldfusia glabrata	Acanthaceae
Goodyera recurva	Orchidaceae
G. robusta	Orchidaceae
Gymnostachyum venustum	Acanthaceae
Habenaria concinna	Orchidaceae
Habenaria furfuraceae	Orchidaceae
H. khasiana	Orchidaceae
Hedychium dekianum	Zingiberaceae
Hyperrhena griffithii	Poaceae
Ilex embelioides	Aquifoliaceae
I. venulosa	Aquifoliaceae
Impatiens acuminata	Balsaminaceae
I. khasiana	Balsaminaceae
I. laevigata	Balsaminaceae
I. porrecta	Balsaminaceae
Ischaemum hirtum	Poaceae
I. hubbardii	Poaceae
Lindera latifolia	Lauraceae
Liparis acuminata	Orchidaceae
Micropera mannii	Orchidaceae
Paramignya micrantha	Rutaceae
Pantlingia serrata	Orchidaceae
Pennilabium proboscidium	Orchidaceae
Phlogacanthus wallichii	Acanthaceae
Photinia cuspidata	Rosaceae
P. polycarpa	Rosaceae

Name of the species	Family
Pogonotherum rufobarbatum	Poaceae
Pogostemon strigosus	Lamiaceae
Pteracanthus griffithianus	Acanthaceae
P. nobilis	Acanthaceae
P. rubescens	Acanthaceae
P. urophyllus	Acanthaceae
Rhychospora griffithii	Cyperaceae
Rubus khasianus	Rosaceae
Salix psilostigma	Salicaceae
Senecio jowaiensis	Asteraceae
Sympagis maculata	Acanthaceae
S. monadelpha	Acanthaceae
Taeniophyllum khasianum	Orchidaceae
Tarphochlamys affinis	Acanthaceae
Tetrastigma obovatum	Vitaceae
Trachyspermum khasianum	Apiaceae
Thrixspermum muscaeflorum	Orchidaceae
Trias pusilla	Orchidaceae
Trivalvaria kanjilalii	Annonaceae

THREATENED AND RARE TAXA

The rich flora of Meghalaya is exposed to a variety of external factors that adversely affect the flora. The generally recognised causal factors like population explosion, urbanisation, settlements, developmental activities like road, dam, industrial and other constructions, different land use practices like jhum agriculture, conversion of natural forest to horticulture, industrial plantation, are all active in the state in a very significant way. Meghalaya is a developing state and is rapidly changing in terms of forest cover. Many climax vegetation seen a decade ago have been dessimated to secondary degraded types with poor plant diversity. Jain and Sastri (1980) have suggested various categories of endangered plants for India. The threatened plants of Meghalaya fall under all these

categories. However, the list of threatened plants may vary from the national one, due to local conditions. As there is possibility of occurrence of a nationally endangered plant, to be very common in the state and vice versa. Thus a regional or state list is always important and more relevant. There has been a few publications on the threatened plants of Meghalaya which brought to light the need for their conservation (Jain and Sastri 1980; Hajra, 1974; Rao and Haridasan, 1983; Kumar and Rao, 1983; Sandhya Jyoti Das and Deori, 1983; Chauhan, 1983; Kataki, 1983; Chauhan and Singh, 1992). The following list is largely based on these works and personal observations. (Table IV).

Table IV
Threatened plants

Name of the species	Family	Distribution
Apodites benthamiana	Olacinaceae	Khasi hills
Aphyllorchis vaginata	Orchidaceae	
Artabotrys caudatus	Annonaceae	Garo hills
Alisma plantago-aquatica	Alismataceae	West Khasi hills
Anthoxanthum clarkei	Poaceae	Khasi hills
Alsodeia racemosa	Violaceae	Khasi hills
Aglaia edulis	Meliaceae	Garo hills
Arachnanthe cathcartii	Orchidaceae	Khasi hills
Ballospermum micranthum	Euphorbiaceae	Khasi hills
Berchemia floribunda	Rhamnacae	Shillong
Bruceae mollis	Simaroubaceae	Garo hills
Bulbophyllum moniliforma	Orchidaceae	Jaintia hills
Cardiopteris lobata	Olacaceae	Balphakram
Carex inclinix	Cyperaceae	Upper shillong
C. rara	Cyperaceae	Upper shillong
Ceropegia angustifolia	Asclepiadaceae	Balphakram
Cherostylis pusilla	Orchidaceae	Balphakram
Chirtia hamosa	Gesneriaceae	Garo hills
Corybas purpureus	Orchidaceae	Khasi hills
Cyathocalyx martabanicus	Annonaceae	Garo hills
Diplomeres pulchella	Orchidaceae	Balphakram

Name of the species	Family	Distribution
Docynea hookeriana	Rosaceae	Balphakram
Epipogium roseum	Orchidaceae	Nangpoh
Eria pusilla	Orchidaceae	Shillong
Eriocaulon echinulatum	Eriocarlaceae	Balphakram
Fraxinus floribundus	Oleaceae	Shillong
Fissistigma verrucosum	Annonaceae	Raliang
F. rubiginosum	Annonaceae	Garo hills
Gastrodia exilis	Orchidaceae	Raliang
Goniothalamus simonsii	Annonaceae	Lailad
Galeola falconeri	Orchidaceae	Khasi hills
Habenaria furfuraceae	Orchidaceae	
H. khasiana	Orchidaceae	
Hedychium dekianum	Zingiberaceae	Jaintia hills
H. hookeri	Zingiberaceae	
H. marginatum	Zingiberaceae	
Hemiorchis rhodorrhachis	Zingiberaceae	Khasi hills
Haematocarpus thompsoni	Menispermaceae	Khasi hills
Ilex khasiana	Aquifoliaceae	Shillong
Liparis torta	Orchidaceae	
Luvunga scandens	Rutaceae	Mausmai
Lepisanthes burmanica	Sapindaceae	Khasi hills
Monotropa uniflora	Monotropaceae	Shillong
Miquelia kleinii	Icacinaceae	
Meliosma manii	Sabiaceae	Khasi hills
Nepenthes khasiana	Nepenthaceae	Garo and Jaintia hills
Nymphaea pygmaea	Nympahaeaceae	Khasi hills
Panax pseudoginseng	Araliaceae	Shillong
Pantlingia serrata	Orchidaceae	
Paphiopedilum hirsutissimum	Orchidaceae	Khasi hills
P. insigne	Orchidaceae	Khasi hills
P. venustum	Orchidaceae	
Pennilabium proboscidium	Orchidaceae	

Name of the species	Family	Distribution
Pleione maculata	Orchidaceae	Shillong
P. lagenaria	Orchidaceae	Khasi hills
Polygala tricholopha	Polygalaceae	Khasi hills
Rhododendron formosum	Ericaceae	Shillong
Stylidium kunthii	Stylidiaceae	Garo hills
Sageretia oppositifolia	Rhamnaceae	
Sapindus rarak	Sapindaceae	Jaintia hills
Trachelospermum auritum	Apocynaceae	Garo hills
Taeniophyllum khasianum	Orchidaceae	Khasi hills
Thrixspermum muscaeflorum	Orchidaceae	
Tropidia angulosa	Orchidaceae	Garo hills
Trias pusilla	Orchidaceae	Khasi and Jaintia hills
Unona dumosus	Annonaceae	Garo hills
Uvaria hamiltonii	Annonaceae	Garo hills
U. lurida	Annonaceae	Garo hills
Vanda coerulea	Orchidaceae	Khasi and Jaintia hills

The above list apparently seems very long but all these species are threatened in one or the other way and need conservation measures.

VULNERABILITY

The flora of Meghalaya has many ornamental plants, botanical curiosities, medicinal and other herbs. They attract collectors and traders in many ways and are often exposed to indiscriminate exploitation. Some glaring examples are *Nepenthes khasiana* (pitcher plant) collected as botanical specimens, orchids like *Vanda coerulea* (blue vanda), *Paphiopedilum venustum, P. hirsutissimum, P. insigni,* etc. gathered as ornamental home plants and *Panax pseudo-ginseng* collected as medicinal plant. A few plants like *Epipogeum, Gastrodea, Galeola, Monotropa,* etc. are threatened due to their habitat specificity and forest destruction. Many of the threatened plants of Meghalaya found sheltered in the sacred grooves are preserved intact due to religious reasons. But with the

changing cultural style and educational advancement, the young generation are moving away from tradition and are inclined to violate the conservation ethos intrinsic on the community. Tragically, one can see the total disappearace of the sacred groove at Shillong peak described by Bor (1942) Raju (1964). This attitudinal change of the people will surely make many of our plants vulnerable. Added to this, is the rapid removal of forest produce and accelerated forest clearance consequent upon the increased demand of an inflated population.

CONSERVATION

From the forgoing discussion on threatened taxa, it can be seen that there is a series of adverse factors acting upon the flora seriousely endangering a few of them at least. It is evident that the singular most important factor is human interferance. To save the flora from imminent threats and possible extinction, we need to resolve for strong conservation efforts. It should aim both species conservation and habitat conservation using *in-situ* and *ex-situ* means. Fortunately, Meghalaya has an elite population with conservation ideas and a number of institutes and departments like the Botanical Survey of India, National Bureau of Plant Genetic Resource, North Eastern Hill University, Indian Council of Agriculture Research, The Department of Environment and Forests both of the Meghalaya State and the Government of India are all equiped to forewarn and educate the people about the dangers of deforestation and threat to species. There are already a few protected areas and sanctuaries in the state to cater to the needs of protection and conservation like the Balphakram, Nongkhyllum, Jarain etc. Our remaining sacred grooves too contribute favourably to the cause of conservation.

Though, Meghalaya is comparatively better explored from a botanical point of view but there are still scope for exploration in some important biodiversity rich areas and an assessment of the threatened plants of the state is an urgent requirement. Once the documentation and surveys for the habitat conditions are available, adequate conservation measures could be evolved basing on strong ecological principles. All the available resource and technology could be tapped to provide this goal of conservation. Fortunately, the tools of Biodiversity conservation are familiar and accessible to us. Though, much damage has occured in the recent past to the flora of Meghalaya but still it is not too late. Dedicated efforts could still reverse the trend and bring the flora to its enviable position. Conservation does not mean a total avoidance of utilization of the floral

wealth. Useful plant resource could be utilized making sure to see their regeneration and survival through modern forestry practices.

The flora of Meghalaya has attracted many eminent botanists from the very early times of Hooker (1854) Kanjilal *et al.* (1934-40), etc. After the reorganisation of Botanical Survey of India further boost to the botanical exploration of the state was possible and the works of Rao (1994) Joseph (1982), Balakrishnan (1981), Kataki (1986) Haridasan and Rao (1985) Baishya and Rao (1982) Joseph and Joseph (1980) appeared. The rapidly changing environmental scenario of the state warrants such studies at periodical intervals. Due to various causes, the flora of Meghalaya is exposed to different threats and needs conservation measures to negate the adverse effects. With well planned interdisciplinary conservation programmes, and involvement of the government, non-government and people in these programmes, the losing glory of the flora of Meghalaya could be regained.

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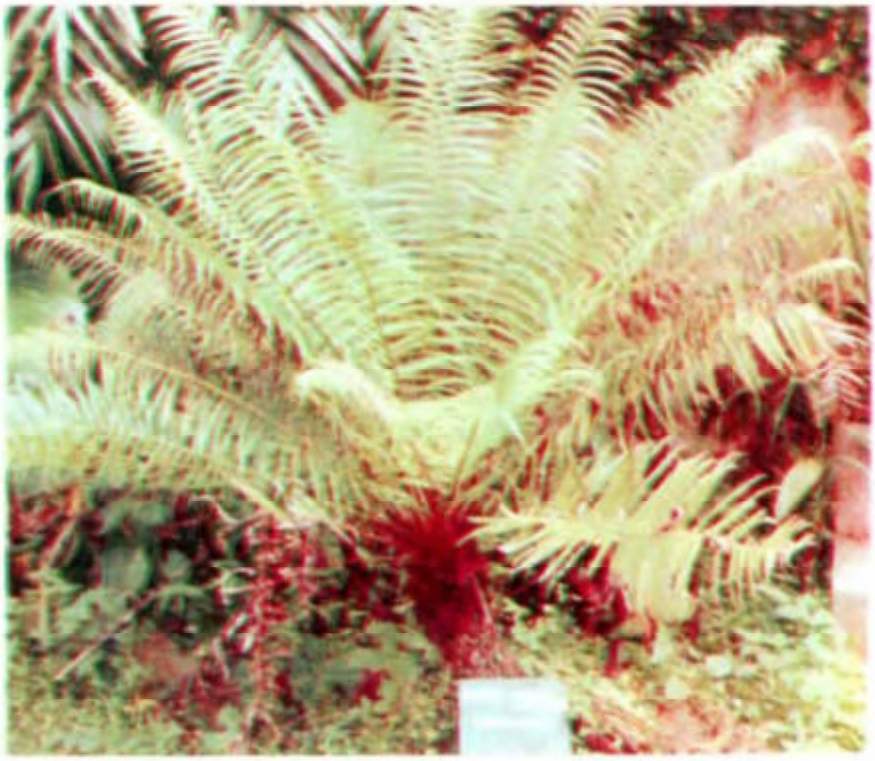
Pleione praecox

Lawlyngdoh : the Sacred grove at Mawphlong

Nepenthes khasiana
(Courtesy : T.M. Hynniewta)

Rhododendron formosum
(Courtesy : T.M. Hynniewta)



Brainea insignis
(Courtesy : T.M. Hynniewta)

Rauvolfia serpentina

Vanda coerulea

MIZORAM

K.P. Singh

Mizoram or Lushai hills, as it was known formerly, is situated in the north-eastern part of India. It was called Lushai hills and later Mizo district, and formed part of old Assam till 1971. In 1972 it was constituted into Union Territory and was renamed as Mizoram. It attained full fledged statehood on 20th February, 1987 and presently comprises three districts namely Aizawl (area about 12588 sq km), Lunglei (5436 sq km) and Chhimtuipui (3957 sq km).

The state is situated within tropics between 20° 20' - 24° 27' N Latitude and 90° 20' - 93° 27' E Longitude with a total area of about 21,090 sq km. It is bordered in north by Cachar district of Assam, in the east by the state of Manipur, in the south and south-west by Myanmar and in the west by Chittagong hill tracts of Bangladesh and the state of Tripura. The entire state presents a mountainous terrain with more or less parallel hill ranges running in the north-south direction with deep river valleys, averaging 700 - 1300 m in altitude. The Eastern and Southern regions are higher as compared to the Western and Northern regions. However, the isolated peaks, attain height over 1900 m with Phongphuithlang in the 'Blue Mountain' being the highest peak (2157 m) in Chhimtuipui district, South Mizoram. The other important peaks are Lengtenthlang, Ngurthlang, Mawmrang, Tawitlang, Chalfilh, Lurh, etc. Mizoram has over 75% of the geographical area under forests which is the highest (Garbyal 1996) among the states of the country. The total forest areas as reported in the various Government statistics is about 15,935 sq km (Bathew 1991), of which about 7,127 sq km forest are under the control of Government while remaining forests are under the control of village councils (*ca* 7022 sq km) and district councils (*ca* 1783 sq km).

Mizoram has a moderate climate. It is generally warm in summer and not very cold in winter. The monsoon starts from May to September and winter from December to February, which is rain free and pleasant. The autumn is between October and December. The state receives annual rainfall between 2000-2600 mm from both North-East and South-West monsoons, which together with conducive range of temperature of 20° 30° C during summer and 11° - 21° C in winter, with humidity varying from 70% 80%, supports a rich flora both in luxuriance and species

diversity. The rivers occupying the longitudinal valleys often form deep gorges and flow towards either North or South.

The important rivers like Tlawng (Dhaleswari), Tuivail (Sonai), Tuivawl, Karnafuli, Tuipui or Koladyne and their tributaries create congenial sites for rich and diverse vegetation specially along their banks. The drainage pattern in general has a direct bearing on the floristic compositions. The water holding capacity of the soil is low because of its clayey nature.

A perusal of literture has revealed that, botanically the state is quite under explored with only a few collection forrays in the past and our knowledge about the flora of mizoram, in general, is rather inadequate.

Gage (1901) for the first time recorded 317 species, including 26 species of cryptogams, based on his own collections made from a very small area in Lunglei district during March - April 1899. J.E. Leslie also made some collections in December 1902 and sent them to Calcutta. Some valuable collections made by Mrs. N.E. Parry from 1924 to 1928 were sent to Royal Botanic Garden, Kew and a smaller quantity to the Royal Botanic Garden, Calcutta (now India Botanic Garden, Howrah). Rev. W.G.L. Wenger (1926 and 1932), Rev. R.A. Lorrain and his daughter Lorrain Foxall also made some collections from Lunglei, and sent most of them to Kew and some to Calcutta. Based on these collections, Fisher (1938) published 'the Flora of Lushai Hills' enumerating 1360 species including 6 gymnosperms and 155 species of cryptogams.

VEGETATION

The status of vegetation of North-East India as a whole has been discussed by Rao and Panigrahi (1961), Murti and Joseph (1984), Sahni (1981), Jain (1982), Mehra *et. al.* (1983), Rao and Hajra (1986), etc. However, the exclusive account of vegetation pertaining to Mizoram state is not yet available although Deb and Dutta (1987) has thrown some light on the vegetation of the area based on their observations made in Mamit subdivision and west Aizwal. Based on these data together with field observations and collections made by the author, an attempt is made to present a brief account of the vegetation of the Mizoram state. In general the forest of Mizoram can broadly be divided into following types.

1. Tropical wet evergreen and semi-evergreen forest

These forest are usually found below an altitude of 900 m and form one of the major ecological types in the state with a rich floristic diversity. The exact distinction between the evergreen and semi-evergreen types is difficult as they occur in the areas of similar characteristics where rainfall averages between 2000-2500 mm annually and temperature varies between 20°C 22°C. Tropical wet evergreen forest are found usually in south-eastern and western to some extent, Mizoram, while semi evergreen forests occur in northern, north-western, western and central part of the Mizoram.

Tropical wet evergreen forest are characterized by the stratification of the stand into three distinct tiers or canopies consisting of an admixture of numerous species. All the species of the top canopy are evergreen trees with tall boles. Cauliflory is rather common. The middle and lower canopies are dense, evergreen and diverse. Epiphytes and parasites are few. Tree ferns, aroids, small palms, ferns, orchids, bryophytes and lichens are fairly common. Lianes are frequent and conspicious. The ground vegetation is rich, comprising numerous herbaceous species. Grasses and Sedges are common in humid places or along the banks of rivers or rivulets. The dominant species of top canopy are *Dipterocarpus turbinatus* (Dawangthing), *D. macrocarpus* (Thingsen), *Michelia champaca* (Ngiau), *Talauma hodgsonii* (Thingtumbu), *Artocarpus chaplasha* (Tatkawng), *Amoora wallichii* (Sahatah), *Duabanga grandiflora* (Zuang), *Schima wallichii* (Khiang), *Adina cordifolia* (Lungkhup), *Terminalia myriocarpa* (Char), *Sterculia colorata* (Khaukhim), *Syzygium cumini* (Lenhmui), *Actinodaphne angustifolia*, etc. In exposed and drier areas, where soil is only a thin layer, deciduous trees, like *Bombax cieba, Juglans regia, Phyllanthus emblica, Erythrina arborescens, Albizia lebbek, A. procera, Lagerstroemia speciosa, Sterculia villosa, Bischofia javanica*, etc. are common. The second canopy species grow usually along with smaller trees of this top canopy. The common species of the canopy are *Litsea laeta, Dysoxylum binectariferum, Pterospermum semisagitatum, P. lanceaefolium, Hydnocarpus kurzii, Sterculia indica, Dillenia indica, Symplocos javanica, Elaeocarpus lanceaefolius, Stereospermum personatum, Turpinia pomifera, Ardisia colorata*, etc.

The third canopy shows the maximum diversity of smaller trees and shrubs. The species like *Meliosma simplicifolia, Litsea meissneri,*

Saurauia napaulensis, Garcinia paniculata, Leea indica, Eurya cerasifolia, Maesa paniculata, Clausena heterophylla, Mycetia longifolia, Pandanus foetidus, Buddleja asiatica, Tournfortia roxburghii, Symplocos theaefolia, Diospyros lanceaefolia, Daedalcanthus spp., *Pinanga* spp., etc. are very common. *Rubus niveus, R. ellipticus, Globba clarkei, G. multiflora, Costus speciosus, Phrynium capitatum, Laportea crenulata, Impatiens* spp., *Begonia* spp., *Ophiopogon* spp., etc. are also common.

Climbers like *Rhaphidophora exima, Pothos scandens, Entada rheedi, Dioscorea pentaphylla, Cissampelos pareira, Canavalia* spp., *Mucuna pruriens, Passiflora foetida, Hoya parasitica, Trichosanthes* spp., *Smilax* spp., *Piper* spp., *Cuscuta reflexa,* etc. are quite abundant in the forest.

The forest are rich in both epiphytic as well as terrestrial orchids. *Coelogyne nitida, C. punctulata, Cymbidium aloifolium, C. longifolium, Dendrobium aphyllum, D. chrysanthum, Vanda coerulea, Paphiopedilum villosum, Renanthera imschootiana, Bulbophyllum* spp., *Thunia alba, Habenaria* spp. are of common occurence in Lunglei and Champhai areas. Among the parasites, *Scurrula pulverulenta, Helixanthera parasitica, Viscum monoicum, Cuscuta reflexa, Balanophora dioca,* etc. are seen.

In exposed places or abandoned Jhum land, the canopies are not distinct. In these places the species, like *Aporosa oblonga, Mallotus philippensis, Maesa ramentacea, Cordia* spp., *Bridelia retusa, Macaranga denticulata, Murraya exotica, Dysoxylum binectariferum, Callicarpa arborea, Dalbergia stipulacea, Senna alata, Meliosma simplicifolia, Gmelina arborea, Bauhinia variegata, Erythrina arborescens, Syzygium* spp., etc. are common. Similarly climbers, like *Dalhousiea bracteata, Spatholobus parviflorus, Combretum roxburghii, Mucuna nigricans, Thunbergia grandiflora,* members of Cucurbitaceae, Dioscoriaceae are also abundant. The ground floor of these forest is full of herbs or undershubs like *Triumfetta rhomboidea, Clerodendron viscosum, Melastoma malabathricum, Desmodium heterocarpon, D. caudatum, Uraria clarkei, Atylosia barbata, Ageratum conyzoides, Blumea glomerata, Crotalaria ferruginea, Urena lobata, Indigofera* spp., *Erigeron linifolium, Eupatorium odoratum, Gallinsoga parviflora, Vernonia cinerea, Solanum nigrum,*

members of Scrophulariaceae, Acanthaceae, Lamiaceae, etc. The three species of "Dancing girl" viz. *Mantisia saltatoria, M. spathulata* and *M. wengeri*, the later being endemic to this region, are also found in shade on rocks in Lungleh and Blue mountain area.

Swamp vegetation as mentioned by Deb and Dutta (1987) consists of many herbaceous species, some shrubs and a few trees. The common tree species are *Barringtonia acutangula* and *Lagerstroemia parviflora.* The dominant herbaceous species are *Phragmites karka, Alpinia allughas, Saccharum spontaneum, Erianthus arundinaceus, Polygonum microcephalum, Elaeocharis ramulosa, Scirpus supinus, Cyperus difformis, Fimbristylis dichotoma, Utricularia exoleta,* etc. *Eichhornia crassipes* is also abundant in water bodies. Along the river courses in marshy places, *Alpinia* spp., *Impereta cylindrica, Pharagmites karka, Erianthus arundinaceus* and *Saccharum spontaneum* are very common. They form asocies and grow in various proportions. They usually form *Phragmites - Alpinia* associes and *Alpinia - Phragmites-Saccharum* associes. Aquatic species, either floating or submerged, are few in Mizoram. Some such species are *Ludwigia octovalvis, L. prostrata, Osbeckia chinensis, Nymphoides cristata, Trapa natans* var. *bispinosa, Pistia stratoites, Spirodela polyrrhiza, Hydrilla verticillata, Limnophylla sessilis, Leersia hexandra, Polygonum* spp., etc.

2. Montane subtropical forest

These forest usually are found between 900 - 1500 m altitudes in the eastern fringes bordering kachin hills of Myanmar and places which are cooler and have less precipitation. Subtropical vegetation shows mixed pine forests. The common species of pine forest are *Pinus kesiya, Quercus incana, Q. serrata, Q. semiserrata, Castanopsis hystrix, Podocarpus nerifolia, Schima wallichii, Prunus cerasoides, Myristica* spp., *Rhus* spp., etc. The other species of subtropical forest belong to genera *Acacia, Albizia, Bridelia, Castanopsis, Cinnamomum, Engelhardtia, Erythrina, Ficus, Garcinia, Michelia, Terminalia,* etc. In some places palms, such as *Calamus erectus, Caryota urens, Didymocarpus nana, Licuala pelta, Phoenix humilis,* etc. are also found and form part of subtropical forest. The species of *Lyonia, Gaultheria, Rhus,* etc., are some of the common shrubs in the forest, whereas the herbaceous elements are represented by *Potentilla fulgens, Ranunculus spp., Artemisia* spp., *Elsholtzia* spp., etc.

3. Temperate forest

These forest are usually common above 1600 m in the areas like Pharpak, Thaltlang and Phawngpui reserve forest and display impenetrable virgin pimary forest. In several congenial localities, particularly on the valley slopes of different tributaries, however, the vegetation present an admixture of tropical and sub-tropical elements. The predominent arboreal elements in these forest are *Pinus kesiya, Actinodaphne macroptera, Betula alnoides, Exbucklandia populnea, Dillenia pentagyna, Kadsura heterophylla, Michelia doltsopa, M. champaca, Garcinia anomala, Schisandra neglecta, Photinia integrifolia, Litsea* spp., *Quercus dealbata, Q. dialatata, Rhododendron arboreum, R. vitchianum, R. wattii, R. johnstoneanum,* etc. The prominent shrubs occuring in these forest are *Pittosporum podocarpum, Xylosma controversum, Camellia caudata, Mahonia* spp., *Rubus* spp., *Clerodendron infortunatum, Rosa* spp., *Sorbus* spp., *Baliospermum* spp., *Helicia nilagirica, Vibernum* spp., *Osbeckia* spp., *Mussaenda* spp., etc. The common herbaceous species of these forest are *Hypericum elodeoides, H. mananthemum, Plantago major, Potentilla fulgens, Impatiens* spp., *Centella asiatica, Cyanotis cristata, Chirita* spp., members of Asteraceae, Commelinaceae and grasses like *Arundinaria callosa, Coix lacryma-jobi; Cyanodon dactylon, Erianthus longisetus, Eragrostis unioloides, E. nigra,* etc. Besides, the common lianas in these forest are *Brachystemma calycinum, Illigera khasiana, Milletia* spp., *Rosa longicuspis, Smilax* spp., *Vitis* spp., *Trichosanthes* spp., etc. These forest also abound in good diversity of ferns and fern-allies, viz. *Selaginella* spp., *Lycopodium* spp., *Cyosorus* spp., *Dryopteris* spp., *Devallodes membranulosum, Arthromeris wallichiana, Egenolfia appendiculata, Hypolepis punctata, Microlepia* spp., *Onychium siliculosum, Polypodium* spp., *Pyrosia stenophylla, Pteris vitata,* etc. The epiphytic components of these forest are dominated mostly by lichens, bryophytes, pteridophytes, various species of orchids, *Aeschynanthus* spp., *Agapetes* spp., *Hoya* spp., *Vaccinium* spp., *Viscum* spp., etc.

4. Bamboo forest

Bamboos are usually found in tropical and sutropical areas of the state. Few species also extend up to temperate zone. Mizoram is extremely rich in Bamboos. This appears to have been resulted from Jhumming (Deb and Dutta, 1987) system of cultivation. Abandoned Jhum land is favourable for rapid growth of Bamboos. Bamboos are more concentrated along the Tripura border. They are more abundant in the western and eastern

fringes. In eastern region bamboos are mostly confined along the river banks. The common species of bamboos found in Mizoram are *Melocanna baccifera, Bambusa tulda, B. pallida, Dendrocalamus hamiltonii, Schizostachyum polymorphum* and *S. dalloa.* Bamboos usually grow in clumps but *Melocanna* and *Schizostachyum* grow single stemmed wihout forming clumps. Of all the species that are found, those of *Melocanna* and *Bambusa* are commercially most important because of their superior quality and relative abundance.

FLORISTIC DIVERSITY

Angiosperms

Although the knowledge of flora of state is inadequate due to lack of thorough explorations but the forest of Mizoram exhibit an enormous floristic diversity. There are diverse species of orchids, medicinal plants, horticultural plants, taxa of ethnobotanical importance, bamboos, canes, wild relative of cultivated crop plants and some endemic, rare and endangered species with highly restricted range of distribution. The diversity is also supplemented by numerous species of adjacent and distant regions, that are present in the flora. According to present estimate the flora of Mizoram comprises about 2141 species of flowering plants, distributed within 905 genera and 176 families. The number of species will be much more if unexplored and under explored areas are explored thoroughly. Incidentally, many areas particularly in the Southern and Eastern regions, still remain unexplored.

However, the present status of different groups of vascular plants in Mizoram is shown in the Table I.

Table 1
Status of different groups of vascular plants

Group	Species	Genera	Family
ANGIOSPERMS	2141	905	176
Monocot	514	200	26
Dicot	1627	705	150
GYMNOSPERMS	6	6	4
PTERIDOPHYTES	211	66	35

A perusal of the table I indicates that the gymnosperms show minimum diversity of species in the area, while angiosperms exhibit maximum diversity. The proportion of monocoyledons to dicotyledons at species level is about 1: 3.1 and at generic level is about 1: 3.5. The ratio of genera and species of angiosperms is about 1: 2.3. Among angiosperms the dicotyledons maintain maximum diversity from specific level to family level. The diversity of some of the families like Asteraceae, Fabaceae, Rubiaceae, etc. is discussed separately. Among monocotyledons the maximum diversity is observed in Orchidaceae, Poaceae and Cyperaceae which together constitute about 67% of this group while remaining 33% species are distributed into 23 families. The species diversity of some of dominant families of this group is also discussed in forthcoming pages.

Table II
A conspectus of families showing number of genera and species

Family	Genera	Species
DICOTYLEDONS		
Ranunculaceae	4	12
Dilleniaceae	1	2
Magnoliaceae	2	5
Schisandraceae	2	3
Annonaceae	6	8
Menispermaceae	6	11
Berberidaceae	1	3
Papaveraceae	1	1
Fumariaceae	1	1
Brassicaceae	3	7
Capparaceae	4	9
Violaceae	1	5
Bixaceae	1	1
Flacourtiaceae	5	5
Pittosporaceae	1	2
Polygalaceae	2	5
Caryophyllaceae	2	2
Portulacaceae	1	1

Family	Genera	Species
Hypericaceae	2	6
Clusiaceae	3	7
Theaceae	3	8
Saurauiaceae	1	2
Dipterocarpaceae	2	4
Malvaceae	9	15
Bombacaceae	2	3
Sterculiaceae	7	15
Tiliaceae	4	7
Elaeocarpaceae	1	7
Malphighiaceae	2	4
Geraniaceae	1	1
Oxalidaceae	2	4
Balsaminaceae	1	13
Rutaceae	13	21
Simaroubaceae	1	1
Bursaraceae	2	2
Meliaceae	12	19
Olacaceae	2	3
Icacinaceae	4	4
Celastraceae	4	10
Hippocrateaceae	2	4
Rhamnaceae	4	7
Vitaceae	7	19
Leeaceae	1	6
Sapindaceae	8	10
Aceraceae	1	3
Sabiaceae	2	8
Anacardiaceae	7	9
Connaraceae	1	1
Fabaceae	34	88
Caesalpinioideae	8	27
Mimosoideae	9	18

Family	Genera	Species
Rosaceae	8	22
Saxifragaceae	1	1
Hydrangeaceae	1	1
Iteaceae	1	1
Crassulaceae	2	4
Droseraceae	1	2
Hamamelidaceae	2	2
Rhizophoraceae	1	1
Combretaceae	4	13
Hernandiaceae	1	1
Myrtaceae	5	10
Lecythidaceae	1	1
Melastomaceae	7	19
Lythraceae	5	8
Punicaceae	1	1
Sonneratiaceae	1	1
Onagraceae	2	3
Trapaceae	1	1
Samydaceae	1	1
Passifloraceae	2	4
Caricaceae	1	1
Cucurbitaceae	11	15
Begoniaceae	1	18
Aizoaceae	1	1
Apiaceae	10	18
Araliaceae	7	12
Cornaceae	1	1
Alangiaceae	1	2
Nyssaceae	1	1
Caprifoliaceae	3	10
Rubiaceae	39	109
Dipsacaceae	1	1
Asteraceae	45	93

Family	Genera	Species
Campanulaceae	4	8
Lobeliaceae	1	4
Vacciniaceae	2	6
Ericaceae	2	6
Monotrapaceae	1	1
Primulaceae	2	4
Myrsinaceae	5	22
Sapotaceae	3	3
Ebenaceae	1	4
Styracaceae	1	2
Symplocaceae	1	9
Oleaceae	4	19
Apocynaceae	22	26
Asclepiadaceae	13	20
Loganiaceae	2	4
Buddleiaceae	1	3
Gentianaceae	7	15
Limnanthaceae	1	2
Polemoniaceae	1	1
Hydrophyllaceae	1	1
Boraginaceae	5	10
Heliotropiaceae	1	1
Convolvulaceae	7	23
Cuscutaceae	1	1
Solanaceae	8	23
Scrophulariaceae	19	29
Orobanchaceae	1	1
Lentibulariaceae	1	4
Gesneriaceae	10	30
Bignoniaceae	6	9
Martyniaceae	1	1
Acanthaceae	29	71
Thunbergiaceae	1	4

Family	Genera	Species
Verbenaceae	11	38
Lamiaceae	30	66
Plantaginaceae	1	3
Nyctaginaceae	2	2
Amaranthaceae	9	13
Chenopodiaceae	1	1
Polygonaceae	2	21
Aristolochiaceae	1	1
Piperaceae	2	18
Saururaceae	1	1
Chloranthaceae	1	2
Myristicaceae	3	6
Lauraceae	10	34
Hernandaceae	1	1
Proteaceae	1	4
Thymelaeceae	4	6
Elaegnaceae	1	1
Loranthaceae	8	13
Viscaceae	1	2
Santalaceae	3	5
Balanophoraceae	1	1
Euphorbiaceae	33	78
Buxaceae	1	1
Urticaceae	13	41
Ulmaceae	3	6
Cannabinaceae	1	1
Moraceae	7	43
Juglandaceae	2	3
Myricaceae	1	2
Betulaceae	2	3
Fagaceae	3	24
Corylaceae	1	1
Salicaceae	1	1

Family	Genera	Species
MONOCOTYLEDONS		
Hydrocharitaceae	1	1
Burmaniaceae	1	1
Orchidaceae	75	244
Zingiberaceae	13	39
Marantaceae	1	2
Cannaceae	1	1
Musaceae	1	4
Haemodoraceae	1	4
Amaryllidaceae	1	2
Hypoxidaceae	2	4
Agavaceae	1	1
Taccaceae	1	1
Dioscoreaceae	1	13
Stemonaceae	2	2
Liliaceae	9	17
Smilaceae	1	5
Asparagaceae	1	3
Pontederiaceae	2	3
Commelinaceae	8	19
Arecaceae	10	13
Pandanaceae	1	1
Araceae	14	29
Lemnaceae	1	1
Eriocaulaceae	1	1
Cyperaceae	7	36
Poaceae	43	66

An analysis of families in Table II present an interesting data pertaining to the diversity of species and genera in the state as shown below.

(i) Species diversity under families

Families with	1	species	47
Families with	2 - 10	species	79
Families with	11 - 25	species	31
Families with	26 - 50	species	11
Families with	51 100	species	6
Families with	101 - 250	species	2

(ii) Generic diversity under families

Families with	1	genus	79
Families with	2	genera	28
Families with	3	genera	9
Families with	4 - 5	genera	16
Families with	6 - 10	genera	26
Families with	11 - 20	genera	9
Families with	21 - 30	genera	3
Families with	31 - 40	genera	3
Families with	41 - 75	genera	3

Thus, it is deduced from the above data that maximum species diversity occurs in the families belonging to 51-100 and 101-250 species categories while maximum number of families belong to 1, 2-10, 11 - 25 species categories. Similarly maximum generic diversity occurs in the families belonging to 21 - 30, 31-40 and 41-75 generic categories while maximum number of families belong to 1, 2 and 6-10 generic categories.

An equally important data also emerge when an analysis of species diversity within genera as shown below is made.

Genera with	1	species	511
Genera with	2	species	172
Genera with	3	species	72
Genera with	4	species	51
Genera with	5	species	31
Genera with	6 - 10	species	46
Genera with	11 - 15	species	13
Genera with	16 - 20	species	6
Genera with	21 - 40	species	3

Here also the maximum genera belong to 1, 2, 3 and 4 species categories and maximum diversity of species occurs in 16 20 and 21 40 species categories. The species diversity of certain dominant genera is also given separately.

In order of dominance family orchidaceae ranks first as the largest with about 244 species belonging to 75 genera. This is followed by Rubiaceae (about 109 spp. under 39 genera), Asteraceae (about 93 spp. under 45 genera), Fabaceae (about 88 spp. under 34 genera), Euphorbiaceae, Acanthaceae, Lamiaceae, Poaceae, Moraceae, Urticaceae, Verbenaceae., etc.

The species diversity within the families is more interesting. The Orchidaceae is a family with a lot of diversity. The status of orchids of Mizoram has already been discussed (Singh *et al.*, 1990). A variety of orchids are found particularly in wet tropical and subtropical forests. Of the 244 taxa recorded from Mizoram, 60 are terrestrial, 177 are epiphytes and 7 are saprophytes. *Dendrobium* with 41 species is the largest genus. The other genera such as *Bulbophyllum, Eria, Cymbidium, Coelogyne,* etc. are well represented with more than 10 species each, 3 genera viz. *Anthogonium, Neogyne* and *Ornithochilus* are monotypic in the area. Besides, there are 41 genera which are represented by a single species each. It is followed by 12 genera with 2 species each; 6 genera with 3 species each; 3 genera with 4 species each; 2 genera with 5 species each; 9 genera with 6 - 15 species each and remaining 2 genera with 21 and 41 species respectively. Thus, it is interesting to note that maximum genera belong to 1 species category. While considering distributional analysis of orchids of this state (Singh *et al.*, 1990) in relation to other parts of India, it is revealed that of the 244 taxa so far recorded from Mizoram, 60 are common to peninsular India, 104 to North-West India, 198 to Sikkim, 179 to Arunachal Pradesh, 90 to Assam, 136 Manipur, 192 to Meghalaya, 138 to Nagaland and 49 to Tripura. It is rather interesting that orchids of Mizoram have maximum affinity with the orchids of Sikkim. It is also significant that out of the 7 species of *Paphiopedilum* (a commercially highly exploited genus) known to occur in India (Kataki, 1984), 3 species viz., *Paphiopedilum villosum, P. hirsutissimum* and *P. spiceriamum* occur in the state. This figure is highest for any Indian state and is comparable to that in Sikkim and Meghalaya.

Rubiaceae are well represented in Mizoram flora. Their members range from small or large sized trees to shrubs and herbs in tropical

forest. Some members are climbers forming dense growth in the forest. Of about 616 species reportedly occuring in India, about 109 species occur in Mizoram. There are 14 genera which are represented by a single species each. The largest genus is *Hedyotis* with 13 species, followed by *Ophiorrhiza* (11 spp.), *Mussaenda* (7 spp.), *Uncaria* and *Lacianthus* (5 spp. each). The species of *Adina* and *Anthocephalus* are good timber trees.

Asteraceae, predominantly a herbaceous family, is fairly represented. Out of about 803 species reported from India, 93 species under 45 genera occur in the state. *Blumea* and *Vernonia* are the largest genera with 8 species each. The other genera such as *Senecio, Gynura* have over 5 species each. The species like *Veronia cinerea, Gerbera piloselloides, Eupatorium odoratum,* etc. are used for their medicinal value by local inhabitants.

Fabaceae also shows good diversiy of forms. Their members range from large trees in evergreen forest to shrubs and herbs on hilly slopes and along the roads. Out of 1141 species reportedly known from India, about 88 species occur in Mizoram. Maximum diversity is observed in the genus *Desmodium* with 17 species, followed by *Crotolaria* with 12 species. There are about 12 genera which are represented by single species each. The species of *Dalbergia* have good timber value. In addition, there are many species of medicinal and other economic importance and wild relatives of cultivated plants

Another well represented family in Mizoram is Euphorbiaceae with mostly shrubs or trees and a few herbs. Out of about 523 species under 84 genera known from India, about 78 species under 33 genera occur in Mizoram. Genera *Phyllanthus* and *Glochidion* are the largest, represented by 12 and 7 species respectively. Twenty genera have single species each. The species of *Aporosa, Glochidion* and *Bridelia* are medium sized trees. Some species of *Phyllanthus* and *Ricinus* are of medicinal importance.

Acanthaceae is a family of mostly herbs and shrubs and their members are usually common in moist places. Out of 500 species known from India, 71 species under 29 genera occur in Mizoram. The genus *Strobilanthes* with 18 species is the largest. Genera *Justicia* and *Phlogacanthus* have 7 and 6 species respectively. About 10 genera have 2 species each.

Lamiaceae is another family fairly well represented in this state. Out of about 435 species known from India, 66 species under 30 genera occur in Mizoram. *Pogostemon* is the largest genus with 9 species, followed by *Plectranthus* (6 spp.), *Gomphostemma* (5 spp.) and *Eustralis* (4 spp.), etc. The species of *Ocimum* and *Mentha* have high medicinal value, while *Coleus* and *Salvia* are of great horticultural importance.

Poaceae, a family of great economic importance, is rather poorly represented in Mizoram as compared to other north-eastern states. Of the 1291 species known from India, only 66 species under 43 genera occur in Mizoram. Bamboos are one of the dominant components of the vegetation and comprise 18 species under 8 genera. Majority of the genera are represented by single species only. Species like *Arundinaria phar* and *Sinarundinaria longispicata* are endemic in the area.

Moraceae (Mulbery family) is also well represented in this state. Out of 122 species known from India, 43 species (35%) are distributed in Mizoram. Their members range from large trees to shrubs in evergreen forest. The maximum diversity is seen in the genus *Ficus* which has 34 species alone, followed by *Artocarpus* with 3 species and *Morus* with 2 species.

Urticaceae is represented mostly by herbs or undershrubs. Out of 151 species under 27 genera known from India, 41 species under 13 genera occur in Mizoram. Genus *Elatosstoma* shows the maximum diversity with 10 species followed by *Boehmeria* with 9 species. Seven genera are represented by single species each.

Verbenaceaeous members vary from large trees to shrubs. Out of 145 species known from India, 37 species in 10 genera are known from Mizoram. The genus *Clerodendron* with 10 species are highly medicinal. *Tectona grandis* and *Gmelina arborea* (both cultivated) are choice timber trees in the forests. *Lantana camera* shows great diversity in flower colours.

Like Poaceae, Cyperaceae is also poorly known from Mizoram. Out of 545 species found in India, 35 species under 7 genera are known to occur in Mizoram. Genus *Cyperus* with 15 species is the largest, followed by *Fimbristylis* with 6 species and *Scleria* and *Carex* with 5 species each.

Lauraceae include mostly evergreen aromatic, trees or shrubs and represented by 34 species within 10 genera in Mizoram. The genera *Litsea* with 9 species and *Cinnamomum* with 8 species are well represented, while *Alseodaphne, Lindera* and *Phoebe* have 3 species each.

Gesneriaceae includes 30 species in 10 genera which are herbs or undershrubs and distributed in evergreen forest. *Aeschynanthus,* mostly with epiphytic habit, is the largest genus with 9 species in the area. It is followed by *Didymocarpus* with 6 species, of which 3 species are endemic to Mizoram. *Chirita,* a genus of medicinal importance is represented by 5 species. The genus *Petrocasma* is represented by a single endemic species, *P. parryorum.*

Scrophulariaceae is another family with mostly herbs and showy bilabiate corolla of variable colours. It is represented by 29 species under 19 genera in evergreen forest. About 13 genera, such as *Bonnaya, Buchnera, Curanga, Hemiphrangma, Linaria, Mazus, Mecardonia, Mimulus, Melasma, Scoparia, Staurogyne, Sopubia,* and *Wightia* have single species each. While *Lindernia* has 5 species and *Limnophylla* 3 species.

The aroids with characteristic spadix as inflorescence are represented by 28 species under 13 genera in Mizoram. Their members vary from erect herbs to scandent shrubs on evergreen trees in moist places. The largest genus *Arisaema* commonly known as "Cobra lilies" is represented by 7 species against the 42 species known from India. It is followed by subtropical, lofty epiphytic climber *Rhaphidophora* with 4 species against 9 species known from India. Of the 6 species of *Pothos* known from India, 2 species occur in Mizoram. The other genera represented by 2 species are *Alocasia, Gonatanthus, Steudnera, Colocasia* and *Ramusatia.* The species of *Colocasia* are cultivated for their tubers and are usually used as vegetable.

Another important family is Zingiberaceae with numerous species of medicinal and horticultural importance. Members are mostly perennial herbs with fleshy rhizomes. Out of 189 species of family known from India, 28 species occur in Mizoram. The largest genus *Hedychium* of ornamental importance is represented by 11 species in the area against the 34 species known from north-east India. Medicinally highly important plant *Costus speciosus* is widely distributed in moist places. The other important genus *Alpinia* with 4 species is also found. The genus *Mantisia*

commonly known as 'dancing girl' is represented by 3 species, of which *M. wengeri* is endemic. Some of other important families like Caesalpinioideae, Apocynaceae and Fagaceae are represented by 27, 26 and 24 species respectively.

The species diversity at generic level is also interesting. The orchid genus *Dendrobium* is the largest and represented by 41 species in Mizoram, against 105 species reported from India. The species are essentially epiphytes found growing on trees or rocks. The vegetative structure of *Dendrobium* species varies considerabley. The stems (pseudobulbs) with dwarf or elongate internodes are jointed like 'cane' They are fleshy, erect, cylindrical angled or variously shaped. Inflorescence may be terminal or lateral with one to many flowers in racemes. The flowers vary in size and colour of many combinations with attracitve lip of various shapes.

Ficus with 34 species are shrubs or trees of very variable size often showing cauliflory. The other genera, viz. *Bulbophyllum* with 21 species, *Polygonum* with 20 species, *Quercus* with 18 species, *Strobilanthes* and *Begonia* with 18 species each, *Desmodium* with 17 species, *Piper* with 16 species, *Coelogyne* and *Cyperus* with 15 species each, *Jasminum* with 14 species, *Impatiens, Cymbidium, Eria, Dioscorea* with 13 species each, etc. are also significant. However, a comparative statistics of species pertaining to 20 dominant families and genera occuring in India and Mizoram is presented in the Tables III and IV.

Table III
Families exhibiting maximum diversity

	Mizoram		India	
Family	Genera	Species	Genera	Species
Orchidaceae	75	244	184	1229
Rubiaceae	39	109	113	616
Asteraceae	45	93	166	803
Fabaceae	34	88	133	1141
Euphorbiaceae	33	78	84	523
Acanthaceae	29	71	92	500
Lamiaceae	30	66	72	435

Family	Mizoram		India	
	Genera	Species	Genera	Species
Poaceae	43	66	245	1291
Moraceae	7	43	13	122
Urticaceae	13	41	27	151
Verbenaceae	10	37	25	145
Cyperaceae	7	36	38	545
Lauraceae	10	34	17	212
Gesneriaceae	10	30	24	114
Scrophulariaceae	19	29	62	368
Araceae	13	28	29	126
Zingeberaceae	13	28	23	189
Caesalpinioideae	8	27	19	92
Apocynaceae	22	26	47	119
Fagaceae	3	24	6	57

Table IV
Genera exhibiting maximum diversity

Name of the genera	Number of species	
	Mizoram	India
Dendrobium	41	105
Ficus	34	86
Bulbophyllum	21	107
Polygonum	20	80
Quercus	18	20
Strobilanthes	18	36
Begonia	18	45
Desmodium	16	45
Piper	16	50
Coelogyne	15	36
Cyperus	15	100

Name of the genera	Number of species	
	Mizoram	India
Jasminum	14	40
Hedyotis	13	20
Impatiens	13	230
Cymbidium	13	28
Eria	13	57
Dioscorea	13	56
Phyllanthus	12	60
Crotalaria	12	95
Rubus	11	50
Ophiorrhiza	11	46

A reference to some biologically or otherwise interesting species may further highlight the diversity. The parasites that occur here belong to the diverse families viz. Balanophoraceae (*Balanophora dioca*), Cuscutaceae (*Cuscuta reflexsa*), Loranthaceae (*Loranthus* spp *Viscum* spp.) Orobanchaceae (*Aegenatia indica*), etc. Saprophytes are represented by *Epipogium roseum, Cymbidium macrorrhizon, Aphyllorchis montata,* etc. Insectivorous plants like species of *Utricularia* (4 spp.) and *Drosera peltata* are also found.

A number of primitive flowering plant taxa belonging to families Ranunculaceae, Schisandraceae, Magnoliaceae, Menispermaceae, Myrsinaceae, Hamamelidaceae, Piperaceae, Betulaceae etc. are also significant.

Gymnosperms

The gymnosperms are represented by only 6 species (Fischer, 1938) in Mizoram. Family Pinaceae is represented by genera *Cephalotaxus, Pinus* and *Podocarpus* with 1 species each. Gnetaceae with *Gnetum* is scarcely distributed in evergreen forests. Taxaceae with *Taxus wallichiana* and Cycadaceae with *Cycas pectinata* are other species which also occur sporadically.

Cryptogams

Mizoram is also rich and diverse in cryptogamic plants like algae, fungi, lichens, mosses, liverworts and pteridophytes. The lower plants have not received due attention from botanists as compared to higher plants. Hence, there is an immence scope to work on these groups in Mizoram. Lichens grow at higher elevations in open and moist places usually towards Myanmar border and are represented by the species belonging to genera *Heterodermia, Parmelina, Hypotrachyna, Usnea, Lecanora,* etc. Fischer (1938) reported single species (*Cyathophorum adiantum*) of moss from the area. The species of algae, fungi and liverworts are yet to be studied. Pteridophytic flora is rather well documented and are represented by about 211 species under 66 genera. Major contributions on this group were made by Fischer (1938) and Deb and Dutta (1987). The largest genus is *Polypodium* which is represented by 19 species. It is followed by *Dryopteris* (*ca* 17 spp.) *Selaginella* (*ca* 15 spp.), *Diplazium, Pteris, Asplenium* (9 spp. each), *Pyrrhosia* (8 spp.), *Adiantum* (6 spp.), etc. Thirty one genera are represented by single species each. Further studies on the species of this group need to be intensified to record endemic, rare and threatened taxa.

ECONOMIC PLANTS

Mizoram has rich wealth of plants having economic potential as ornamental, horticulture, timber, medicinal and ethnobotanical significance. There are many wild relatives of cultivated crops. There are about 125 good timber yielding species which are used in making plywood, pulp and constructional work. Some of them deserving special mention are given in Table V.

Table V
Some timber plants of Mizoram

Name of the species	Mizo name	Family
Adina cordifolia	Lungkhup	Rubiaceae
Aphanamixis wallichii	Sahatah	Meliaceae
Albizia lebeck	Thingri	Mimosoideae
A. odoratissima	Kangtek	Mimosoideae

Name of the species	Mizo name	Family
Arotcarpus chaplasa	Lamkhuang, Tatkawng	Moraceae
Bombax ceiba	Phunchawng	Bombacaceae
Castanopsis spp.	Sehaw	Fagaceae
Chukrasia tabularis	Zawngtei	Meliaceae
Cordia fragrantissima	Muk	Cordiaceae
Dillenia indica	Kawrthingdeng	Dilleniaceae
Dipterocarpus macrocarpus	Thingsen	Dipterocarpaceae
D. turbinatus	Thingsen	Dipterocarpaceae
Duabanga grandiflora	Zuoang	Sonneratiaceae
Gmelina arborea	Thlanvawng	Verbenaceae
Mangifera indica	Theihai	Anacardiaceae
Mesua ferrea	Herhae	Clusiaceae
Michelia champaca	Zobul	Magnoliaceae
Pinus kesiya	Fir	Pinaceae
Phoebe goalparensis	Lawngthingtha	Lauraceae
Schima wallichii	Khiang	Theaceae
Shorea robusta	Lawngthing	Dipterocarpaceae
Sterculia spp.		Sterculiaceae
Syzygium cumini	Hmuipui	Myrtaceae
Terminalia myriocarpa	Char	Combretaceae
Toona ciliata	Teipui	Meliaceae

In Mizoram flora, there are numerous ornamental species of commerical potential. Some of the most ornamental orchid taxa occuring here are *Coelogyne barbata, C. punctulata, Cymbidium elegans, C. hookerianum, C. iridioides, C. mastersii, Dendrobium chrysanthum, D. chrysotaxum, D. densiflorum, D. falconeri, D. fimbriatum, Eria paniculata, Neogyne gardneriana, Papilionanthe vandarum, Pleione praecox, Renanthera imschootiana, Vanda coerulea,* etc. Other ornamental species found in this area are *Ixora acuminata, I. roxburghii, I. undulata, Hedychium coccineum, H. coronarium, H. gardnerianum, H. ellipticum, H. spicatum, Begonia thomsonii, B. annulata, B. wattii, Impatiens* and members of Gentianaceae, Gesneriaceae, etc.

Another aspect of the diversity and richness of flora is the presence of a large numer of wild relatives of cultivated crops that would help a breeder to evolve new varities with desirable characters. Some species deserving special mention are *Artocarpus chaplasa, Citrus indica, C. media, Camellia caudata, C. lushaiensis, Musa* spp., *Colocasia* spp., *Prunus* spp., *Alpinia* spp., *Ammomum* spp., *Cajanus* spp., *Cinnamomum* spp., *Cissus* spp., *Curcuma* spp., *Garcinia* spp., *Ipomoea* spp., *Piper* spp., *Saccharum* spp., *Zingiber* spp., etc.

Some of the fibre yielding plants are species of *Abelmoschus, Acacia, Bauhinia, Hibiscus, Kydia, Sterculia, Grewia, Helicteres,* etc.

Bamboos, a group of tall arborescent grasses, are intimately associated with the life of Mizos. They are used as water pipes, food (tender shoot tips), building material and also as a raw material for cottange industry by the rural people. Out of about 113 species under 22 genera (including 3 exotics) reported (Bahadur and Jain, 1983) in India, as many as 63 spp. occur (Biswas, 1988) in north-eastern region, that are widely distributed in Indo-Malesian region. Of the 63 species of north-east region, 18 species occur in Mizoram. The genera *Dendrocalamus* with *D. hamiltonii, D. hookeri, D. longispathus, D. sikkimensis* and *Bambusa* with *B. oliveriana, B. pallida, B. spinosa* and *B. tulda* are the largest and dominant in Mizoram. Similarly *Arundinaria* represented by 3 species viz., *A. callosa, A. falcata, A. phar* (endemic) and *Schizostachyum* also by 3 species viz., *S. polymorphum, S. dulloa* and *S. capitatum.* Of all the species known so far from Mizoram, *Melocanna baccifera, Dendrocalamus hamiltonii, Schizostachyum polymorphum, S. dulloa* and *Bambusa tulda* are most common.

Mizoram forest also abound in good diversity of medicinal as well as plants of ethnobotanical importance. Shukla and Baishya. (1978) recorded 59 economically important plants of Mizoram. So far, about 430 species of medicinal and aromatic plants are recorded (J.H. Lalramnghinglova, *in lit.*) from the area. However, there is a urgent need for a detailed study of medicinal and other economic plants of Mizoram. Some medicinal plants along with their local names and uses are given in the Table VI.

Table VI
Plants of Medicinal and Ethnobotanical importance

Name of the species	Local name	Family	Uses
Acacia pinnata	Khangsen	Mimosoideae	Juice of leaves with milk given to inflants during indigestion. Fruits and stem as fish poison.
Aegle marmelos	Belthei	Rutaceae	Fresh leaf juice to treat asthma.
Asginetia indica	Sanghar-vaibel	Orobanchaceae	Juice of tubers and rhizome in mumps.
Aeschynanthus maculata	Bawltchlantei	Gesneriaceae	Flowers in throat pain.
Adathoda vasica	Kawldai	Acanthaceae	Leaves, flowers and roots as antiseptic.
Adina cordifolia	Lungkhep	Rubiaceae	Leaves juice for killing worms in sores. Bark antiseptic.
Asparagus racemosus	Arkebawk	Asparagaceae	Roots as anti-diarrhoea, anti-dysentery and in kidney disorder.
Averrhoa carambola	Teiber-awt	Oxalidaceae	Fruits in jaundice, ripe fruits in bleeding piles.
Carica papaya	Thingtanhma	Caricaceae	Fruits in Beri-Beri; seeds anti-helminthic; leaf juice in tooth decay.
Cinnamomum zeylanicum	Thakthing	Lauraceae	Bark in checking vomitting and nausea.

Name of the species	Local name	Family	Uses
Cinnamomum tamala	Teapata	Lauraceae	Leaves in rheumatism, colic, diarrhoea and in scorpion string.
C. ceidodaphyne	Khiangzo	Laurnceae	Leaf juice and bark in pneumonia bronchitis, cough.
Clerodendron colebrookianum	Phuifmun	Verbenaceae	Roots in Malaria. Leaves in fever, snake-bite, decoction of leaves in jaundice and high blood pressure.
Coix lachryma-jobi	Pingpin	Poaceae	Roots in menstrual disorder, seeds as good blood purifier and diuretic.
Cordia wallichii	Muk	Boraginaceae	Leaves and bark in expelling retained placenta in female.
Costus speciosus	Sanibal	Zingiberaceae	Roots as purgative, tonic antibelminthic, stimulant and in snake-bite.
Dendrocalamus strictus	Tur-sing	Poaceae	Leaves ecbolics to animals.
Derris wallichi	Hulhu	Fabaceae	Decoction of fruits in stomachache and dysentery.
Dichroa febrifuga	Khawsik-damdawi	Saxifragaceae	Leaves and leafy tops are emetic and febrifuge.

Name of the species	Local name	Family	Uses
Dichrocephala latifolia	Vawk-ek-a-tum-tual.	Asteraceae	Tender shoots in diarrhoea.
Dillenia indica	Kawrthindeng	Dilleniaceae	Fruits as tonic, laxative and also used in abdominal pain; juice of leaves, bark and fruits in diarrhoea.
Dioscorea alata	Rambachhim	Dioscoreaceae	Tubers antihelminthic and used in piles.
D.bulbifera	Rambahra	Dioscoreaceae	Tubers in piles, syphillis and dysentery.
Dysoxylum gobara	Thingthupui	Meliaceae	Decoction of leaves and buds in diarrhoea and dysentery.
Embelia subcoriacea	Thing	Myrsinaceae	Decoction of leaves for bathing during treatment of smallpox.
Engelhardtia spicata	Hnup	Juglandaceae	Bark as fish poison.
Ervatamia coronaria	Par-arsi	Apocynaceae	Milky juice for eye diseases and root in toothache.
Eryngium foetidum	Bahkhawr	Apiaceae	Leaf juice applied externally in 'kaih' (shivering in high fever).
Erythrina variegata	Fartuah	Fabaceae	Leaf juice antihelminthic, laxative and diuretic.

Name of the species	Local name	Family	Uses
Eupatorium odoratum	Tlangsen	Asteraceae	Leaf juice externally in fresh wounds and in bleeding of nose.
Ficus benghalensis	Hurawng	Moraceae	Milky juice applied externally for pains, in rheumatism and lumbago.
F. tinctoria	Zamanhmawng	Moraceae	Root juice in bladder complaints and boiled in milk is for visceral complaints.
Garcinia cowa	Chengkek	Clusiaceae	Decoction of leaves in dysentery and in diarrhoea.
G. sopsopia	Vawmva	Clusiaceae	Decoction of leaves in round worms.
Gmelina arborea	Thlanvawng	Verbenaceae	Roasted fruits applied externally in itches.
Gynura conyza	Buarzo	Asteraceae	Decoction of leaves in tuberculosis, stomach ulcer, dysentery; leaf juice in scabies, fresh wounds and skin diseases.
Helicia robusta	Pasal-taka-za	Proteaceae	Bruised leaves for sores and stomac trouble.
Hodgsonia macrocarpa	Khaum	Cucurbitaceae	Decoction of seed in 'Chhul chak lo' (female diseases)
Hydnocarpus kurzii	Khawitur	Flacourtiaceae	Fruits as fish poison.

Name of the species	Local name	Family	Uses
Impatiens chinensis	Hawilo	Balsaminaceae	Plants paste applied externally for burns.
Imperata cylindrica	Di	Poaceae	Root juice in expelling intestinal worms.
Ipomoea batatas	Kawlbahra	Convolvulaceae	Root paste in scorpion bite. Plants are laxative.
Jasminum grandiflorum	-	Oleaceae	Leaves chewed as treatment for ulcerations or eruptions in the mouth.
Jatropha carcus	Kangdamdawi	Euphorbiaceae	Stem juice in burns.
Juglans regia	Khawkhuah	Juglandaceae	Decoction of leaves in tumours. Fruits and leaves as fish poison.
Lagerstroemia speciosa	Thlado	Lythraceae	Decoction of roots in jaundice.
Leea indica	-	Leeaceae	Roots in diarrhoea and dysentery. Roasted leaves applied to the head in vertigo.
Mangifera indica	Theihai	Anacardiaceae	Decoction of youn leaves in diarrhoea.
Mentha arvensis	Pudina	Lamiaceae	Leaves in asthma.
Mesua ferrea	Herhse	Clusiaceae	Seed oil in scabies.
Milletia pachycarpa	Ru-teng/Ruloi	Fabaceae	Root juice in scabies, skin diseases.

Name of the species	Local name	Family	Uses
Mikania micrantha	Japan-hlo	Asteraceae	Leaf juice in fresh wounds, malaria, dysentary and diarrhoea.
Momordica charantia	Changkha	Cucurbitaceae	Decoction of leaves or fruits in high blood pressure.
Mussaenda glabra	Vakep	Rubiaceae	Leaf juice in chronic ulcers and in snake-bite.
Paederia scandens	Vowih-uih-hrui	Rubiaceae	Leaf juice in tooth-ache and gumboil.
Parkia temoriana	Zawnguh	Mimosoideae	Root juice in fever. Green legumes eaten raw.
Phyllanthus emblica	Sinhlu	Euphorbiaceae	Juice of bark in desentery ; Juice of fruit in 'Chuapro'; bark as fish poison.
Polygonum barbatum	Anbawng	Polygonaceae	Seeds to relieve colic pain.
Prunus cerasoides	Tlaizawng	Rosaceae	Decoction of bark in fever and Malaria.
Punica granatum	Theibuhfai	Punicaceae	Fruits in diarrhoea.
Quercus pachyphylla	Thil	Fagaceae	Bark as astringent
Rhus javanica	Khawhma	Anacardiaceae	Fruits in colic
Saccharum officinarum	Fu	Poaceae	Stem juice in jaundice.

Name of the species	Local name	Family	Uses
Smilax lanceaefolia	Kaiha	Smilacaceae	Fresh root juice to cure rheumatism.
Sapindus mukorossi	Hlingsi	Sapindaceae	Fruits in salivation, chorocis and epilepsy, as fish poison and substitute for soap.
Swertia paniculata		Gentianaceae	Plant as tonic and laxative
Tagetes erecta	Derhken	Asteraceae	Flowers juice in eye diseases, Ulcers, purifying blood; leaf juice in earache.
Tamarindus indica	Tengtere	Caesalpinioideae	Seeds applied in snake-bite.
Thunbergia grandifolia	Zawngs-fain/vako	Thunbergiaceae	Decoction of leaves in stomach complaints.
Tinospora cordifolia	Theisawntlung	Menispermaceae	Fresh plant juice diuretic and gonorrhoea.
Trichosanthes anguina	Be-rul	Cucurbitaceae	Fruits purgative, emetic and antihelminthic.
Urena lobata	Leitha	Malvaceae	Roots diuretic.
Utricularia bifida		Lentibulariaceae	Plants in urinary diseases.

PHYTOGEOGRAPHICAL AFFINITTIES

The territorial contiguity of Mizoram with adjacent regions has contributed much to the diversity and richness of the flora. As the flora of Mizoram is under investigation it is not possible to present a detail account of its phytogeographical affinities. In general, one can say that the wet evergreen forest of the area are similar in characteristic with that of Chittagong (Bangladesh) and are in continuation with that of Jampui evergreen forest of Tripura state. The flora of Mizoram shows greater resemblance with the flora of Malayan region. In Mizoram flora, there are numerous floristic elements which are common to Peninsular India, Arunachal Pradesh, Nagaland, Assam, Manipur, Tripura, Sikkim, Meghalaya, Bhutan, Nepal, China, Myanmar and other south-east Asian countries.

Apart, there are some elements in the Mizoram flora which exhibit wide trans - oceanic distribution extending from Europe, Northern Asia, and Africa to Japan, Australia and New Zealand. A clear picture of phytogeographical affinites will emerge only after the completion of flora.

ENDEMISM

North-eastern India is centre of active speciation (Murti and Joseph, 1984) hence it harbours large number of endemic taxa. Mizoram being a part of this region is expected also to have good number of endemics, but surprisingly, it has poor endemic flora in comparison to other north-eastern states. Such a low degree of endemism in the state may be correlated with to and fro migration of species since it is geographically contiguous with its surrounding regions without any physical barriers. A current estimate indicates that there are about 30 species which are exclusively endemic to Mizoram. Many of them are known by the type collections only, while others have restricted distribution in a small area. For proper evaluation of these species thorough explorations are required to relocate them. Some endemic taxa known from the area are given in the Table VII.

Table VII
Endemic Taxa of Mizoram

Name of the species	Family
Arundinaria phar	Poaceae
Begonia lushaiensis	Begoniaceae
Bulbophyllum parryae	Orchidaceae
Chasalia lushaiensis	Rubiaceae
Derris lushaiensis	Fabaceae
Dichrocephala minutifolia	Asteraceae
Didymocarpus adenocarpa	Gesneriaceae
D. rodgeri	Gesneriaceae
D. parryorum	Gesneriaceae
D. wengeri	Gesneriaceae
Eria lacei	Orchidaceae
Glycosmis cyanocarpa var. *linearifolia*	Rutaceae
Jasminum wengeri	Oleaceae
Mahonia borealis var. *parryii*	Berberidaceae
Mantisia wengeri	Zingiberaceae
Mussaenda parryorum	Rubiaceae
M. pentasaemia	Rubiaceae
Orthosiphon glandulosus	Lamiaceae
Petrocosmea parryorum	Gesneriaceae
Rhododendron vitchianum	Ericaceae
Sinarundinaria longispicata	Poaceae
Senecio lushaiensis	Asteraceae
Sonerila villosa	Melastomaceae
Stereogyne lushaiensis	Orchidaceae
Strobilanthes parryorum	Acanthaceae
Trisepalum lineicapsa	Gesneriaceae
Veronia parryae	Asteraceae

RARE AND THREATENED TAXA

The flora of Mizoram is not fully known on account of inadequate explorations. Hence our knowledge on the rare and threatened plants is indeed poor. Most of the species known at present are collected only once or twice from limited localities. Their exact distribution and status is unknown. Hence, what is required in the present situation is concerted efforts by individuals and research instiutions to explore for specific groups of plants. According to a current estimate over 50% species belonging to orchids, Begonias, Impatiens, etc. of Mizoram, fall under different categories of threat as envisaged by the International Union for Conservation of Nature and Natural Resources (IUCN), mostly because of over exploitation and practice of Jhum cultivation. The status of all orchid taxa has already been presented by Singh *et al.* (1990). However, some important rare and threatened taxa of the area are enumerated in Table VIII.

Table VIII
Rare and threatened taxa

Name of the species	Family	Status
Acampe ochracea	Orchidaceae	Rare
Arundina chinensis	Orchidaceae	Rare
Arundinaria phar	Poaceae	Rare
Begonia lushaiensis	Begoniaceae	Rare
B. watti	Begoniaceae	Endangered
Bulbophyllum parryae	Orchidaceae	Endangered
Coelogyne nitida	Orchidaceae	Threatened
C. ovalis	Orchidaceae	Threatened
Crotalaria kurzii	Fabaceae	Rare
Cymbidium macrorhizon	Orchidaceae	Rare and threatened
C. eburneum	Orchidaceae	Vulnerable
Dendrobium falconeri	Orcidaceae	Rare
Elaeocarpus prunifolius	Elaeocarpaceae	Rare
Mantesia wengeri	Zingiberaceae	Rare and threatened
M. saltatoria	Zingiberaceae	Rare

Name of the species	Family	Status
Paphiopedilum villosum	Orchidaceae	Vulnerable
P. charlesworthii	Orchidaceae	Not collected after type collection
Renanthera imschootiana	Orchidaceae	Threatened
Rhododendron johnstoneanum	Ericaceae	Endangered
R. wattii	Ericaceae	Rare and threatened
R. vitchianum	Ericaceae	Rare
Synotis lushaiensis	Asteraceae	Rare

MAJOR THREATS

Tropical forest are the major store houses of the species diversity. In Mizoram they are greatly effected due to various biotic activities and thus, resulting in the decrease of forest cover gradually. Gerbyal (1996) has made efforts to present the status of forest and consequences of forest degradation in Mizoram based on the forest report of 1993, brought out by the forest Survey of India pertaining to the period 1989 - 91. According to that report, in Mizoram, dense forest cover (having crown density above 40%) has decreased by 41 sq km and open forest cover (having crown density between 10% to 40%) by 115 sq km. The decrease in the forest cover is entirely because of jhumming -practice of shifting cultivation adopted not only in Mizoram but throughout north-eastern states. The report discloses that 256 sq km of forest cover has been lost on account of jhumming during this period and forest cover had increased by 100 sq km because of regeneration in abundoned jhum land, resulting in net overall loss of 156 sq km.

Jhumming is a life style in Mizoram. More than 70% work force depend upon jhumming. In recent years the period of jhum cycle has come down considerably on account of demographic pressure. As a result majority of the virgin forest have been replaced by bamboos and grasses. In order to discourage jhumming and encourage substitute trade or occupation jhumias were given financial assistance by the Government during eighties, under a New Land Use Policy (NLUP). This scheme was not

totally successful. Many jhumia families continued their jhumming practise even after availing financial assistance under NLUP.

Another major cause responsible for forest degradation was the large scale encroachment of the forest land. There is no demarcation of forest land on the ground. The forest department and revenue department have no proper records of land other than that of notified reserve forest. Moreover, Revenue Department has been issuing land settlement certificates within the reserve forest without the consultation of forest department. This has created tremendous confusion and difficulties in the management of forest. During insurgency period many villages were relocated along the roads and valleys within the reserve forest land. The people have encroached the land during that period and now settled permanently. Beside above mentioned factors, the construction of new roads, buildings and urbanisation are other factors responsible for forest degradation.

CONSERVATION

Conservation of plant resources in the entire north-eastern region is a major problem. In this direction, the Government departments and non governmental organisations (NGOs) are continuously contributing their efforts to overcome the problem. Symposia, Seminars and Workshops are often arranged to discuss the problems and to evolve strategies of conservation. North-Eastern Council (NEC) and concerned state governments are providing financial assistance to the people through various schemes to develop the region. Inspite of all these efforts, the forest cover is decreasing day by day. It is not desirable here to go into the details of all these aspects since all the information is already available through various reports, news articles, media and research publications. What is required in the present situation is the concerted efforts by all the people to solve the problem. All the conservation programmes should be precise, result oriented and intergrated with the local people starting at village and panchayat levels. It should be a people's movement, only then one can hope to get some desired results. However, some important sugggestions concerning the conservation of plant resources of Mizoram state are discussed here.

In-situ preservation through the establishments of Sanctuaries, National parks and Reserve forest is the most effective means of conservation. At present Mizoram has two National Parks (Blue Mountain and Murlen) and three Wildlife sanctuaries (Dampa, Khawanglung and

Ngengpui) which are serving the cause of conservation. The management of these sanctuaries and parks is poor and hence need to be strengthened further.

To preserve rich orchid diversity, the orchid sanctuaries at Sairep, near Lunglei and Ngopa, near Champhai, set up by the state forest department are positive measures in this direction. Similarly additional sanctuaries in the orchid rich habitats in different eco-climatic zones like Blue Mountain, Mamit, north-Vanlaiphai, Saithah, Ngurthlang for preserving orchid flora can be established. A gene sanctuary for rare and endemic plant '*Mantisia wengeri*' can be proposed near Darzo or Blue Mountain in order to save it.

Another viable means for the preservation of selected taxa is their *ex-situ* conservation in the botanic gradens where they can be cultivated and multiplied. Some such botanic gardens need to be established in Sangau, Aizwal and Lunglei regions. The *ex-situ* conservation for rare and threatened taxa can also be carried out by using tissue culture techniques. Some work in this direction pertaining to orchid taxa has already been initiated at Botanical Survey of India, Shillong. Successful tissue culture of economic and rare plants will be a great contribution for rapid multiplication and towards *in-vitro* conservation. Thus, *in-vitro* raised seedlings would, in future be made available both for rehabilitation in the wild and for commercial purposes to check the depletion of wild populations.

Jhum cultivation is a great problem in Mizoram and need to be tackled effectively and cleverly since it is an integral part of the culture of the Mizos. It cannot be given up over night by giving them some financial help. One has to create awareness amongs the people and make them realise that 'jhuming' is an inefficient agriculture practice and not profitable. All the concerned development departments have to evolve policies which are suitable in local conditions.

All the forest areas need to be demarcated on ground and boundary disputes settled as early as possible to check further encroachment by the local inhabitats. Revenue department should always consult the forest department before issueing any land settlement certificate.

The forest department should always keep in mind the prevailing market prices of various timber species, while deciding the rates of

royalty in order to avoid illegal tree felling, a profitable venture. Bamboo resources need to be managed sustainably to improve the living standards of the local people that ultimately will reduce the growing demands on natural forest. Bamboo based industries should always be encouraged by the government in the state like Mizoram where industries are negligible. Finally, until and unless the living conditions of local inhabitants are not improved and unemployment problem is solved, it would be rather a difficult task to conserve our resources. Hence, all conservation programmes should be by the people, of the people and for the people.

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Paphiopedilum villosum

Platycerium wallichii

Ficus mysorensis

Oxystelma esculentum

NAGALAND

T. M. Hynniewta

The north-eastern India (21°9" - 29°6" N. Latitude and 89°7" - 97°5" E. Longitude) covering a geographical area of 264037 sq km, comprising of 7 states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura) of which Nagaland is one of the richest and most interesting 'Botanical province'

Nagaland includes the former Naga hills district of Assam (established in 1881) and the Tuensang division of the North East Frontier Agency (NEFA, now Arunachal Pradesh). The administrative 'unit' known as the 'Naga Hills and Tuensang Area' (NHTA) was established on 1st December, 1957. NHTA was renamed as Nagaland on 18th February, 1961. Nagaland was constituted as a full-fledged state of the Indian Union on 1st December, 1963.

Nagaland lies in the extreme north eastern part of India, covering an area of 16,527 sq km between 25°6" - 27°4" N. Latitude and 93°2" - 97°13" E. Longitude. The state is bounded by Assam in the west and north-west and flanked by Tirap district of Arunachal Pradesh in the north-east. The southern boundary is marked by the state of Manipur, while the eastern limits are continuous with the International boundary between India and Myanmar.

Administratively, the state is divided into seven districts namely; Kohima, Mokokchung, Mon, Phek, Tuensang, Wokha and Zunhebato. The capital is Kohima, at an altitude of 1444.12 m. from sea level. Several areas for the present work, at different altitudes, covering all the districts have been selected and explored.

Nagaland is entirely hilly except a narrow-belt of foot-hills bordering Assam and the small valleys in between the lower ranges of the western and north-western flank. The Barail range flanks the boundary with Myanmar and the highest mountain summit 'Saramati' (3048 m) lies on this range. Apart from this there are numerous other hill ranges, such as Japfu in Kohima district (3,014 m) Kapu (2,840 m) Paona (2,790 m) and Kapameyu (2, 430 m). These hills exhibit a remarkable topographic diversity and are dissected by a number of seasonal and perennial rivers

with more or less 'V' shaped valleys in between. There are 4 major river systems in the state, namely Doyang, Dhansiri, Dikhu and Tizu, of these the first three flow towards west through the Assam plains to join the mighty Brahmaputra; while the Tizu river system flows towards east and south-east and pours into Irawadi in Myanmar.

The Dhansiri river in the southwest corner of Nagaland flows a northwesterly course and then turns at right angle to the northeast and forms the northern boundary of the state. Doyang river rises near Mao Thana and flows a north-easterly course for about 45 miles and abruptly turns to northwest and pierces the main chain of hills. The largest tributary to this river is Rengmapani. The important river in the northern frontier of the state is Dikhu. All these rivers receive a number of tributaries, which are all very short running for only a few miles.

Nagaland is located in the Northern extension of the Arakan Yoma ranges which are of tertiary-Cretaceous age, and belong to a fairly young, mobile belt of the earth. The rock sequence is of the geosynclinal facies, represented by the Disang group (Lower and Middle Eocene-upper Cretaceous), the Barail Group (upper Eocene and Oligocene), the Surma and the Tipam Group (Miocene), the Namsang beds (Mio-Pliocene) and the Dihing Group (Pliocene, Pleistocene).

The soil of Nagaland is acidic in general and the pH value ranges from 4.8 to 5.62. The organic carbon content of the surface soil is quite high, but the soil is very poor in phosphate content. The soil texture varies from loam to silty coarse sandy and sandy loam. The soil of Nagaland can be grouped mainly under Entisol, Exisol, Mollisol and Spodosol.

Since the entire state is hilly, land is prone to soil erosion. There are nearly 6,00,000 hectares of forest cleared areas (Jhumland) which are subjected to severe soil erosion.

The climate over the foothills is warm sub-tropical over mid slopes and lower ranges of western flank is moderate, sub-montane type and cool and temperate type over the high hills. The average annual rainfall is between 200 to 250 cms occurring over 6 months from May to October. The bulk of the precipitation is received through south-west monsoon during the four months from June to September. There is not a single completely dry month in the year. The rainy season is characterised by high

humidity. and dry spells that occur during the months of July to September are muggy and enervating.

There is also a significant variation in temperature records with respect to different places in the state. March to June may said to be the summer months and the advent of summer is characterised by thunder showers and hailstorms, often accompanied by strong wind. The summer temperatures over the hills vary from 5°C - 30°C and those over the foothills have a range between 12°C - 32°C. During winter, large tracts of frost is observed over higher elevations. The winter months (December to March) at the foothills and lower ranges of the hills are characterised by heavy dew fall and misty nights.

The relative humidities are low during summer and higher during rainy months. The monthly mean relative humidities vary from 67% in March to 88% in September and October.

VEGETATION

The state of Nagaland supports an altitudinally distributed vegetation dense in growth and diverse in its rich species content. Its geographical location, climate and topography have all contributed to the characteristic vegetation and flora of the state. Broadly based on the altitude and floristic composition, the following vegetational types can, be indicated.

Sub-alpine meadows

These are confined only at Mt. Saramati at an altitude ranging between 3500-3841 m in the area and lack tree species. Shruby plants like *Juniperus recurva* and *Rhododendron lepidotum.* The main herbaceous components, to mention a few, of the area are *Campanula aristata, Carex cruciata, Impatiens racemosa, Hypericum monanthemum. Deyeuxia pulchella* and *Cassiope fastigiata.*

Tropical Evergreen and Semi-Evergreen forest

These forest are confined to elevations between 200-450 m and represent one of the major ecological types in the state with a rich floristic diversity. The western and north-western parts of the state bordering

Assam in the west and Arunachal Pradesh in the north and the south-western foothills of the state are covered by this type of forest. The rainfall is very high and spread over most parts of the year.

There is bewildering wealth of species in these multi-tiered forest. The top canopy is characterised by some of the important timber species such as *Dipterocarpus retusus, Shorea assamica, Terminalia myriocarpa, Duabanga grandiflora, Artocarpus chama, Michelia champaca, Altingia excelsa, Gmelina arborea, Tetrameles nudiflora*; and a host of others. Some of the upper canopy species shed their leaves for a very brief period.

The middle storey is characteised by preponderance of *Mesua ferrea, Endospermum chinense, Terminalia* spp., *Garuga pinnata* and *Toona ciliata*. In moist areas and in valleys often these forest are interspersed by bamboo species such as *Dendrocalamus hamiltonii* and *Bambusa tulda*. In certain semi-evergreen patches this layer is however dominated over by *Bischofia javanica, Dysoxylum procerum, Vatica lanceaefolia* and *Cyclostemon ellipticus*.

The lower storey is characterised by *Talauma hodgsoni, Ficus glomerata, Garcinia* spp., *Litsaea* spp. and a number of smaller trees of the higher storeys.

There is a variety of canes (*Calamus* spp.) in these semi-evergreen forest specially at the foothills. Apart from the canes numerous shrubs and herbs cover the ground. many of which are quite attractive on account of their showy flowers.

The climatic climax of these forests is being lost in many places due to extensive jhuming (shifting agriculture) and also due to unregulated felling of timber trees.

Tropical deciduous forest

These forest are met within areas receiving an annual rainfall of about 200 cm and with a varying range of elevation from 400 to 1200 m. The flora is quite diverse here, specially in the lower elevations, where these forest merge with patches of semi-evergreen forest. Though these forest also exhibit multi-tiered nature the different storeys are not quite distinct, as one could see in the case of Evergreen forest. Further, the species are very irregular. Some of the important top canopy species are

Albizzia procera, A. odoratissima, Terminalia bellirica, T. myriocarpa, Salmalia malabarica, Gmelina arborea and others. *Schima wallichii* one of the important commercial species is also found in great profusion in and around Jalukie area.

The middle and lower storey is predominated over by bamboos belonging to *Bambusa tulda, Teinostachyum dullooa* and *Bambusa arundinacea*. Some of these species form pure patches in certain areas, specially in jhum fallows. Other deciduous species scattered in these patches are *Kydia calycina, Oroxylum indicum, Erythrina suberosa, Phyllanthus emblica* and in Zealiang area the agarwood, *Aquilaria malaconsis*, one of the important minor forest produces of the state.

The ground cover in these forest consists of several herbs and shrubs, particularly during monsoon. These include apart from flowering plants, a number of terrestrial ferns mostly belonging to genera such as *Diplazium, Athyrium, Thelypteris, Cyclosorus, Pteris, Plagiogyria, Pronephrium* and *Dryopteris*. In disturbed areas *Eupatorium odoratum* forms the dominant ground cover.

Temperate forest

These forest are confined to higher elevations from 1300 - 1500 m. Due to prolonged rains and high humidity the vegetation is quite luxuriant. The top canopy is constituted by commercially important species such as *Phoebe cooperiana, Michelia champaca, Castanopsis indica, Exbucklandia populnea, Juglans regia, Betula alnoides, Alnus nepalensis*. The branches of these trees are heavily moss-laden and offer a suitable habitat for a luxuriant growth of epiphytic species. Especially orchids and ferns. Some of the important ferns belong to *Polypodium amoenum, Loxogramme involuta, Crypsinus hastatus, Lepisorus* spp., *Asplenium* spp., *Microsorum membranaceum* and *Pyrrosia* spp. are commonly encountered in these forest. The lower storey is composed of several evergreen species such as *Alnus nepalensis, Quercus serrata, Bischofia javanica, Magnolia campbellii* and *Engelhardtia spicata* are common elements. In some places *Rhododendron arboreum* with their scarlet red flowers are quite conspicuous.

The ground cover is composed of a number of herbaceous species belonging to *Impatiens, Strobilanthes* and *Polygonum*.

Subtropical pine forest

These forest are distributed in the eastern and south-eastern parts of Tuensang and Phek districts. The elevation varies from 1000 to 2000 m and the average annual rainfall is around 175 cm. *Pinus kesiya* is the principal element which occurs almost in pure strands. Occasionally broad-leaved species such as *Quercus* spp. and *Schima wallichii* are also noticed interspersed among these pines. The forest floor which is covered by a thick mat of litter, supports very little of herbaceous flora, chief among which are *Eupatorium* spp., and other members of Asteraceae.

Mixed Bamboo forest

These forest are chiefly contained to old jhum fallows and are mainly formed of *Dendrocalamus hamiltonii*, *Teinostachyum dullooa* and *Bambusa tulda*. The former two species prefer moist localities along streams while the latter prefers well drained hill slopes.

FLORISTIC DIVERSITY

There is no comprehensive flora of this state, though Nagaland along with the neighbouring regions once formed a famous hunting ground for a number of British botanists from time to time. The only regional account of the flora of N.E. India is that of Kanjilal et. al., (1934-40) which deals with dicotyledonous species (except, for Poaceae by. N.L. Bor).

Further, subsequent to the publication of this regional flora, there has been a large scale change in the native flora of the state. Owing to the practice of the so called 'jhuming' or shifting agriculture. It is therefore, not only essential but worth recording the plant species of the state before we are left with only barren, grass-covered hills, devoid of any luxuriant vegetation, besides basic information about plant species is highly essential for further exploration of our plant resources, and this is particularly so for a state like Nagaland, which along with other states in northeast India is on the threshold of numerous intensive programmes of development.

As there exists a conspicuous gap in our knowledge of the flora of Nagaland. and as a prelude towards achieving a full flora of the state, the present account is attempted here based on several extensive collections from different parts of the state encompassing all seasons. Moreover, the

work is also based on the historical collections of the Assam Forest herbarium deposited at the Regional herbarium of the Eastern circle, Botanical Survey of India, Shillong (ASSAM) and Central National Herbarium (CAL).

The state of Nagaland harbours a very rich floristic diversity. The angiospermic flora is represented by 2431 species belonging to 963 genera and 186 families. In this, the share of dicots are 1688 species, 724 genera from 158 families and monocots by 743 species under 239 genera from 28 families. Gymnosperms also register their presence with 9 species, under 6 genera from 5 families, (Table I). An analysis of floristic diversity on various parameters being given in Table II-VII.

Table I
A conspectus of families showing number of genera and species

Family	India		Nagaland	
	Genera	Species	Genera	Species
ANGIOSPERMS				
Dicotyledons				
Ranunculaceae	28	193	7	20
Dilleniaceae	3	12	2	3
Magnoliaceae	3	24	2	13
Illiciaceae	1	1	1	1
Annonaceae	24	120	6	7
Menispermaceae	22	43	6	13
Berberidaceae	4	70	2	3
Lardizabalaceae	3	5	2	2
Nymphaeaceae	2	7	1	1
Papaveraceae	5	27	2	2
Fumariaceae	4	65	2	4
Brassicaceae	64	207	4	11
Capparaceae	7	55	3	9
Violaceae	3	41	1	9
Flacourtiaceae	10	38	4	5
Pittosporaceae	1	11	1	1

Family	India		Nagaland	
	Genera	Species	Genera	Species
Polygalaceae	4	31	2	6
Caryophyllaceae	25	122	6	8
Portulacaceae	2	8	1	1
Hypericaceae	3	29	1	8
Clusiaceae	5	53	2	8
Theaceae	9	23	6	10
Actinidiaceae	2	10	2	4
Stachyuraceae	1	1	1	1
Dipterocarpaceae	5	30	3	4
Malvaceae	22	93	7	10
Bombacaceae	3	5	1	1
Sterculiaceae	19	68	9	14
Tiliaceae	8	53	4	10
Elaeocarpaceae	2	33	2	8
Linaceae	4	9	2	3
Erythroxylaceae	1	6	1	1
Malpighiaceae	4	25	2	3
Geraniaceae	4	45	1	1
Oxalidaceae	3	21	2	3
Balsaminaceae	1	200	1	18
Rutaceae	29	114	12	24
Simaroubaceae	8	15	2	2
Burseraceae	8	22	3	4
Meliaceae	23	97	7	12
Olacaceae	4	12	1	1
Erythropalaceae	1	3	1	2
Opiliaceae	3	3	1	1
Icacinaceae	12	22	1	1
Cardiopteridaceae	1	1	1	1
Aquifoliaceae	1	25	1	4
Celastraceae	13	67	4	11
Rhamnaceae	15	68	5	10
Vitaceae	10	94	5	17

Family	India		Nagaland	
	Genera	Species	Genera	Species
Leeaceae	1	15	1	8
Sapindaceae	18	50	9	11
Hippocastanaceae	1	2	1	1
Aceraceae	1	25	1	7
Staphyleaceae	2	4	1	2
Sabiaceae	1	8	2	3
Anacardiaceae	21	70	5	10
Connaraceae	4	14	1	1
Luguminosae	167	1141	30	68
Rosaceae	44	432	16	33
Saxifragaceae	9	172	3	4
Parnassiaceae	18	201	1	1
Iteaceae	1	1	1	2
Hydrangeaceae	3	9	2	2
Philadelphaceae	2	9	1	1
Escalloniaceae	1	1	1	1
Grossulariaceae	1	9	1	1
Crassulaceae	10	71	2	8
Hamamelidaceae	6	9	2	2
Rhizophoraceae	8	18	1	1
Combretaceae	8	48	2	1
Hernandiaceae	2	8	1	1
Myrtaceae	14	146	6	12
Melastomataceae	21	129	6	12
Lythraceae	9	51	3	5
Sonneratiaceae	2	4	1	1
Punicaceae	1	1	1	1
Onagraceae	6	49	3	3
Trapaceae	1	3	1	1
Passifloraceae	3	24	2	5
Caricaceae	1	2	1	1
Cucurbitaceae	39	99	15	29
Begoniaceae	1	55	1	7

Family	India		Nagaland	
	Genera	Species	Genera	Species
Tetramelaceae	1	1	1	1
Cactaceae	1	3	1	1
Aizoaceae	8	11	1	1
Apiaceae	72	288	15	22
Araliaceae	17	69	10	21
Cornaceae	7	15	3	5
Alangiaceae	1	7	1	2
Caprifoliaceae	6	83	4	10
Rubiaceae	113	616	32	71
Valerianaceae	5	27	1	2
Dipsacaceae	4	10	1	1
Asteraceae	166	803	47	101
Campanulaceae	10	75	9	16
Lobeliaceae	1	22	1	6
Vacciniaceae	2	24	2	23
Ericaceae	15	192	6	22
Pyrolaceae	2	6	1	1
Monotropaceae	4	5	2	4
Primulaceae	10	183	2	11
Myrsinaceae	12	109	8	26
Sapotaceae	14	49	1	1
Ebenaceae	1	51	1	7
Styracaceae	4	6	1	2
Symplocaceae	1	43	1	13
Oleaceae	10	99	5	26
Apocynaceae	47	119	13	17
Asclepiadaceae	57	260	10	16
Loganiaceae	9	33	2	3
Buddlejaceae	1	10	1	4
Strychnaceae	1	3	1	2
Spigelliaceae	1	1	1	1
Gentianaceae	22	188	6	21

Family	India		Nagaland	
	Genera	Species	Genera	Species
Boraginaceae	43	209	8	18
Convolvulaceae	28	184	8	25
Cuscutaceae	1	15	1	1
Solanaceae	17	75	8	30
Scrophulariaceae	62	368	23	41
Orobanchaceae	7	32	1	1
Lentibulariaceae	2	36	1	2
Gesneriaceae	24	119	13	30
Bignoniaceae	20	34	3	4
Acanthaceae	92	500	26	67
Thunbergiaceae	1	10	1	2
Verbenaceae	25	145	9	27
Lamiaceae	72	435	29	65
Plantaginaceae	1	12	1	2
Nyctaginaceae	4	15	3	3
Amaranthaceae	20	60	10	16
Chenopodiaceae	23	69	1	3
Phytolaccaceae	4	6	1	1
Polygonaceae	17	163	4	30
Aristolochiaceae	5	25	1	1
Piperaceae	3	100	2	18
Saururaceae	1	1	1	1
Chloranthaceae	2	3	2	2
Myristicaceae	5	25	2	2
Lauraceae	17	212	13	58
Proteaceae	2	7	1	1
Thymelaeaceae	14	23	3	6
Elaeagnaceae	2	19	1	2
Loranthaceae	9	49	5	7
Santalaceae	10	18	3	4
Balanophoraceae	3	8	1	1
Euphorbiaceae	84	523	25	49

Family	India		Nagaland	
	Genera	Species	Genera	Species
Buxaceae	2	6	1	2
Urticaceae	27	151	17	50
Cannabaceae	2	2	1	1
Ulmaceae	6	22	4	4
Moraceae	13	122	5	27
Juglandaceae	2	2	1	2
Myricaceae	1	1	1	1
Betulaceae	2	7	2	3
Fagaceae	6	57	4	24
Salicaceae	2	64	1	1
Monocotyledons				
Burmanniaceae	2	8	1	1
Orchidaceae	184	1229	63	248
Zingiberaceae	23	189	13	34
Marantaceae	6	14	1	1
Musaceae	2	25	1	3
Cannaceae	1	3	1	1
Haemodoraceae	4	23	3	10
Bromeliaceae	1	1	1	1
Iridaceae	5	21	1	1
Amaryllidaceae	5	24	1	1
Agavaceae	2	18	1	2
Taccaceae	1	3	1	2
Dioscoreaceae	4	34	1	8
Stemonaceae	2	2	1	1
Liliaceae	54	249	5	34
Asparagaceae	1	20	1	3
Smilacaceae	2	33	1	9
Pontederiaceae	2	3	1	1
Xyridaceae	1	6	1	1
Commelinaceae	14	90	12	31

Family	India		Nagaland	
	Genera	Species	Genera	Species
Juncaceae	2	53	2	5
Arecaceae	24	94	6	12
Pandanaceae	2	17	1	1
Araceae	24	94	10	23
Alismataceae	6	14	1	1
Eriocaulaceae	1	70	1	1
Cyperaceae	38	545	9	56
Poaceae	264	1291	98	251
GYMNOSPERMS				
Cycadaceae	1	4	1	1
Taxaceae	2	4	2	3
Pinaceae	6	17	1	2
Cupressaceae	2	8	1	2
Gnetaceae	1	5	1	1

Table II
Largest families by number of species

Sl.No.	Family	Nagaland	India
1.	Poaceae	251	1291
2.	Orchidaceae	248	1229
3.	Asteraceae	101	803
4.	Fabaceae	99	1141
5.	Rubiaceae	71	616
6.	Acanthaceae	67	500
7.	Lamiaceae	65	435
8.	Lauraceae	58	212
9.	Cyperaceae	56	545
10.	Urticaceae	50	151

Table III
Ten Largest families by number of genera

Sl.No.	Family	Nagaland	India
1.	Poaceae	98	264
2.	Orchidaceae	63	184
3.	Asteraceae	47	166
4.	Fabaceae	44	167
5.	Rubiaceae	32	113
6.	Acanthaceae	26	92
7.	Euphorbiaceae	25	84
8.	Lamiaceae	24	72
9.	Scrophulariaceae	23	62
10.	Rosaceae	16	40

Table IV
Largest families of monocots by number of species

Sl.No.	Family	Nagaland	India
1.	Poaceae	251	1291
2.	Orchidaceae	248	1229
3.	Cyperaceae	56	545
4.	Liliaceae	34	249
5.	Zingiberaceae	34	189
6.	Commelinaceae	31	90
7.	Arecaceae	23	94
8.	Haemodoraceae	10	23
9.	Smilacaceae	9	33
10.	Dioscoreaceae	8	34

Table V
Largest families of monocots by number of genera

Sl.No.	Family	Nagaland	India
1.	Poaceae	98	264
2.	Orchidaceae	63	184
3.	Liliaceae	15	54
4.	Zingiberaceae	13	23
5.	Commelinaceae	12	14
6.	Araceae	10	29
7.	Cyperaceae	9	38
8.	Arecaceae	6	24
9.	Haemodoraceae	3	4
10.	Juncaceae	2	2

Table VI
Largest families of dicots number of species

Sl.No.	Family	Nagaland	India
1.	Asteraceae	101	803
2.	Fabaceae	99	1141
3.	Rubiaceae	71	616
4.	Acanthaceae	67	500
5.	Lamiaceae	65	435
6.	Lauraceae	56	212
7.	Urticaceae	50	151
8.	Euphorbiaceae	49	523
9.	Scrophulariaceae	41	368
10.	Rosaceae	33	432

Table VII
Ten largest families dicots by number of genera

Sl.No.	Family	Nagaland	India
1.	Asteraceae	47	166
2.	Fabaceae	44	167
3.	Rubiaceae	32	113
4.	Lamiaceae	29	72
5.	Acanthaceae	26	92
6.	Euphorbiaceae	25	84
7.	Scrophulariaceae	23	62
8.	Rosaceae	16	432
9.	Cucurbitaceae	15	39
10.	Apiaceae	15	72

PHYTOGEOGRAPHICAL AFFINITIES WITH SPECIAL REFERENCE TO ORCHIDACEAE

North-west regin in the eastern Himalays i.e. Sikkim is very rich in orchids content. This region is cut off from Nagaland by a considerable area and extreme dry season (Assam plain). Clarke (1987) remarked that the Flora of Nagaland closely resembles to that of Sikkim. An analysis of the data (shown below) revealed that Sikkim represents about 80% of the Nagaland orchids.

Most of the orchids found in Nagaland are common to the rest of north-eastern India being in the same botanical region (ASSAM) which represents 217 species and 4 varieties. While only 104 species and 1 variety are common to the rest of India.

Again, seven species, viz. *Goodyera viridiflora, Habenaria goodyeroides, Liparis caespitosa, Luisia teretifolia, Malaxis latifolia, Oberonia pyrulifera* and *Spiranthes sinensis* are widely distributed, one species endemic to Nagaland, four to North Eastern India and thirteen to India.

In the following table (Table VIII), a list is supplied of all the orchid genera with the number of their species (and varieties if any, inside

Table VIII
Distribution of Orchid Genera with species

	Number of species					
	Nagaland	Rest of N.E. India	Sikkim	Rest of India	Rest of Asia	Rest of World
Genera	1.	2.	3.	4.	5.	6.
Oberonia	10	10	7	5	9	1
Malaxis	3	3	3	3	3	1
Liparis	13	13	12	7	12	1
Dendrobium	23(1)	22(1)	16(1)	19(1)	22(1)	0
Ephemerantha	1	1	1	1	1	0
Kathernea	4	2	3	0	4	0
Bulbophyllum	19	15	17	9	16	0
Ione	2	2	1	0	2	0
Sunipia	1	0	0	0	0	0
Panisea	1	0	1	0	1	0
Eria	14	12	14	4	13	0
Spathoglottis	1	1	0	0	1	0

Genera	1.	2.	3.	4.	5.	6.
Acanthephippium	1	0	1	0	1	0
Phaius	2	2	2	0	2	0
Thunia	1	1	1	1	1	0
Tainia	2	2	1	0	2	0
Anthogonium	1	1	1	0	1	0
Agrostophyllum	3	3	3	1	3	0
Ceratostylis	2	2	2	1	2	0
Cryptochilus	2	2	2	1	2	0
Coelogyne	18	17	11	7	16	0
Neogyne	1	1	0	0	1	0
Pleione	3	3	3	2	3	0
Otochilus	4	4	4	2	4	0
Pholidota	6(3)	5(3)	4(1)	1(1)	5(3)	0
Calanthe	13	11	11	5	10	0
Armodina	1	1	1	0	1	0
Eulophia	2	2	2	1	2	0
Cymbidium	11	10	9	5	11	0
Luisia	1	1	1	1	1	1

Genera	1.	2.	3.	4.	5.	6.
Stauropsis	1	1	1	0	1	0
Arachnanthe	1	1	1	0	1	0
Kingidium	1	1	1	1	1	0
Rhynchostylis	1	1	1	1	1	0
Pteroceras	1	1	1	0	1	0
Aerides	3	3	3	2	3	0
Renanthera	1	1	0	0	1	0
Vanda	5	4	3	3	5	0
Gastrochilus	4	3	4	2	4	0
Ascocentrum	2	2	2	1	2	0
Cleisocentron	1	1	1	0	1	0
Schoenorchis	1	1	1	0	1	0
Unclfera	2	2	2	0	1	0
Acampe	3	3	3	3	3	0
Sarcanthus	6	6	5	0	5	0
Cleisostoma	3	3	2	0	3	0
Ornithochilus	1	1	1	0	1	0
Thelasis	1	1	1	0	1	0

Genera	1.	2.	3.	4.	5.	6.
Galeola	1	1	1	0	1	0
Anoectochilus	6	6	5	4	4	0
Spiranthes	1	1	1	1	1	1
Cheirostylis	1	1	1	0	1	0
Zeuxine	5	5	5	2	4	0
Goodyera	4	4	4	3	4	1
Hetaeria	1	1	1	0	1	0
Herminium	1	1	1	1	1	0
Habenaria	12	11	8	6	12	1
Satyrium	1	1	1	1	1	0
Paphiopedilum	1	1	0	0	1	0
Total	238(4)	217(4)	195(2)	104(1)	219(4)	7

bracket) hitherto recorded from Nagaland and their geographical distribution outside Nagaland. From the table, it might be possible to get some impression of endemism and the affinities to the orchid flora of surrounding areas. As will appear from the Table the author finds it useful to single out the species recorded from North Eastern India and Sikkim from other parts of India, because both these areas are representing closer affinities of their orchid flora to Nagaland, in comparison to other part of India.

Table IX
Endemic taxa

Family	Nameof the species
Apiaceae	*Chaerophyllum orientalis*
	Pimpinella evoluta
	P. flaccida
Begoniaceae	*Begonia watti*
Berberidaceae	*Berberis micropetala*
	B.wardii
Fumariaceae	*Corydalis boweri*
Menispermaceae	*Cyclea wattii*
Orchidaceae	*Coelogyne hitendrae*
Poaceae	*Calamagrostis nagensis*
	Capillipedium nagense
	C. pteropechys
	Sinobambusa elegans
	Themeda huttonensis

ECONOMIC USES

A very large proportion of the population of Nagaland lives in villages in the interior forest areas, and thus, the schemes of forest utilization have to be planned in such a way so as to bring immediate economic relief to the local inhabitants. There are prospects of establishing and promoting several plant based trades/industries in this region. According to their economic and agricultural/industrial utilization and exploitation, following few deserves to be mentioned.

Wild relatives of cultivated plants: Though the various crops are grown all over the world, the initial domestication of the crops had taken place in one centre, from which they have migrated to different parts of the world. No doubt, some major centers for the origin of almost all the cultivated plants are there, and in Nagaland is one of them. Those deserves to be mentioned are *Artocarpus chama* (Moraceae) - jack-fruit. *Camellia caudata* (Theaceae)-tea. *Coffea benghalensis* (Rubiaceae)-coffee. *Mangifera sylvetica* (Anacardiaceae)- mango. *Musa glauca, M. rosacea, M. velutina,* (Musaceae) - bananas, etc.

Timber: The forest are very rich in species of timber value. Big industrial units based on timber and bamboos have been established. The 'Sal' (*Shorea robusta*) and 'Teak' (*Tectona grandis*) are the major timber tree species. Other important timber trees are 'Champa' (*Michelia champaca*), 'Semul' (*Bombax ceiba*), 'Makai' (*Shorea assamica*), 'Hollong' (*Dipterocarpus macrocarpus*), 'Hollock' (*Terminalia myriocarpa*), etc.

Some other important timber plants of this region are *Albizzia lebbek, Cinnamomum glanduliferum* (timber being insect resistant), *Alseodaphne dumicola, Phoebe attenuata, P. goalparensis, Litsaea cebifera* (timber insect proof), *Juglans regia, Engelhardtia spicata, Podocarpus nertifolia, Taxus baccata, Pinus kesiya, Quercus semicarpifolia, Q. griffithti, Q. semiserrata, Q. lanceaefolia and Castanopsis hysterix,* etc.

Bamboos: Bamboos form an indispensable item, closely woven with life and culture of people of this region, and chief source of pulp for paper industry. Some of the important species are *Bambusa tulda. B. pallida, B. vulgaris, Dendrocalamus strictus, D. hamiltonii, Melocanna bambusoides, Chimenobambusa khasiana, Arundinaria callosa, Cephalostachyum capitatum, Oxytenanthera macrostachya and Phyllostachys mannii,* Other equally important species of bamboos growing in the area are *Dendrocalamus giganteus, Bambusa khasiana, B. nana, B. balcooa, Arundinaria hirsuta, A. suberecta, Chimenobambusa polystachya, C. griffithiana and Sinobambusa elegans.*

Essential oils, gums dyes, resins and Tannins: The oil from lemon grass (Cymbopogon martini) is used in perfumery, cosmetic, etc. The oil is also extracted from *Jasminum* spp. Oils from *Litsea* spp., *Bassia* and *Rhus* are edible.

Gums are obtained from *Acacia arabica* (Gum arabic) and *Sterculia* spp. Terpentine oil is extracted from *Pinus wallichiana. Indigofera tinctoria, Rubia cordifolia* and *Lawsonia alba* yield dyes. For tannin purposes *Terminalia citrina* and *T. tomentosa* are used. *Canarium strictum* and *C. sikkimensis* yield aromatic resins. Some other plant species yielding dyes are *Acanthopanax trifoliatus, Aporusa dioca, Baccaurea sapida, Indigofera dosua, Smilax acreata and Turpinia nepalensis.*

Minor forest products: Some of the important minor forest products are cane, agar wood and oil, menthol, peppermint oil, lemon grass oil, turpentine, *Cinnamomum* (leaf, oil and bark), *Cassia* (leaves and barks), and broom grass.

Paper and Match Industry: Pine and bamboos are two main sources for pulp for paper industry. The important tree species utilised in match industry are *Albizzia lebbek, Alstonia scholaris* and *Bombax ceiba.*

Orchids: Out of 600 species reported from N.E. India, about 250 flourish in Nagaland. Orchid flowers are prized all over the world for their ornamental value. The North-Eastern region is prolific with many epiphytic and terrestrial orchids of surpassing horticultural value which are the progenitors of the present day commercial hybrids and which deserve protection and regeneration for future hybridisation programmes.

A few of the important orchid species are well known for their fascinating beauty are *Acampe ochracea, Acanthephippium striatum , Aerides fieldingii, A. odorata, Anoectochilus sikkimensis Arundina graminifolia Ascocentrum ampullaceum, Bulbophyllum ornatissimum, Calanthe masuca, C. plantaginea, C. tricarinata, Coelogyne barbata, C. corymbosa, C. cristata, C.nitida , C. punctulata, C. suaveolens, Cryptochilus luteus, C. sanguinea, Cymbidium cochleare, C. devonianum, C. eburneum, C. elegans, C.hookerianum, C. iridioides, C. longifolium, C. lowianum, C. mastersii , C. tigrinum, Dendrobium aphyllum, D. chrysanthum, D. chrysotoxum , D. crepidatum, D. densiflorum, D. devonianum, D. falconeri, D. fimbriatum, D. fimbriatum oculatum, D. hookerianum, D. infundibulum , D. lindleyi, D. lituiflorum, D. moschatum, D. nobile, D. wardianum , Epigenetum amplum, Erta bambusifolia, Esmeralda cathcartii, E. clarkei, Paphiopedilum hirsutissimum, Papilionanthe teres, Pectellis susannae, Phaius flavus, P. tankervilliae, Pleione humilis, P. maculata , P. praecox, Renanthera imschootiana, Rhynchostylis retusa., Vanda bicolor, V. coerulea, V. crista,* etc.

Wild edible plant: Almost the entire population makes its living by means of Agriculture. The tribals, in general, follow a system of shifting cultivation called 'Jhum' Most of the wooded areas are not virgin forest owing to the frequent destructon of forest by this type of cultivation practice from early times. The main crop consists of rice, job's tear and millets, but a large number of subsidiary crops are also grown. Their diet is supplemented by several wild edible plants. Some of such plants are enumerated below

Bark: *Baliospermum montanum*. (Euphorbiaceae), *Callicarpa arborea* (Verbenaceae).

Leaves: *Actiphila excelsa*. (Euphorbiaceae), *Alternanthera sessilis*, *Amaranthus caudatus* (Amaranthaceae), *Bidens tripartita*, *Baliospermum calycinum*. (Euphorbiaceae), *Blumea fistulosa* (Asteraceae), *Boehmeria macrophylla* (Urticaceae), *Centella asiatica* (Apiaceae), *Clerodendron bracteatum*, *C. colebrookianum* (Verbenaceae), *Crepis japonica*. (Asteraceae), *Cornus capitata*. (Cornaceae), *Chenopodium album* (Chenopodiaceae), *Eranthemum platiferum* (Acanthaceae), *Fagopyrum esculentum*. (Polygonaceae), *Hydrangea robusta* (Hydrangeaceae), *Impatiens racemosa*, *I. scabrida* (Balsaminaceae), *Lobellia affinis*. (Campanulaceae), *Murraya paniculata* (Rutaceae,) *Mussaenda macrophylla*, *M. glabra*. (Rubiaceae), *Oenanthe javanica* (Apiaceae), *Pavetta indica* (Rubiaceae), *Pilea bracteosa* (Urticaceae), *Piper griffithii*, *P. pedicellosum*, *P. sylvaticum*, *P. thomsonii* (Piperaceae), *Polygonum alatum*, *P. caespitosum*, *P. Chinense*, *P. hydropiper* (Polygonaceae), *Psychotria calocarpa* (Rubiaceae), *Rubus insignis* (Rosaceae), *Selaginella wallichii* (Selaginellaceae), *Spiradiclis bifida* (Rubiaceae), *Viola betonicifolia* (Violaceae), *Vitis repens* (Vitaceae).

Fronds: *Angiopteris evecta*(Angiopteridaceae), *Diplazium esculentum* (Athyriaceae), *Dryopteris elongata* (Aspidiaceae).

Fruits: *Alpinia bracteata* (Zingiberaceae), *Ardisia floribunda* (Myrsinaceae), *Artocarpus chaplasha* (Moraceae), *Bauhinia tenuiflora* (Caesalpiniaceae), *Canarium strictum* (Burseraceae), *Canavalia ensiformis* (Papilionaceae), *Calamus floribundus* (Arecaceae,) *Dillenia Indica* (Dilleniaceae), *Dysoxylum binectariferum* (Meliaceae), *Eleaegnus pyriformis*, *E. umbellata* (Eleagnaceae), *Ficus auriculata*, *F. cunia* , *F. fistulosa*, *F. semicordata* (Moraceae), *Garcinia cowa*, *G. kydia*

(Clusiaceae), *Grewia multiflora* (Tiliaceae), *Illicium griffithii* (Illicinaceae), *Limacia oblonga* (Menispermaceae), *Litsea cebifera* (Lauraceae), *Mahonia acanthifolia* (Berberidaceae), *Piper clarkei* , *P. khasianum* (Piperaceae), *Prunus cerasoides*, *P. rufa* (Rosaceae), *Pueraria phaseoloides* (Papilionaceae), *Rubus biflorus*, *R. birmanicus* , *R. ellipticus*, *R. niveus* (Rosaceae), *Saurauia nepalensis* (Saurauiaceae), *Solanum kurzii*, *S. torvum* (Solanaceae), *Toddalia aculeata* (Rutaceae), *Trichosanthes himalensis* (Cucurbitaceae), *Viburnum coriaceum* (Caprifoliaceae) *Vitis repens* (Vitaceae).

Inflorescences: *Cymbidium longifolium* (Orchidaceae), *Melastoma malabathricum* (Melastomataceae), *Musa sapientum* (Musaceae), *Rhodendron arboreum*, *R. lepidotum* (Ericaceae).

Roots: *Glycine pentaphylla* (Papilionaceae).

Seeds : *Amaranthus caudatus* (Amaranthaceae), *Castanopsis indica*, *Quercus dealbata*, *Q. robusta* (Fagaceae), *Scleria terrestris* (Cyperaceae), *Vigna sinensis* (Papilionaceae), *Zanthoxylum oxyphyllum*, *Z. rhetsa* (Rutaceae).

Shoots: *Bambusa tulda* (Bambusaceae),*Bauhinia variegata* (Papilionaceae), *Berberis nepalensis* (Berberidaceae), *Caryota urens* (Arecaceae), *Conocephalus suaveolens* (Urticaceae), *Dendrocalamus hamiltonii* (Bambusaceae).*Dichrocephala bicolor* (Asteraceae), *Ficus glaberrima* (Moraceae), *Saccharum spontaneum* (Poaceae), *Mycetia longifolia*. (Rubiaceae).

Stems/Piths: *Cyathea brunoniana*, *C. gigantea* (Cyatheaceae), *Musa velutina* (Musaceae), *Oxyspora paniculata* (Melastomataceae).

Tubers and Bulbils : *Aspidopterys glabriuscula* (Malpighiaceae), *Dioscorea hamiltonii*, *D. pentaphylla*, *D. prazerii* (Dioscoreaceae)

Whole Plants: *Ajuga macrosperma* (Lamiaceae), *Anisomeles ovata* (Lamiaceae), *Begonia roxburghii* (Begoniaceae), *Cardamine hirsuta* (Brassicaceae), *Chlorophytum arundinaceum* (Liliaceae). *Elatostema japonica* (Urticaceae), *Oenanthe javanica* (Apiaceae), *Oxalis corniculata* (Oxalidaceae), *Steptolirion volubile* (Commelinaceae).

Medicinal plants

List of ailments/diseases along with medicinal plants used

Bone-Ache: *Hedychium coronarium* (Zingiberaceae).

Bone-Fracture: *Pouzolzia frondosa* (Urticaceae), *Vitis quadrangularis* (Vitaceae).

Boils and Blisters: *Cissus repens* (Vitaceae), *Litsea cibifera* (Lauraceae). *Stephania hernandifolia*. (Menispermaceae). *Viburnum colebrookianum* (Caprifoliaceae).

Burns: *Artemisia nilagirica* (Asteraceae); *Colocassia esculenta* (Araceae); *Zalacca becarii* (Arecaceae).

Asthma: *Bauhinia purpurea* (Caesalpinioideae) *Calotropis gigantea* (Asclepiadaceae); *Stephania glabra* (Menispermaceae).

Contraceptives: *Abrus precatorius* (Fabaceae), *Dioscorea prazeri* (Dioscoreaceae), *Solanum torvum* (Solanaceae).

Cholera: *Houttunyia cordata*. (Saururaceae), *Piper diffusum, P. attenuatum, P. Clarkei, P. griffithii* (Piperaceae).

Cough: *Begonia roxburghii, B.thomsonii* (Begoniaceae); *Berginia ciliata*. (Saxifragaceae); *Derris robusta*. (Papilionaceae); *Messua ferrea*. (Clusiacesae); *Morinda angustifolia* (Rubiaceae); *Piper brachystachyum* (Piperaceae); *Zanthoxylum rhetsa* (Rutaceae).

Cuts/Wounds/Injuries: *Acorus calamus* (Arecaceae), *Ageratum conyzoides* (Asteraceae), *Bergenia ciliata* forma *ligulata* (Saxifragaceae), *Boenninghausenia albifera* (Rutaceae), *Crassocephalum crepidioides* (Asteraceae), *Ficus hirta* (Moraceae), *Gynocardia odorata* (Flacourtiaceae), *Gynura crepidioides* (Asteraceae), *Hypericum japonicum* (Hypericaceae), *Indigofera tinctoria, Mastersia assamica*. (Papilionanceae), *Macaranga denticulata*. (Euphorbiaceae), *Pouzlzia viminea, Villebrunea frutescens* (Urticaceae).

Dog-Bite: *Calotropis gigantea* (Asclepiadaceae).

Diarrhoea: *Blumea fistulosa* (Asteraceae).

Dysentry: *Begonia roxburghii* (Begoniaceae). *Hedyotis scandens* , *Richardsonia pilosa* (Rubiaceae), *Rhododendron arboreum* (Ericaceae), *Stephania hernandifolia* (Menispermaceae), *Tacca integrifolia* (Taccaceae). *Zanthoxyllum acanthopodium* (Rutaceae).

Ear-Ache: *Calotropis gigantea* (Asclepiadaceae), *Casearia vareca* (Flacourtiaceae), *Pterospermum acerifolium* (Sterculiaceae), *Vitis quadrangularis* (Vitaceae)

Eye-Ache: *Allium cepa* (Liliaceae), *Artemisia vulgaris* (Asteraceae), *Berberis nepalensis* (Berberidaceae), *Mucuna pruriens* (Papilionoideae).

Food-Poisoning: *Clerodendron bracteatum* (Verbenaceae). *Milletia pachycarpa* (Papilionaceae), *Polygonum dibotrys* (Polygonaceae), *Rhaphidophora glauca* (Araceae), *Tetrastigma rumicispermum* (Vitaceae).

Head-Ache: *Garcinia kydia* (Clusiaceae). *Miliusa roxburghiana* (Annonaceae), *Jussiaea suffruticosa* (Onagraceae), *Tupistra aurantiaca* (Liliaceae).

Hystseria: *Entada phaseoloides* (Mimosoideae), *Zingiber officinale* (Zingiberaceae).

Fever: *Aconitum ferox*, *Thalictrum minus* (Ranunculaceae); *Clerodendron colebrookianum*, *C. serratum* (Verbenaceae); *Hedychium stenopetalum* (Zingiberaceae), *Picrorhiza kurroa* (Scrophulariaceae); *Plectranthus coetsa* (Lamiaceae); *Swertia macrosperma* (Gentianaceae).

Insect-Bite: *Colocassia esculenta* (Araceae), *Gynocordia odorata* (Flacourtiaceae), *Morinda angustifolia* (Rubiaceae), *Perilla ocimoides* (Lamiaceae).

Impotency: *Canarium strictum* (Burseraceae).

Intestinal parasites: *Anplectrum assamicum* (Melastomataceae), *Baliospermum calycinum* (Euphorbiaceae), *Gynura cusimbu* (Asteraceae), *Melia composita* (Meliaceae), *Meconopsis grandis* (Papavaraceae).

Itches: *Begonia palmata* (Begoniaceae), *Chirita vestitum* (Gesneriaceae), *Drymeria cordata* (Caryophyllaceae), *Elsholtzia blanda* (Lamiaceae), *Hydnocarpus kurzii* (Flacourtiaceae), *Solanum torvum* (Solanaceae). *Villebrunea frutescens* (Urticaceae).

Malaria: *Clematis smilacifolia* (Ranunculaceae).

Menstrual disorder: *Alstonia scholaris* (Apocynaceae), *Vitis quadrangularis* (Vitaceae).

Gyneocological treatment: *Cissampelos pareira* (Menispermaceae), *Molineria prainiana* (Hypoxidaceae).

Muscular Pain: *Aconitum ferox* (Ranunculaceae), *Anisomeles ovata* (Lamiaceae), *Cissus repens* (Vitaceae), *Cyathea gigantea* (Cyatheaceae), *Thelypteris gracilescens* var. *glandulosus* (Thelypteridaceae).

Rheumatism: *Alpinia allughas* (Zingiberaceae), *Cyclosorus parasiticus* (Thelypteridaceae), *Gerbera piloselloides* (Asteraceae), *Lycopodium equamosus* (Lycopodiaceae), *Macropanax undulatum* (Araliaceae).

Ring-worms: *Cassia alata* (Caesalpinioideae), *Euphorbia uniflora*, *Manihot esculenta* (Euphorbiaceae).

Snake-Bite: *Jasminum pubescens* (Oleaceae), *Pothos cathcartii* (Araceae), *Ricinus communis* (Euphorbiaceae).

Stomach-Ache and Indigestion: *Begonia josephii* (Begoniaceae), *Clerodendron squamatum*, *Gmelina arborea* (Verbenaceae), *Fagopyrum cymosum* (Polygonaceae), *Eriobotrys japonica* (Rosaceae), *Hedychium spicatum* (Zingiberaceae), *Litsea cebifera* (Lauraceae), *Plantago major* (Plantaginaceae), *Rhus javanica* (Anacardiaceae).

Tooth-Ache: *Berberis nepalensis* (Berberidaceae), *Chenopodium ambrosioides* (Chenopodiaceae), *Solanum khasianum* (Solanaceae), *Zanthoxylum alatum* (Rutaceae), *Naravelia zeylanica* (Ranunculaceae).

Throat-sore: *Polygonum flaccidum* (polygonaceae), *Toddalia asiatica* (Rutaceae).

Vomiting: *Artemisia vulgaris* (Asteraceae), *Croton caudatus* (Euphorbiaceae), *Pithecelobium heterophyllum* (Mimosoideae).

VULNERABILITY AND MAJOR THREATS

The forest in Nagaland constitute 86.5% of the total geographical areas. The residents of the state are mostly tribals and are dependent on forest for shifting (Jhum) cultivation while others are also known to cut forest for the sale of wood and other forest products. The livelihood security of these tribals is closely linked with the resource base of forest and over the millenia forest-farming has been the traditional socio-cultural practice passed from one generation to another. Another major reason for degradation of forest is that the state finds forest convenient source of income to enable it to meet various expenditure on development and welfare. In Nagaland, the forest revenue meets 60-70% of such expenditure. Added to these the increase in human population, heavy incidence of grazing and pressure on land for agriculture have also been responsible for removal of forest cover and in turn resulting in barren or only grass covered hills in the state.

Table X
Rare and threatened taxa

Name of the species	Family	Status
Acranthera tomentosa	Rubiaceae	Vulnerable
Begonia watti	Begoniaceae	Endangered or possibly extinct
Chaerophyllum orientalis	Apiaceae	Indeterminate
Crotalaria meeboldii	Fabaceae	Indeterminate
Cyclea watti	Menispermaceae	Endangered or possibly extinct
Cymbidium eburneum	Orchidaceae	Vulnerable
C. tigrinum	Orchidaceae	Rare
Gleditsia assamica	Fabaceae	Indeterminate
Kalanchoe roseus	Crassulaceae	Endangered
Livistona jenkinsiana	Arecaceae	Endangered

Name of the species	Family	Status
Michelia punduana	Magnoliaceae	Rare
Ophiorrhiza gracilis	Rubiaceae	Indeterminate
O. griffithii	Rubiaceae	Indeterminate
O. tingens	Rubiaceae	Vulnerable
O. wattii	Rubiaceae	Endangered
Pimpinella evoluta	Apiaceae	Possibly extinct
P. flaccida	Apiaceae	Indeterminate
Pollia pentasperma	Apiaceae	Indeterminate
Renanthera imschootiana	Orchidaceae	Endangered
Senecio rhabdos	Asteraceae	Rare
Silene vagans	Caryophyllaceae	Indeterminate
Vanda coerulea	Orchidaceae	Rare

CONSERVATION

A study on the relationship of the tribal community of the state with their ambient environment revealed many interesting informations. They have a sensitive understanding of ecological interdependence and seasonal variations and know-how to exploit the forest resources without destroying it. The conservation of many plants/animals of the forest were a part of their faith and traditions and a set of fables, folklores, totems, taboos, religious beliefs, etc., perpetuated this culture. But of late, there has been a change in the outlook of these tribals/aboriginals as a result of their contact and interactions with the modern world leading to a transition of from what may be termed as constructive dependence to destructive dependence on the forest. The reason of this unfortunate and undesirable trend in them can be traced to the onslaught by the civilized society on the forest and forest resources who unscrupulously began to over exploit the resource base which the tribals of the state have guarded so safely for centuries.

However, unlike elsewhere in India, the forest lands in Nagaland as with the rest of the north-east India are mostly under the control of village institutions such as Durbars/Clans, etc. and even recognised Jhum or shifting cultivation as a customary right and thus in effect. classification of land as reserved forest has little meaning. With its profusion of

species, variety and vegetal forms, Nagaland enjoys the status of State Mega diversity. But despite such a bounty from nature, this state is yet to accord adequate protective responses from the people for conservation of its floristic diversity. Whilst the protected areas constituted within the Reserve Forest and Protected Forest are having some measure of protection, the bulk of areas falling outside is facing threats mainly due to jhumming. To bring some order and semblance of good conservation practices to Jhum farmers the state has initiated Jhum control regulations. Key features of these regulations include the prohibition of jhums and encouragement to plant quick growing trees in jhum fallows. Moreover, the Nagaland Department of Agriculture, through their well organized grass-root level Village Development Boards (VDBs) have recently been able to catalogue over a thousand plant species used by the villagers, as perceived by the local communities. This is based on a quick evaluation done during a short 6-month period. Such an extensive use of biodiversity suggests that the traditional farmers of the state rely heavily on forest ecosystem to meet their varied needs. This implies that conserving this biodiversity is crucial for their survival.

A preliminary study of the existing literature gives a clear impression that the 'Flora of Nagaland' has not been throughly worked out by earlier workers than that of the surrounding states. The main reason they faced is the difficult terrains and lack of transport facilities. Clarke (1989), while exploring Nagaland, recorded his experience as: *"I had a vague idea that I could, in a mere passing visit to collect a nearly complete set of Kohima species in flowers in October, but if for no other reason I can not do this for want of paper. Transport here is exceedingly difficult, the approach to Kohima is admitted to be the worse 'line in India"* Furthermore, even after India's independence and the establishment of Eastern Circle, Botanical Survey of India in 1956, Nagaland remained botanically unexplored till 1972. It was only from 1973 onwards that the author and his colleagues could made several botanical explorations in different parts of the state encompassing different seasons and the Flora of Nagaland is now well-known. A critical appraisal of the flowering plant species collected including the historical collections deposited at Regional Herbarium (ASSAM) and Central National Herbarium (CAL) revealed the occurrence of *ca* 2500 species (of which 14 are endemic). in over 191 families. So far about 50 plant species of this state have been identified as rare or threatened. What is rather intriguing is the fact that a number of these plants are confined only to Nagaland or in the North eastern region. Still worse, the loss of certain taxa, such as *Begonia watti* (Begoniaceae) *Cyclea watti*

(Apiaceae), known only from their types collected several years ago, perhaps extinct, as they have not been collected again during the recent botanical tours in Nagaland by the Eastern Circle, Botanical Survey of India.

During 1980-85, through a programme entitled "Project on Study, Survey and Conservation of Endangered Species of Flora (POSSCEF)", funded by U. S. Fish and wildlife Board under PL-480, the Botanical Survey of India has provided baseline data on about a thousand threatened species of India which also included taxa from Nagaland. Based on these studies and those individually carried by the scientists of the Department, the survey has compiled Red Data sheets on such plants, of which following from Nagaland deserve special mention with such data as status, distribution, habitat and ecology, cultivation, conservation measures (taken and proposed), biology and potential value and the taxonomic profile *Pimpinella evoluta* (Apiaceae), *Pollia pentasperma* (Commlinaceae), *Michelia punduana* (Magnoliaceae), *Cymbidium eburneum*, *Renanthera imschootiana* (Orchidaceae), *Ophiorrhiza wattii* (Rubiaceae), *Chaerophyllum orientalis*, *Pimpinella flaccida* (Apiaceae), *Crotalaria meeboldii* (Fabaceae), *Cymbidium tigrinum* (Orchidaceae), *Acranthera tomentosa*, *Ophiorrhiza gracilis* *O. griffithii*, *O. tingens* (Rubiaceae), *Adiantum soboliferum* (Adiantaceae), *Livistona jenkinsiana*(Arecaceae), *Senecio rhabdos* (Asteraceae), *Begonia watti* (Begoniaceae), *Silene vagans* (Caryophyllaceae), *Kalanchoe roseus* (Crassulaceae), *Gleditsia assamica* (Fabaceae), *Cyclea watti* (Menispermaceae), *Vanda coerulea* (Orchidaceae). Besides, the Eastern Circle, Botanical Survey of India has brought a number of endemic and threatened species collected from Nagaland under cultivation in its National Orchidarium, Shillong and Experimental Botanic Garden, Barapani and has also taken up some rare and vulnerable species for large scale multiplication through tissue culture in its laboratory at Barapani. A detailed taxonomic account on the state flora of Nagaland is under process for publication by the Botanical Survey of India

Apart from the protected areas as Reserved Forest or wildlife sanctuaries that already existed in Nagaland and under the control of the State Forest Department, the Eastern Circle, Botanical Survey of India has also proposed certain more areas, one such area deserves special mention is at Mt. Saramati which lies on the Barail Range in the Tuensang district of Nagaland, on Indo-Myanmar border. Mt. Saramati provides a good habitat for conservation of flora and serves a better site for the purpose of

proposal as a Biosphere reserve, particularly so as there are many virgin forest still intact, with several rare, endangered and threatened plants occur here, to mention a few of the forest, are: *Aconitum lycoctonum* and *Panax pseudo gingseng* of great medicinal value; *Cymbidium macrorhizon* the only terrestrial leafless Indian *Cymbidium*; *C.tigrinum* which occurs only in Nagaland in India and *Panisea apiculata* a new record for the country, etc., besides the lower groups of plants, especially Lichens, such as *Usnea* and *Parmelia* spp., which are favoured by the musk deer during scarcity. It is also a home of several other protected species of the wildlife in India, such as the clouded leopard, golden cat, lion-tailed macacau; the peacock, great himalayan barbet and blythe's tragopan.

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Cloth making : using different plant species in weaving and dyeing form one of the tribal livelihood in Nagaland

Extraction of timber : a cause of depletion

Jhum operation

Grassland vegetation as a result of jhum operation

Jhum land with temporary tribal huts during jhum operation

Wet-terrace cultivation, rare in Nagaland

Mt. Saramati, 3841 m (distant view), highest Peak in
Nagaland with subalpine vegetation at top

Mt. Saramati : showing virgin forest (close up view)
at the mountain slope, a good site to establish
a Biosphere Reserve

Panax pseudo-ginseng : a rare medicinal herb

Cymbidium tigrinum : a rare orchid endemic to Nagaland

ORISSA

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Orissa, a coastal state in the eastern part of India, lies within tropic of cancer, between 17° 49' 22° 34' N latitude and 81° 27' - 87° 29' E longitude, covering a geographical area of ca 155, 842 sq km. The state is bounded on the north-east by the state of West Bengal, on the north by the state of Bihar, on the west by the state of Madhyapradesh, and on the south-east by the Bay of Bengal. The state is divided into 30 districts and has a coastal line of about 480 km.

The state enjoys a tropical climate. The south-west and retreating north-east monsoon effectively control the climate of the state. The rainfall is widespread during monsoon and ranging from 1075-1812 mm. The average annual rainfall is 1506 mm. In winter, the state does not get rain except a very little in north-east region. The mean annual temperature of the state varies from 20.5° C in the coastal plains to 38.5° C in the inland areas. The relative humidity is high in the coastal plains (75% or more) and low (60%) in the inland regions. The state goes from semi-aridity in the west to moist conditions in the east.

Taking the overall topography into account, the state may be divided into three main regions, viz., i) Coastal plains ii) Mountainous region and iii) Plateaus and uplands. The Eastern Ghats though not continuous all along the state but demarcate the coastal plains from the plateaus in the extreme north and west.

(i) Coastal plains : These extend from Subernarekha in the north to Rushikulya in the south and are inervated by some important rivers, viz., Mahanadi, Subarnarekha, Baitarani, Brahmani, Rushikulya, Budhabalang and Salandi. It has three parallel belts - a) A narrow salt tract of 5-6 km width along the shore line, b) a vast strech of arable tract full of monotonous rice fields and c) a sub montane tract representing a meeting zone of flat alluvial plains and steep slopes of Eastern Ghats.

(ii) Mountainous region : This constitutes the middle region of the state, and includes important mountains, major water-sheds of the

rivers, deep broad fertile valleys and rich vegetation. Some of the important hills are Deomali (1670 m), Sinkaram (1617 m), Galikoda (1616 m), Yendrika (1582 m), Nimgiri (1516 m), Mahendragiri (1525 m), Devgiri (1383 m), Gandhamardan (1002 m), Mankarnacha (1110 m) and Meghasani (1162 m).

(iii) **Plateaus and uplands** : These are mainly found in the extreme north, west and central regions of Orissa. The major categories of plateaus are the Panposh - Keonjhar Pallahara plateau and Nawrangpur - Jeypore plateau with their altitudes ranging between 305-610 m. Some important rolling uplands are Koel - Sankh basin of upper Brahmani, the Ib, the Suktel and the Tel of middle Mahanadi and Sabari basins.

The State is endowed with a rich floristic diversity. The contributions made by Haines (1921-25) and Mooney (1950) are still the major sources for all botanical information. Some other important contribution made on the floristics are by Fischer (1904, 1905), Narayanswami and Carter (1920), Mooney (1941), Bal (1942), Srinivasan and Rao (1961), Panigrahi (1963). Panigrahi *et al* (1964), Kapoor (1964). Saxena (1976), Rath *et at* (1979), Misra (1980, 1982, 1989, 1990), Saxena and Brahmam (1983. 1989, 1994), Banerjee (1984), Choudhury (1984), Bairiganjan *et al* (1985), Choudhury and Patnaik (1985), Patra and Choudhury (1988), Banerjee and Rao (1990), Panda and Patnaik (1993, 1994) and Das *et al* (1994) are worth mentioning. In recent years Saxena and Brahmam (1994-96) have made efforts and published the state flora in four volumes dealing with 2727 species within 1062 genera and 228 families of angiosperms, gymnosperms and Pteridophytes. Thus the knowledge of Botany of Orissa have considerably been improved.

VEGETATION

The state has major forests in mountainous regions, scrubs and grasslands on the plateaus and uplands and aquatic vegetation mainly in the lakes of coastal plain. In general the vegetation of the state may be grouped into - I) Forest, II) Scrubs, III) Grasslands and IV) Aquatics.

I. FOREST VEGETATION

It is mainly restricted to the hilly districts extending from south-western corner of Malkangiri to north-eastern Mayurbhanj district. The distribution of forest within the state, however, is uneven. The coastal plain

has occasional patches of littoral and swamp forest. According to Champion and Seth (1968) there are five groups of forest under three major types, which are as follows

1. MOIST TROPICAL FOREST
   a. Tropical Semi-Evergreen Forest
   b. Tropical Moist Deciduous Forest
   c. Littoral and Swamp Forest

2. DRY TROPICAL FOREST
   a.. Tropical Dry Deciduous Forest

3. MONTANE SUBTROPICAL FOREST
   a.. Sub-Tropical Broad Leaved Hill Forest

1. MOIST TROPICAL FOREST

a. Tropical semi-evergreen forest

These forest occur in the pockets of permanently moist valleys with fertile soil around 800 m. The vegetation is characterised by upper canopy of transiently deciduous trees and completely evergreen undergrowths. Luxuriant growth of epiphytic flora comprising large number of orchids, ferns and mosses are available mainly due to prevailing moist conditions. The dominant elements of these forest are *Artocarpus lakoocha, Dillenia pentagyna, Syzygium cumini, Mangifera indica, Dalbergia latifolia, Bridelia monoica, Mallotus philippensis, Firmiana colorata, Michelia champaca, Celtis tetrandra, Saraca asoca, Ficus spp., Macaranga peltata, Terminalia alata, Schleichera oleosa,* etc., forming the upper canopy. The second storey of the forest is composed of medium sized trees and the important species here are *Aphanamixis polystachya, Symplocos racemosus, Mesua ferrea, Glochidion lanceolarium, Phoebe lanceolata, Protium serratum, Litsea monopetala* and *Polyalthia cerasoides.*

Profusely occurring climbers are represented by *Anamirta cocculus, Entada rheedii, Pothos scandens, Smilax ovalifolia, Erycibe paniculata, Scindapsus officinalis, Schefflera venulosa, Uvaria hamiltonii, Butea parviflora,* etc. Similarly some of the epiphytes of these forest are *Aerides odorata, Bulbophyllum crassipes, Cymbidium aloifolium, Pholidota pallida, Acampe praemorsa* and *Eria bambusifolia.*

The undergrowth is dense and includes evergreen shrubs like *Amomum dealbatum, Barleria strigosa, Glycosmis mauritiana, Melastoma malabathricum, Eranthemum nervosum, Ardisia solanacea, Leea macrophylla, Colebrookia oppositifolia, Psychotria denticulata,* and *Ixora pavetta* in the lighted areas. Some notable herbs viz., *Canscora diffusa, Curculigo orchioides, Begonia picta, Lindernia multiflora, Tainia hookeriana,* and *Tropidia curculigoides* are found here mostly in shady places. However, grasses are rare due to inadequate penetration of light. Bamboo and cane brakes occur distinctly in pure patches along the streams and nalas as well as on the shady slopes.

b. Tropical moist deciduous forest

These are found in continuation with semi-evergreen forest close to moist valleys. The forest are characterised by predominant deciduous species of 25-40 m high, comprising the top storey and some evergreens, forming the second storey. *Shorea robusta* (Sal) represents the chief constituent of this type. The other species associated with it in the top storey are *Callicarpa arborea, Dalbergia latifolia, D. paniculata, Schleichera oleosa, Bridelia squamosa, Toona ciliata, Haldina cordifolia, Mitragyna parvifolia, Terminalia bellirica, T. tomentosa, T. chebula, Madhuca longifolia, Diospyros melanoxylon, Lagerstroemia parviflora, Bombax ceiba, Gmelina arborea, Pterocarpus marsupium, Albizia odoratissima* and a few others.

The second storey is formed by medium sized evergreen trees like *Syzygium cumini, Careya arborea, Buchanania lanzan, Dillenia indica, D. pentagyna, Cleistanthus collinus, Kydia calycina, Premna tomentosa, Protium serratum, Phyllanthus emblica, Ficus racemosa, Alstonia venenata, Polyalthia cerasoides, Mallotus philippensis, Oroxylum indicum, Macaranga peltata, Canthium dicoccum, Cassia fistula,* etc.

The climbers of the forest are *Bauhinia vahlii, Combretum roxburghii, Milletia extensa, Dioscorea* spp. and *Butea superba.*

The undergrowth comprises shrubby evergreen perennials and grasses. The important shrubs are *Cipadessa baccifera, Clerodendrum viscosum, Ixora pavetta, Holarrhena pubescens, Woodfordia fruticosa, Flemingia chappar, Strobilanthes scaber, Flacourtia indica, Sericocalyx scaber,* etc. The herbs include *Cissampelos pareira, Cleome macrophylla, Polygala chinensis, Oxalis corniculata, Atylosia scarabaeoides, Ageratum*

conyzoides, Elephantopus scaber, Tridax procumbens, Hemidesmus indicus, Canscora diffusa, Evolvulus nummularis, etc. Similarly, the important grasses are *Apluda mutica, Aristida setacea, Chloris barbata, Chrysopogon aciculatus, Coix lacryma-jobi, Cymbopogon flexuosus, Cynodon dactylon, Eleusine indica, Heteropogon contortus, Imperata cylindrica, Panicum brevifolium, Themeda triandra* and *Vetiveria zizanioides.*

c. Littoral and tidal swamp forest

The 480 km coastal - line of the state has some forests on sandy coasts (Littoral forests) and in tide innundated swampy areas (Swamp forests) in discontinuous patches. These forests are evergreen in nature due to the prevailing moist conditions and characteristic xerophytic plant communities.

(i) Littoral forest: The vegetation includes xerophytic evergreens adaptable to perpetual physiological drought due to high salinity of soil water, strong wind, shifring sands, with poor nitrogen and less organic matter as well as strong insolation. The most characteristic species *Casuarina equisitifolia* forms pure stands on sand at many places. Associated with it the other constituent species are *Callophyllum innophyllum, Pongamia pinnata, Borassus flabellifer, Phoenix sylvestris, Pandanus fascicularis, Opuntia stricta* var. *dillenii, Calotropis gigantea, Eugenia rothii, Carissa spinarum, Flacourtia indica, Maytenus emarginata, Catunaregam spinosa, Crotalaria verrucosa, Saccharum spontaneum, Phragmites karka,* and a few others. A few shrubs on the sand dunes such as *Calotropis gigantea, Eugenia rothii, Crotalaria verrucosa,* etc. are found associated with herbs viz., *Acalypha lanceolata, Bulbostylis barbata, Crotalaria umbellata, Desmodium biarticulatum, Epaltis divericata, Eragrostis tremula, Gisekia pharnaceoides, Hedyotis graminifolia* var. *arenaria, Indigofera glabra, Leucas montana,* etc. Some sand binders like *Ipomoea pes-caprae, Hydrophylax maritima, Launaea sarmentosa, Spinifex littoreus, Cyperus arenarius,* etc. are also commonly seen. The insectivorous plants such as Sundews (*Drosera indica, D. burmanii)* and bladderworts (*Utricularia polygaloides*) often form carpet on wet sands at the end of monsoon on sea shore. The swamps and depressions possess aquatic species like *Sagittaria guayanensis, Myriophyllum tetrandrum, Aponogeton natans, Eleocharis dulcis, Hygrophila difformis, Blyxa echinosperma, Xyris indica, Monochoria vaginalis, Crinum defixum, Ludwigia perennis, Murdannia spirata, Zoysia matrella* and many others.

(ii) Tidal and swamp forest (Mangrove forest and Scrubs): These forest are characteristic vegetation of coastal Orissa and are concentrated in the deltas of rivers where the mangrove species dominate the area. The species of this vegetation are physiologically xerophytic and exhibit stunted growth (5-10 m). The major elements forming the top canopy are *Sonneratia apetala, S. caseolaris, Avicennia officinalis, A. alba, Heritiera littoralis, H. fomes, Xylocarpus granatum, Rhizophora mucronata, Cynometra mimosoides, Pongamia pinnata* and a few others. The second storey includes *Phoenix paludosa, Ceriopes decandra, Tamarix indica, Hibiscus tiliaceous, Aegiceras corniculatus, Clerodendrum inerme, Cerbera odollam, Pandanus fascicularis, Bruguiera gymnorrhiza, Flagellaria indica, Intsia bijuga, Amoora cuculata, Merope angulata,* etc. Some notable climbers are *Caesalpinia nuga, Derris scandens, D. trifoliata, Finlaysonia obovata, Ipomoea campanulata, Mucuna gigantea, Sarcolobus carinatus, Dalbergia spinosa,* etc. The ground flora is rather poor in respect of species composition. Herbaceous elements are practically absent, except for few patches of grasses.

2. DRY TROPICAL FOREST

a. Tropical dry deciduous forest

These forest are composed of a mixture of trees almost all of which remain leafless during dry season for several months. Most of the species of these forest also occur in moist deciduous forest. The plants are within 13-20 m here and forest have comparatively less number of species. Bamboos occur sporadically in patches but canes and palms are mostly rare within these forest. Climbers are comparatively few and epiphytes and ferns are quite inconspicuous. The most common trees species of these forest are *Anogeissus latifolia, Terminalia alata, Boswellia serrata, Pterocarpus marsupium, Buchanania lanzan, Acacia catechu, Aegle marmelos, Diospyros melanoxylon, Stereospermum chelonoides, Shorea robusta, Dalbergia paniculata, Sterculia urens, Oroxylum indicum, Cassia fistula,* etc. Some notable shrubs are *Wendlandia tinctoria, Helicteres isora, Gardenia gummifera, Grewia hirsuta, Nyctanthes arbor-tristis, Indigofera cassioides, Phoenix acaulis, Flemingia chappar, Phyllodium pulchellum, Catunaregam spinosa, Tadehagi triquetrum, Clerodendrum viscosum, Chromolaena odorata,* etc. The common herbs are *Andrographis paniculata, Boerhaavia diffusa, Achyranthes aspera, Anisomeles indica, Leucas aspera, Barleria cristata, Justicia simplex, Scoparia dulcis, Evolvulus alsinoides, Hemidesmus indicus,* etc.

3. MONTANE SUBTROPICAL FOREST

a. Sub tropical broad leaved hill forest

This type of vegetation is found usually on hill tops between 900-1200 m with poor soil and on steep slopes with thin layer of soil. The trees species here are low crowned and much branched. The sites possess more xerophytic vegetation which resembles tropical dry deciduous forest but usually with a higher proportion of evergreens. The undergrowth is comparatively dense and includes herbs and shrubs. The characteristic trees species include *Diospyros malabarica, Syzygium cumini, Mallotus philippensis, Chionanthus mala-elengi, Manilkara hexandra, Trewia nudiflora* and a few others.

II SCRUB VEGETATION

Stunted trees, shrubs and bushes constituting scrub vegetation of the state is generally found on poor soil like sandstone or lateritic bed in lower elevations where moisture relations are intermediate between desert and Savanna on one hand and rain forests on the other. The chief climatic factor is the imperfect distribution of a sufficient total rainfall. This type of vegetation also occur secondarily due to over exploitation of tall trees from the forest. The vegetation is mostly thorny forests type lacking a tree canopy. Besides, drydeciduous scrub and secondary drydeciduous forest types are also found. In major cases the scrubs represent the climatic climax.

The main constituent of the vegetation are *Gardenia gummifera, Memecylon umbellatum, Woodfordia fruticosa, Atalantia monophylla, Cipadessa baccifera, Flacourtia indica, Maytenus emarginatus, Pavetta crassicaulis, Carissa brevispina, Olax scandens, Streblus asper, Catunaregam spinosa, Bombax ceiba, Phoenix acaulis, Euphorbia* spp. *Canthium parviflorum, Jatropha gossypifolia, Toddalia asiatica, Alstonia venenata, Colebrookea oppositifolia, Grewia tiliaefolia, Psychotria adenophyla, Wendlandia tinctoria* and *Helicteres isora.*

III. GRASSLAND VEGETATION

These are of frequent occurrence within dry deciduous forest of the state. Grassland of flat summits of hill slopes above 1000 m with occasional shrubs and stunted trees, represent a biotic sub-climax. A large

number of grasslands are secondarily developed due to shifting cultivation and repeated deforestation. Most of these have been maintained in their present seral stage due to continued biotic influences. However, the overall picture is the tropical savanna, which supports over 15 million bovine population of the state. The major constituent grass species of this vegetation are *Chrysopogon fulvus, Cymbopogon flexuosus, Eragrostis coarctata, Andropogon ascinodis, Dichanthium pertusum, Microchloa indica, Capillipedium assimile, Pseudoraphis brunonia, Arundinella setosa, Arthraxon lanceolatus, Imperta cylindrica, Sporobolus indicus, Cyperus iria, Kyllinga nemoralis, Paspalidium flavidum, Saccharum spontaneum*, etc.

IV. AQUATIC VEGETATION

The lakes, reservoirs. ponds and vast strech of coastal area harbour rich aquatic vegetation, which may be grouped as freshwater, brackish water and marine hydrophytes. There is an immense scope to study the diversity of brakish water and marine hydrophytes in the state. However, the freshwater aquatics include the floating, submerged as well as the species of swampy and marshy habitats. The important floating species are *Nelumbo nucifera, Euryale ferox, Nymphaea nouchali, Aeschynomene aspera, Nepuntia oleracea, Ludwigia adscendens, Nymphoides hydrophylla, Utricularia* spp., *Eichhornia crassipes, Pistia stratiotes, Lemna perpusilla, Spirodela polyrhiza, Sagittaria guayanensis* and *Aponogeton crispus.* The dominant submerged species found here are *Meriophyllum tetrandrum, Ceratophyllum demersum, Halophila ovalis, Hydrilla verticillata, Ottelia alismoides, Vallisneria natans, Najas foveolata, Ruppia maritima* and *Potamogeton crispus.* Similarly significant species of swampy and marshy habitats include *Ammania baccifera, Ludwigia octovalvis, Coldenia procumbens, Ipomoea aquatica, Hygrophila schulii, Suaeda maritima, Polygonum barbatum, Monocharia hastata, Xyris indica, Commelina benghalensis, Typha angustata, Sagittaria sagittifolia, Bulbostylis barbata, Cyperus cephalotes, Scirpus articulatus, Arundo donax, Leersia hexandra, Paspalum distichum, Saccharum spontaneum* and *Sacciolepis indica.*

FLORISTIC DIVERSITY

The flora of the state is considerably diverse in terms of taxa, habit and growth forms. There are 2630 species of angiospermous plants

distributed within 1060 genera and 194 families. This accounts for about 16% species of that of India. Of the 2630 species, 1868 species with 799 genera belong to Dicots and 762 species with 261 genera to monocots. Overall diversity at genera and species levels are comparatively less than that at family level. In an average there occur 5.5 genera per family and 2.5 species per genus. However, the most diverse families are Poaceae (265 spp.) and Fabaceae (245 spp.), followed by Cyperaceae (140 spp.), Orchidaceae (129 spp.), Asteraceae (117 spp.), Euphorbiaceae (108 spp.), Rubiaceae (89 spp.), Acanthaceae (82 spp.), Lamiaceae (59 spp.) and Scrophulariaceae (56 spp.). About 45% species diversity is restricted to the above ten dominant families. The remaining 55% species belong to less diverse families of which 60 families are represented by single species, 38 families with 2-3 spp., 24 families with 4-5 spp., 18 families with 6-10 species, 25 families having 11-20 species, 15 families with 21-40 species.

Similarly the genus *cyperus* exhibits maximum diversity and has 61 species followed by *Crotalaria* (35 spp.), *Fimbristylis* (30 spp.), *Ipomoea* (25 spp.), Ficus (24 spp.) *Eragrostis* (24 spp.), *Desmodium* (21 spp.) *Indigofera* (20 spp.) *Acacia* (19 spp.) and *Dendrobium* (19 spp). All these ten genera represent *ca* 10.5% of the total species. *Limonia, Lablab, Lawsonia, Hemidesmus, martynia, Nelsonia, Allmania, Riccinus, Hydrilla, Limnophyton*, etc. are some genera represented by one species each.

The status of various groups of vascular plants (Table -I), comparative data of Dicots and Monocots in India (Table II), as well as dominant families and genera are represented in Table III-IV. Similarly a conspectus of families of flowering plants with the number of genera and species in the state is presented in Table V.

The Gymnospermous flora of this state is indeed poor and found with least diversity. There are about 10 species of which7 are cultivated. The species growing in the wild are *Cycas circinalis* var. *orixensis, Gnetum montanum* and *G. ula*. The cultivated species are represented by *Cycas revoluta, C. rumphii* (Cycadaceae), *Araucaria Colemnaris* (Araucariaceae), *Pinus insularis, P. roxburghii* (Pinaceae), *Thuja orrentalis* (Cupressaceae) and *Cryptomeria japonica* (Taxodiaceae). The Pteidophytes represented by 141 species in 66 genera and 41 families of which Polypodiaceae and Thelypteridaceae show the maximum diversity with 17 and 16 species

respectively, followed by Selaginellaceae (7 spp.), Cheilanthaceae (7spp.), Pteridaceae (7 spp.), Aspleniaceae (7 spp.), Athyriaceae (9 spp.), Lomariopsidaceae (6 spp.), Nephrolepidaceae (5 spp.) etc. where as 17 families are represented by single species. *Selaginella nairii* is the endemic taxon.

Floristic studies on Bryophytes and Lichens have not yet been initiated. The Algal flora of Chilka lake (Biswas 1924, 1932) is the only record of this group, while the Aphyllophorales group of fungi include 61 species under 31 genera and 4 families (Pradhan *et al* 1986) have been recorded so far.

Table -I
Status of various groups of vascular plants

Plant Group	Family	Genera	Species
ANGIOSPERMS	194	1060	2630
Dicots	153	799	1868
Monocots.	41	261	762
GYMNOSPERMS	2	2	3
PTERIDOPHYTES	41	66	141

Table II
Comparison of Dicot and Monocot of Orissa with that of India

	Orissa		India	
	Dicot	Monocot	Dicot	Monocot
Family	153	41	210	44
Genera	799	261	2281	705
Species	1868	762	12543	4236

Table III
Dominant families of flowering plants

Sl.No.	Family	Species in Orissa	Species in India
1.	Poaceae	265	1291
2.	Fabaceae	245	973
3.	Cyperaceae	140	545
4.	Orchidaceae	129	1229
5.	Asteraceae	117	803
6.	Euphorbiaceae	108	523
7.	Rubiaceae	89	616
8.	Acanthaceae	82	500
9.	Lamiaceae	59	435
10.	Scrophulariaceae	56	368
11.	Convolvulaceae	52	184
12.	Verbenaceae	41	145
13.	Caesalpiniaceae	40	92
14.	Malvaceae	38	93
15.	Mimosaceae	35	76
16.	Asclepiadaceae	33	260
17.	Commelinaceae	30	90
18.	Rutaceae	29	114
19.	Amaranthaceae	28	60
20.	Solanaceae	27	75

Table IV
Dominant genera

Sl.No.	Genera	Species in Orissa	Species in India
1.	*Cyperus*	61	72
2.	*Crotalaria*	35	97
3.	*Fimbristylis*	30	90
4.	*Ipomoea*	25	60

Sl.No.	Genera	Species	
		Orissa	India
5.	*Ficus*	24	89
6.	*Eragrostis*	22	36
7.	*Desmodium*	21	47
8.	*Indigofera*	20	61
9.	*Acacia*	19	34
10.	*Dendrobium*	19	102
11.	*Eriocaulon*	19	71
12.	*Habenaria*	18	72
13.	*Hedyotis*	18	60
14.	*Euphorbia*	18	84
15.	*Lindernia*	18	27
16.	*Blumea*	17	29
17.	*Flemingia*	16	17
18.	*Grewia*	16	31
19.	*Vigna*	16	24
20.	*Cassia*	15	56

Table V
A conspectus of families of flowering plants

Family	No. of Genera	No. of Species
Acanthaceae	29	82
Agavaceae	3	13
Aizoaceae	2	3
Alangiaceae	1	1
Alismataceae	4	4
Alliaceae	1	4
Amaranthaceae	15	28
Amaryllidaceae	4	9
Anacardiaceae	8	9
Annonaceae	7	19

Family	No. of Genera	No. of Species
Apiaceae	11	16
Apocynaceae	18	30
Aponogetonaceae	1	3
Aquifoliaceae	1	1
Araceae	14	25
Araliaceae	4	5
Arecaceae	7	18
Aristolochiaceae	1	2
Asclepiadaceae	20	33
Asteraceae	54	117
Averrhoaceae	1	1
Avicenniaceae	1	4
Balanophoraceae	1	1
Balsaminaceae	2	4
Barringtoniaceae	2	2
Basellaceae	1	1
Begoniaceae	1	1
Bignoniaceae	8	18
Bixaceae	1	1
Bombacaceae	3	4
Boraginaceae	4	12
Brassicaceae	5	13
Bromeliaceae	1	1
Buddlejaceae	1	1
Burmanniaceae	1	1
Burseraceae	4	5
Butomaceae	1	1
Buxaceae	1	1
Cactaceae	2	7
Caesalpiniaceae	10	40
Campanulaceae	3	5
Cannabinaceae	1	1
Cannaceae	1	1

Family	No. of Genera	No. of Species
Capparaceae	4	15
Caprifoliaceae	1	1
Caricaceae	1	1
Caryophyllaceae	4	5
Casuarinaceae	1	1
Celastraceae	4	9
Ceratophyllaceae	1	2
Chenopodiaceae	3	8
Clusiaceae	4	5
Cochlospermaceae	1	1
Combretaceae	6	18
Commelinaceae	6	30
Connaraceae	1	1
Convolvulaceae	13	52
Costaceae	1	1
Crassulaceae	1	2
Cucurbitaceae	12	25
Cuscutaceae	1	1
Cyperaceae	19	140
Dilleniaceae	1	3
Dioscoreaceae	1	13
Dipterocarpaceae	1	1
Droseraceae	1	3
Ebenaceae	1	11
Ehretiaceae	4	8
Elaeagnaceae	1	1
Elaeocarpaceae	1	4
Elatinaceae	1	2
Eriocaulaceae	1	17
Euphorbiaceae	39	108
Fabaceae	81	245
Flacourtiaceae	5	9
Flagellariaceae	1	1

Family	No. of Genera	No. of Species
Gentianaceae	5	13
Gesneriaceae	4	4
Haemodoraceae	1	1
Haloragaceae	1	2
Hernandiaceae	1	1
Hippocrateaceae	2	3
Hydrocharitaceae	6	7
Hydrophyllaceae	1	1
Hypericaceae	1	3
Hypoxidaceae	2	4
Icacinaceae	1	1
Iridaceae	1	1
Juncaceae	1	1
Lamiaceae	24	59
Lauraceae	10	16
Lecythidaceae	1	1
Leeaceae	1	5
Lemnaceae	3	3
Lentibulariaceae	1	11
Liliaceae	11	15
Linaceae	3	3
Lobeliaceae	1	3
Loranthaceae	4	8
Lythraceae	6	22
Magnoliaceae	1	1
Malpighiaceae	2	3
Malvaceae	12	38
Marantaceae	3	3
Martyniaceae	1	1
Melastomaceae	4	8
Meliaceae	12	19
Memecylaceae	1	1

Family	No. of Genera	No. of Species
Menispermaceae	7	8
Menyanthaceae	1	2
Mimosaceae	12	35
Molluginaceae	3	7
Moraceae	6	25
Moringaceae	1	1
Musaceae	1	2
Myrsinaceae	4	7
Myrtaceae	5	16
Najadaceae	1	4
Nelumbonaceae	1	1
Nyctaginaceae	3	6
Nymphaeaceae	3	4
Ochnaceae	1	1
Olacaceae	1	1
Oleaceae	6	15
Onagraceae	1	6
Opiliaceae	2	2
Orchidaceae	43	129
Orobanchaceae	2	3
Oxalidaceae	2	5
Pandanaceae	1	2
Papaveraceae	1	1
Passifloraceae	1	1
Pedaliaceae	2	2
Periplocaceae	3	5
Piperaceae	2	7
Pittosporaceae	1	1
Plantaginaceae	1	1
Plumbaginaceae	2	3
Poaceae	100	265
Podostemaceae	2	3
Polygalaceae	3	10

Family	No. of Genera	No. of Species
Polygonaceae	3	19
Portulacaceae	1	2
Potamogetonaceae	1	3
Pontederiaceae	2	3
Primulaceae	3	4
Proteaceae	1	2
Punicaceae	1	1
Ranunculaceae	4	8
Rhamnaceae	8	17
Rhizophoraceae	6	12
Rosaceae	3	5
Rubiaceae	38	89
Ruppiaceae	1	1
Rutaceae	17	29
Sabiaceae	1	1
Salicaceae	1	1
Salvadoraceae	2	2
Santalaceae	2	2
Sapindaceae	8	12
Sapotaceae	4	5
Scrophulariaceae	21	56
Simaroubaceae	3	5
Siphonodontaceae	1	1
Smilacaceae	1	3
Solanaceae	7	27
Sonneratiaceae	1	5
Sphenocleaceae	1	1
Spigeliaceae	2	3
Staphyleaceae	1	1
Stemonaceae	1	1
Sterculiaceae	12	20
Strelitziaceae	1	1
Strychnaceae	1	2

Family	No. of Genera	No. of Species
Stylidiaceae	1	1
Styraceae	1	1
Symplocaceae	1	1
Taccaceae	1	1
Tamaricaceae	1	3
Theaceae	1	1
Tiliaceae	5	26
Trapaceae	1	2
Tropaeolaceae	1	1
Turneraceae	1	1
Typhaceae	1	1
Ulmaceae	3	5
Urticaceae	12	19
Vahliaceae	1	1
Verbenaceae	14	41
Violaceae	2	2
Vitaceae	5	15
Xyridaceae	1	3
Zingiberaceae	9	24
Zygophyllaceae	1	1

PHYTOGEOGRAPHICAL AFFINITIES

The state lies within three Phytogeopraphical zones of India, the northern half falls into central Indian floristic region, while the southern half is distributed between Deccan plateau and coastal plains. The sea-front vegetation of the state is perpetually supplemented by the propagules of the flora of the Bay islands and other coastal states and a riverine network helps in inter and intra state dispersal of species. Occurrence of some Himalayan elements on several hill tops of the state adds to the uniqueness of the flora, which might have taken place during the glaciation period. As a whole the flora of the state exhibit wide ranging affinities with the flora of a number of Phytogeographic regions of the

country and also with the adjacent regions. A precise account of the floral affinities are dealt herewith.

Some Plants Common with North Western Himalaya : *Clematis roylei, Polycarpaea corymbosa, Helinus lanceolatus, Trigonella corniculata, Rubus ellipticus, Enhydra fluctuans, Marsdenia hamiltonii, Mimulus strictus, Plantago exigua, Arides odoratum, Bulbophyllum cariniflorum, Eulophia dabia, Naravelia zeylanica, Eleocharis palustris, Chrysopogon fulvus, Cymbopogon gidarba, Panicum astrosanguineum, Phalaris minor, Clerodendrum phlomidis* and *Plectranthus ternifolius*

Some Plants Common with Eastern Himalaya : *Elaeocarpus tectorius, Tetradium glabrifolium, Turpinia nepalensis, Rhus chinensis, Litsea laeta, Baccaurea ramiflora, Habenaria malintana, Liparis nervosa, Staurochilus ramosus, Tainia hookeriana, Zeuxine gracilis, Musa ornata, Alpinia malaccensis, Amomum dealbatum, Curcuma zedoaria, Globba racemosa, Hedychium coccineum, Crinum amoenum, Commelina appendiculata,* and *Ascopis paleacea.*

Some Plants Common with Western Dry region : *Pavonia procumbens, Acacia chundra, Taverniera cuneifolia, Gisekia pharnaceoides, Merremia quinquefolia, Limnophila aquatica, Nepeta hindostana, Trema politoria, Andropogon pumilis, Aristida funiculata, Eragrostis aspera, Eremopogon foveolatus, Paspalum canarae* and *Pennisetum hordeoides.*

Some Plants Common with Gangetic Plains : *Euryale ferox, Crateva adansonii, Merua oblongifolia, Bauhinia semla, Adenanthera pavonina, Erythrina resupinata, Flemingia prostrata, Indigofera atropurpurea, Uraria picta, Syzygium cerasoides, Oenanthe javanica, Pulicaria foliolosa, Primula umbellata, Dipteracanthus beddomei Hemigraphis hirta, Polygonum limbatum, Tragia plukenetti, Commelina hasskarlii, Cyrtococcum accrescens* and *Lolium temulentum.*

Some Plants Common with Eastern India : *Ranunculus pennsylvanicus, Polyalthia korintii, Aphanamixis polystachya, Maytenus kurzii, Dysolobium grande, Terminalia citrina, Syzygium cuneatum, Diplospora singularis, Stylidium kunthii, Teucrium viscidum, Phoebe lanceolata, Antidesma acuminatum, Drypetes assamica, Acampe carinata, Bulbophyllum crassipes, Dendrobium nobile, Goodyera fumata, Tropidia*

curculigoides, Stemona tuberosa, Carex stramentitia and *Microchloa kunthii.*

Some Plants Common with Deccan Plateau : *Alphonsea maderaspatana, Polycarpaea aurea, Allophylus serratus, Mimosa intsia, Indigofera aspalathoides, Cassipourea ceylanica, Zehneria maysorensis, Hedyotis auriculata, Manilkara hexandra, Caralluma adscendens, Toxocarpus kleinii, Hewittia sublobata, Orobanche cernua, Blepharis maderaspatensis, Justicia nilgherrensis, Geniosporum elongatum, Santalum album, Meineckia parvifolia, Eulophia epidendraea, Dipcadi montanum, Murdannia semiteres, Dimeria acutipes* and *Eragrostis maderaspatana.*

Some Plants Common with Western Ghats : *Flacourtia montana, Hypericum mysurense, Mammea suriga, Lepisanthes tetraphyllus, Nothopegia heyneana, Crotalaria epunctata, Desmodium ritchiei, Sesbania javanica, Viburnum punctatum, Alstonia venenata, Carissa paucinervia, Exacum pumilum, Tragia bicolor, Cottonia peduncularis, Dendrobium peguanum, Malaxis densiflora, Polystachya concreta, Curcuma montana, Eriocaulon melaleucum,* and *Tripogon capillatus.*

Some Plants Common with Eastern Ghats : *Cipadessa baccifera, Crotalaria clarkei, Tephrosia tinctoria, Combretum latifolium, Hedyotis biflora, Mollugo disticha, Bupleurum ramosissimum, Lasianthes truncatus, Aganosma cymosa, Exacum bicolor, Merremia aegyptia, Bacopa floribunda, Gmelina asiatica, Piperomia blanda, Acalypha paniculata, Eulophia ochreata, Nervilia discolor, Dioscorea tomentosa, Cyanotis tuberosa, Cyperus hyalinus, Ischaemum indicum* and *Trachys muricatus.*

Some Plants Common with Andaman and Nicobar Islands : *Parabaena sagittata, Heritiera littoralis, Aglaia cucullata, Xylocarpus gangeticus, Colubrina asiatica, Intsia bijuga, Mucuna gigantea, Bruguiera sexangula, Lumnitzera littorea, Sonneratia griffithii, Ophiorrhiza trichocarpos, Sarcolobus globosus, Ipomoea campanulata, Pisonia aculeata, Excoecaria indica, Streblus taxoides, Nervilia punctata, Pristylus parishii, Cynometra iripa* and *Dracaena spicata.*

Some Plants Common with Malayasia : *Avicennia officinalis, Acacia leucophloea, Apluda mutica, Bauhinia racemosa, Crotalaria medicaginea, Ceriops decandra, Coix lacryma-jobi, Dichrostaohys*

cinerea, Eragrostis tenella, Fimbristylis ferruginea, Flacourtia indica, Holoptelia integrifolia, Justicia adhatoda, Indigofera cordifolia, Pongamia pinnata, Oxystelma esculenta, Sageretia oppositifolia, Sonneratia griffithii and *Wrightia tinctoria.*

Some Plants Common with America : *Annona squamosa, Anacardium occidentale, Argemone mexicana, Caesalpinia coriaria, Croton bonplandianum, Datura metel, Eupatorium odoratum, Eichhornia crassipes, Guazama ulmifolia, Gomphrena globosa, Hyptis suaveolens, Ipomoea quamoclit, Lantana camara* var. *aculeata, Martynia annua, Parkinsonia aculeata, Piperomia pellucida, Scoparia dulcis, Swietenia mahagoni; Rauvolfia tetraphylla, Tridax procumbens* and *Turnera ulmifolia.*

Some Plants Common with Africa : *Aerva javanica, Cyperus arenarius, Demostachya bipinnata, Eragrostis ciliaris, Dipteracanthus prostratus, Gnaphalium pulvinatum, Grewia flavescens, Nymphaea nouchali, Prosopis cineraria, Soporobolus toclados, Tamarix troupii* and *Ziziphus nummularia.*

ENDEMISM

There are 29 endemic taxa has , so far, been reported from the state, of which 27 species under 27 genera and 14 families belong to angiosperms. The only endemic gymnosperm is *Cycas circinalis* var. *orixensis* and the only endemic pteridophyte is *Selaginella nairii* (Table VI). The families Orchidaceae, Poaceae and Fabaceae give a cumulative figure of 48% of endemic taxa in the state.

Table VI
Endemic Taxa

Family	Species
Annonaceae	*Uvaria eucinata*
Combretaceae	*Combretum albidum* var. *cooperi*
Ebenaceae	*Diospyros ebenum* var. *acuminata.*
Eriocaulaceae	*Eriocaulon echinulatum*

Family	Species
Euphorbiaceae	*Homonoia intermedia*
Fabaceae	*Mucuna minima, Rhynchosia hainesiana, Tephrosia purpurea* var. *maritima*
Flacourtiaceae	*Flacourtia indica* var. *innocua*
Lamiaceae	*Eusteralis griffithii*
Malpighiaceae	*Aspidopterys tomentosa* var. *hutchinsonii*
Meliaceae	*Aglaia haslettiana, Toona ciliata* var. *brevipetiolulata*
Orchidaceae	*Bulbophyllum panigrahianum, Eria meghasaniensis, Habenaria panigrahiana, H. panigrahiana* var. *parviloba, Liparis vestita* ssp. *seidenfadonii*
Poaceae	*Dimeria mooneyi, D. orissae, Oryza jeyporensis, Themeda mooneyi T. saxicola*
Rubiaceae	*Gardenia gummifera* var. *gummiferoides, Hedyotis graminifolia* sub. sp. *arenaria*
Sterculiaceae	*Eriolaena hookeriana* var. *viridis, Heritiera kanikensis*
Cycadaceae	*Cycas circinalis* var. *orixensis.*
Selaginellaceae	*Selaginella nairii.*

RARE AND ENDANGERED PLANTS

It is estimated that 144 species (ca 5.5% of total sp of state) distributed within 119 genera and 41 families of flowering plants occur either as rare or endangered. These alongwith their status are presented in the Table VII.

Table VII
Rare and Endangered taxa

Family	Name of the species	Status
Acanthaceae	*Acanthus volubilis*	Rare
	Justicia nilgherrensis	Rare
	Strobilanthes circarensis	Endangered
	S. jeyporensis	Rare
	S. lupulinus	Rare
Agavaceae	*Dracaena spicata*	Endangered
Aizoaceae	*Mollugo disticha*	Rare
Anacardiaceae	*Nothopegia heyneana*	Endangered
Annonaceae	*Alphonsea madraspatana*	Endangered
	Polyalthia korintii	Rare
	Uvaria hamiltonii	Rare
Apiaceae	*Peucedanum dhana*	Rare
	Pimpinella bracteata	Rare
Apocynaceae	*Carissa gangetica*	Rare
	Cerbera odollam	Rare
	Rauvolfia serpentina	Rare
Araceae	*Alocasia montana*	Endangered
	Cryptocoryne ciliata	Endangered
	Rhaphidophora decursiva	Endangered
	R. hookeri	Rare
Arecaceae	*Phoenix paludosa*	Endangered
Asclepiadaceae	*Ceropegia hirsuta*	Rare
	Heterostema tanjorense	Endangered
	Sarcolobus carinatus	Rare
	Tylophora rotundifolia	Rare
	T. fasciculata	Rare
Asteraceae	*Anaphalis lawii*	Endangered
	Gynura nitida	Endangered
	Senecio candicans	Endangered
	S. corymbosus	Rare

Family	Name of the species	Status
Balanophoraceae	*Balanophora polyandra*	Endangered
Caesalpiniaceae	*Intsia bijuga*	Endangered
Capparaceae	*Capparis olacifolia*	Rare
	C. roxburghii	Rare
Caprifoliaceae	*Viburnum punctatum*	Rare
Celastraceae	*Maytenus bailadillana*	Endangered
	M. rothiana	Rare
Chenopodiaceae	*Salicornia brachiata*	Rare
Clusiaceae	*Garcinia cowa*	Rare
Cyperaceae	*Fimbristylis sericea*	Endangered
	F. tristachya	Endangered
Eriocaulaceae	*Eriocaulon echinulatum*	Endangered
Euphorbiaceae	*Alchornea mollis*	Rare
	Dimorphocalyx glabellus	Endangered
	Drypetes assamica	Rare
	Lasiococca comberi	Rare
	Micrococca mercurialis	Endangered
	Pachystylidium hirsutum	Endangered
	Tragia bicolor	Endangered
Fabaceae	*Atylosia cajanifolia*	Rare
	Desmodium ritchiei	Endangered
	Eleiotis sororia	Endangered
	Erythrina resupinata	Endangered
	Flemingia nilgheriensis	Endangered
	Indigofera aspalathoides	Rare
	I. wightii	Rare
	Nogra grahamii	Endangered
	Ormocarpum cochinchinense	Endangered
	Psoralia corylifolia	Rare
	Rhynchosia suaveolens	Endangered
	Sophora bakeri	Endangered
	S. glauca	Rare
	Taverniera cuneifolia	Rare
	Tephrosia roxburghiana	Endangered

Family	Name of the species	Status
Flacourtiaceae	*Homalium nepalense*	Rare
Gesneriaceae	*Aeschynanthus parasiticus*	Rare
	Chirita hamosa	Rare
Hydrocharitaceae	*Halophila beccarii*	Endangered
Hypericaceae	*Hypericum gaitii*	Endangered
Icacinaceae	*Natsiatum herpeticum*	Rare
Lamiaceae	*Leucas clarkei*	Rare
Lauraceae	*Neocinnamomum caudatum*	Rare
	Persea macrantha	Rare
Liliaceae	*Dipcadi montanum*	Rare
	Gloriosa superba	Rare
Lobeliaceae	*Lobelia alsinoides*	Rare
Melastomaceae	*Osbeckia stellata* var. *rostrata*	Rare
Meliaceae	*Aglaia cucullata*	Endangered
	A. elaeagnoidea	Endangered
	Chukrasia tabularis	Rare
	Toona ciliata var. *hainesii*	Endangered
	T. cilitata var. *pubinervis*	Endangered
	Xylocarpus gangeticus	Rare
Menispermaceae	*Parabaena sagittata*	Rare
	Tinospora sinensis	Rare
Mimosaceae	*Acacia donaldii*	Endangered
	A. tomentosa	Endangered
	Albizia orissensis	Endangered
Orchidaceae	*Acampe rigida*	Endangered
	Acanthephippium sylhetense	Endangered
	Aerides crispum	Endangered
	Bulbophyllum careyanium	Rare
	B. crassipes	Endangered

Family	Name of the species	Status
	B. guttulatum	Endangered
	B. macraei	Endangered
	B. polyrhizum	Rare
	Dendrobium cathcartii	Endangered
	D. peguanum	Rare
	D. regium	Endangered
	Diploprora championi	Endangered
	Eria bambusifolia	Rare
	Eulophia dabia	Endangered
	Goodyera thailandica	Endangered
	Liparis resupinata	Endangered
	Luisia primulina	Endangered
	Malaxis mackinonii	Rare
	M. purpurea	Endangered
	Nervilia punctata	Endangered
	Oberonia gammiei	Endangered
	Peristylus parishii	Endangered
	Polystachya concreta	Rare
	Pomatocalpa decipiens	Endangered
	Smitinandia micrantha	Rare
	Tainia hookeriana	Endangered
	Tropidia angulosa	Rare
	Zeuxine lindleyana	Endangered
Piperaceae	*Piperomia blanda*	Rare
Pittosporaceae	*Pittosporum wightii*	Rare
Poaceae	*Dimeria acutipes*	Endangered
	D. lehmannii	Endangered
	D. mahendragiriensis	Endangered
	D. mooneyi	Endangered
	Oropetium villosulum	Rare
	Tripogon roxburghianus	Rare
Podostemaceae	*Podostemon wallichii*	Rare
Rhizophoraceae	*Cassipourea ceylanica*	Endangered
Rosaceae	*Prunus pygeoides*	Rare

Family	Name of the species	Status
Rubiaceae	*Lasianthus truncatus*	Endangered
	Neanotis montholoni	Endangered
	Ophiorrhiza trichocarpus	Rare
	Pavetta brevifolia var. *ciliolata*	Endangered
	Psychotria adenophylla	Rare
	P. monticola	Rare
	Wendlandia gamblei	Endangered
Rutaceae	*Merope angulata*	Endangered
	Paramignya scandens	Rare
Scrophulariaceae	*Melasma thomsonii*	Rare
Smilacaceae	*Smilax lancifolia*	Endangered
Sonneratiaceae	*Sonneratia caseolaris*	Rare
Sterculiaceae	*Heritiera kanikensis*	Rare
Stemonaceae	*Stemona tuberosa*	Rare
Verbenaceae	*Premna calycina*	Rare
Gnetaceae	*Gnetum montanum*	Endangered
	G. ula	Rare

ECONOMIC PLANTS

The natural plant resources provide a good deal of useful plants. Besides a number of cultivated species, *ca.* 30% of wild species are economically important. A sketch of economically and ethnobotanically important plants is provided herewith.

Edibles

Common edible plants: *Alternanthera sessiles, Amaranthus spinosus, Ananas cosmosus, Annona reticulata, Basella alba, Dillenia indica, Diospyros melanoxylon, Ipomoea batatas, Mangifera indica, Moringa oleifera, Phoenix sylvestris, Tamarindus indica, Trapa natans, Ziziphus mauritiana,* etc.

Uncommon edibles plants : (Based on ethnobotanical studies)

Leaves and shoots : *Bauhinia purpurea, Celosia argentea, Cleome viscosa, Commelina bengalensis, Leucas aspera, Paederia foetida, Portulaca oleracea,* etc.

Flowers : *Caryota urens, Indigofera cassioides* and *Woodfordia fruticosa.*

Fruits : *Dillenia aurea, Flacourtia indica, Grewia sapida, Madhuca indica, Schleichera oleosa, Solanum nigrum, Spondias pinnata, Ziziphus oenoplia,* etc.

Seeds : *Bauhinia vahlii, Cleome viscosa, Combretum nanum, Sterculia urens, Terminalia bellirica,* etc.

Roots and rhizomes : *Colocasia esculenta, Costus speciosus, Curcuma angustifolia,* etc.

Medicinal plants

The hilly tracts of Orissa are the potential source of medicinal plants. Mythological Gandhamardan is well known for drug plants since time immemorial. It is said that brave Hanuman had collected life saving VISHALYAKARANI (*Tridax procumbens*) from Gandhamardhan to save wounded Laxman, during the war between Ram and Ravan. There are *ca.* 600 medicinal plants (*ca.* 23% of total s.p.) in the state. Some common medicinal plants are as follows.

Common medicinal plants

Aloe indica
Abrus precatorious
Alstonia scholaris
Andrographis paniculata
Aspargagus racemosus
Azadirachta indica
Barleria prionitis
Boerhavia diffusa
Datura fastuosa
Eclipta prostrata
Elephantopus scaber
Euphorbia hirta
Hemidesmus indicus.
Holarrhena pubescens
Jatropha curcas
Justicia adhatoda

Calotropis gigantea
Cassia fistula
Centella asiatica
Cissampelos pareira
Cissus quadrangula
Curculigo orchioides
Smilax ovalifolia
Strychnos nux-vomica
Terminalia arjuna
T. bellirica
T. chebula
Nyctanthes arbortristis
Ocimum sanctum
Oxalis corniculata
Phyllanthus emblica
Pongamia pinnata
Ricinus communis
Stephania hernandifolia
Tinospora cordifolia
Tridax procumbens,

Uncommon medicinal plants : (Based on ethnobotanical studies)

Anthelmintic — *Aristolochia grandiflora, Asparagus racemosus, Cassia fistula, Clerodendrum viscosum, Rauvolfia serpentina* and *Thespesia lampas.*

Antidote — *Curculigo orchioides, Oxalis corniculata,* and *Tephrosia purpurea.*

Antifertility — *Alysicarpus vaginalis, Azadirachta indica, Indigofera cassioides, Moringa oleifera* and *Plumbago indica.*

Antiseptic — *Boswellia serrata, Eclipta prostrata, Justicia adhatoda* and *Tridax procumbens.*

Aphrodisiac — *Abrus precatorious, Asparagus racemosus, Evolvulus alsinoides* and *Tinospora cordifolia.*

Asthma — *Acalypha indica, Alstonia scholaris, Curculigo orchioides, Phyllanthus emblica* and *Tylophora indica.*

Bone fracture — *Ampelocissus latifolia, Cuscuta reflexa, Cissus quadrangularis,* and *Scindapsus officinalis.*

Bronchitis — *Alstonia scholaris, Cissampelos pareira, Ichnocarpus frutescens, Strychnos nux-vomica* and *Symplocos racemosa.*

Dental problems	*Achyranthes aspera, Azadirachta indica, Glossogyne bidens, Streblus taxoides* and *Vitex negundo.*
Digestive disorders	*Bauhinia purpurea, Carica papaya, Chenopodium album, Stephania hernandifolia* and *Tephrosia purpurea.*
Ear complaints	*Achyranthes aspera, Borassus flabellifer, Curculigo orchioides* and *Spondias pinnata.*
Eye diseases	*Alternanthera sessilis, Bauhinia purpurea, Commelina benghalensis,* and *Moringa oleifera.*
Gynaecological complaints	*Asparagus racemosus, Euphorbia hirta, Lygodium flexuosum, Phyllanthus emblica* and *Sida cordata.*
Lactation problems	*Cryptolepis buchananii, Curculigo orchioides, Ichnocarpus frutescens, Ipomoea batatas.*
Leucorrhoea	*Barleria prionitis, Evolvulus alsinoides, Euphorbia hirta* and *Phyllanthus emblica.*
Menestrual complaints	*Boerhavia diffusa, Cassia fistula, Ochna obtusata,* and *Smilax ovalifolia.*
Rheumatism	*Aristolochia grandiflora, Bridelia squamosa, Clerodendrum viscosum Guziotia abyssinica* and *Syzygium cumini.*
Skin diseases	*Atlanthus excelsa, Centella asiatica, Clerodendrum viscosum, Guzotia abyssinica Martynia diandra* and *Calotropis procera.*
Snake bite	*Aegle marmelos, Bidens biternata, Cissampelos pareira, Oroxylum indicum* and *Tamarindus indica.*
Veneral diseases	*Alstonia scholaris, Ficus benghalensis, Scoparia dulcis,* and *Tinospora cordifolia.*
Veterinary Medicine	*Achyranthes aspera, Alstonia scholaris, Boswellia serrata, Calotropis procera,*

(Relating to injuries, fractures and stomach complaints)	*Clerodendrum viscosum, Colebrookea oppositifolia, Costus speciosus, Cuscuta reflexa, Martynia diandra, Mimosa pudica, Schrebera switenoides, Semecarpus anacardium, Vitex negundo and Woodfordia fruticosa.*

Timber yielding plants

Anogeissus latifolia, Bombax ceiba, Buchanania lanzan, Bridelia retusa, Careya arborea, Dalbergia latifolia, Diospyros melanoxylon, Gmelina arborea, Grewia tiliifolia, Haldina cordifolia, Mangifera indica, Mitragyna parviflora, Mallotus philippensis, Morinda pubescens, Pterocarpus marsupium, Schleichera oleosa, Shorea robusta, Syzygium cumini, Tectona grandis, Terminalia tomentosa, T. arjuna, T. bellirica, and *Xylia xylocarpa* are some common timber plants.

Fibre yielding plants

Abutilon indicum, Bauhinia vahlii, Crotalaria juncea, Cryptolepis buchananii, Grewia asiatica, Helicteres isora, Kydia calycina, Marsdenia tenacissima, Sida acuta and *Urena lobata.*

Gum and resin yielding plants

Acacia farnesiana, Bombax ceiba, Buchanania lanzan, Cochlospermum religiosum, Ficus benghalensis, Shorea robusta, Sterculia urens and *Terminalia bellirica.*

Oil yielding plants

Celastrus paniculatus, Hyptis suaveolens, Jatropha curcas, Litsea glutinosa, Madhuca indica, Pandanus fascicularis, Pongamia pinnata, Ricinus communis, Schleichera oleosa and *Vetiveria zizanioides.*

Insect repellant plants

Annona squamosa, Arisaema speciosum, Azadirachta indica, Cascabela thevetia, Haldina cordifolia, Madhuca indica, Milletia extensa, Schleichera oleosa, and *Vitex negundo.*

Piscicidal plants/fish stupefying plants

Barringtonia acutangula, Careya arborea, Cascabela thevetia, Cleistanthus collinus, Milletia extensa, Sphearanthus indicus, and Strychnos nux-vomica.

Avenue plants

Albizia lebbeck, Azadirachta indica, Cassia fistula, C. siamea, Delonix regia, Ficus benghalensis, F. religiosa, Lagerstroemia parviflora, Peltophorum pterocarpum, Polyalthia longifolia, Pongamia pinnata, Syzigium cumini, Swietenia mahagoni and *Tamarindus indica.*

CONSERVATION

The State of Orissa is facing severe threat to its flora due to growing needs of human society. There has been a continuous depletion of forest area due to shifting cultivation practised by tribals, developmental activities in the coastal area, rapid industrialisation and urbanisation, burning of forest for hunting, expansion of roads, etc. The shrinkage of swampy habitat at Bhitarkanika has adversely affected the mangrove vegetation.

Chilka, the largest lagoon in India, attracts tourists and naturalists to observe indigenous and migratory birds. Accumulation of garbage and chemicals (used in prawn culture) disturbs the salinity level of water, thereby causing a great loss of microphytes and fishes, resulting in the depletion of food of migratory brids. This ultimately affects the ecotourism.

Mangrove vegetation at Bhitarkanika is under threat due to felling of trees for fuel, timber and prawn culture.

Casuarina plantations developed at various river beds of the state as wind breaks to combat soil erosion and desertification are also being cleared by the local people for domestic use.

The State has Simlipal Biosphere Reserve (*ca* 2750 sq km), Bhitarkanika National Park (*ca* 537 sq km) and 19 Wild Life Sanctuaries (*ca* 5668 sq km), (Table VIII).

Table VIII
Protected areas

Sanctuary	Area in sq km	Location (District)	Characteristic Vegetation
Badrama	304	Sambalpur	Sal Mixed deciduous forest.
Baishipali	166	Nayagarh	Mixed deciduous forest Riverine forest
Balimela	160	Malkangiri	Mixed deciduous forest
Balukhand	72	Puri	Mangrove and scrub Littoral forest Salt water mixed forest
Chandaka	175	Khurda	Semi-evergreen forest Sal forest Moist mixed deciduous forest
Chilka lake	1100	Puri and Ganjam	Sea weeds and Sea grasses
Debrigarh	346	Jharsuguda	Mixed deciduous forest and scrub
Hadgarh	192	Keonjhar	Sal Moist deciduous forest
Kapilasa	126	Dhenkanal	Moist mixed deciduous and Sal forest

Sanctuary	Area in sq km	Location (District)	Characteristic Vegetation
Karlapat	147	Kalahandi	Mixed deciduous forest and scrub, on hills
Khalasuni	116	Sambalpur	Mixed deciduous forest and sal forest
Kondakameru	430	Malkangiri	Mixed deciduous forest and scrub
Kotagarh	400	Phulbani	Mixed deciduous forest
Kuldiha	273	Balasore	Semi-evergreen forest Moist mixed deciduous forest Littoral and Swamp forest
Lakhari valley	118	Gajapati	Coastal sal and Mixed deciduous forest
Saptasajya	20	Dhenkanal	Sal and Mixed deciduous forest
Satkoshia Gorge	796	Angul	Mixed deciduous forest including Sal Riverine forest
Sunabeda	442	Kalahandi	A dry teak and Mixed deciduous scrub
Ushakothi	285	Sambalpur	Moist deciduous forest and bamboo brakes.

Nandan Kanan, Barang, the state botanic garden, Regional Plant Resource Centre, Bhubaneswar and Central Rice Research Institute, Cuttack are some of the germplasm centres of the state, conserving various economical, medicinal, agricultural and ornamentally potential plants.

For checking the exploitation of mangrove forest and Chilka lagoon, the local people should be engaged in cottage industries utilising potential of agar yielding algae of Chilka and honey of Bhitarkanika.

Tribals of the state be dissuaded from perinicious practice of shifting cultivation and otherwise be encouraged for terrace cultivation, sericulture, apiculture, etc.

Gandhamardan, a natural forest containing invaluable indigenous drug plants require immediate attention for conservation.

Species rich areas of the state viz. Malyagiri, Palalahara (Angul dist.); Nrushingnath, Harishankar (Baragarh dist.); Mahendragiri (Gajapati dist.); Pottangi, Ramgiri (Koraput dist.); Gochha (Nayagarh dist.); Belghar, Kotagarh (Phulbani dist.); Tamana, Dhuanali (Puri dist.); Kashipur (Rayagada dist.) and Bonai (Sundargarh dist.) are required to be protected.

Oil yielding plants viz., *Pandanus* spp., *Cymbopogon* spp., *Cinnamomum* spp., *Eucalyptus* spp., *Vetiveria zizanioides*, etc., should be introduced for economic upliftment of the local population.

Agave spp., *Calotropis* spp., *Coldenia procumbens*, *Cyperus arenarius*, *Ipomoea pes-caprae*, *Spinifex littoreus* etc., should be protected to regenerate naturally as they act as excellent soil and sand binders along the shore line.

Inventories of the flora of all the Wildlife Sanctuaries of the state should be completed.

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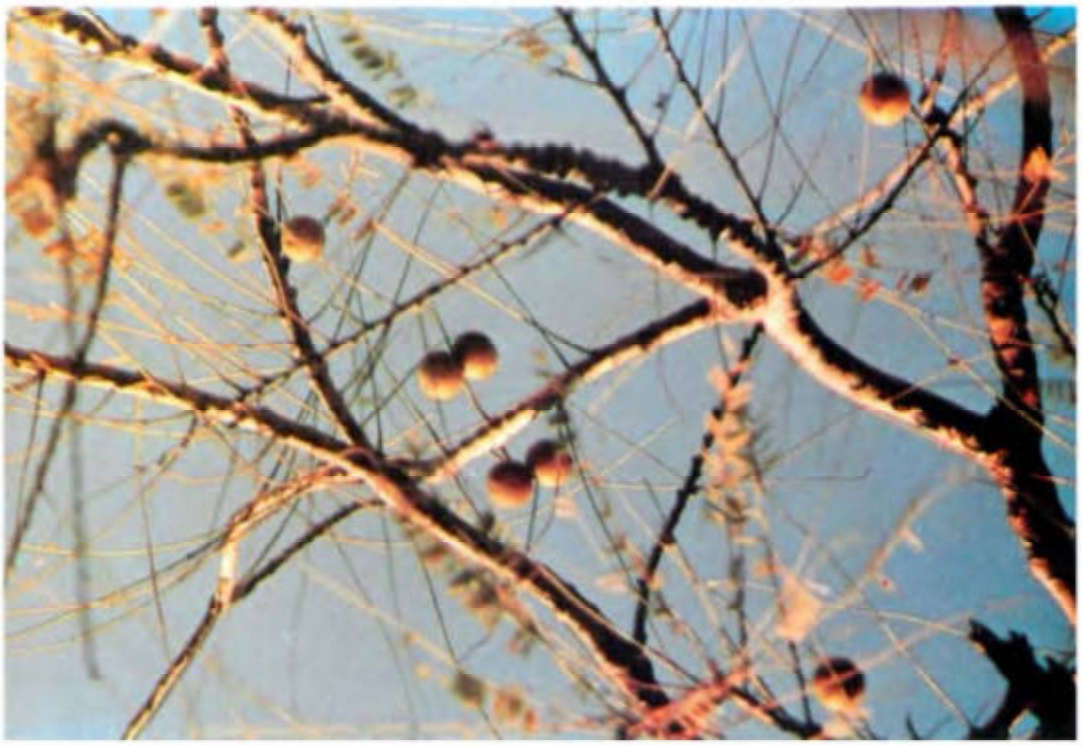

Phyllanthus emblica : common edible fruit plant in the forest
(Courtesy : S. Chandra and S. Ghosh)

Holarrhena pubescens : a popular medicinal plant
(Courtesy : S. Chandra and S. Ghosh)

Equisetum ramosissimum ssp. *debile* : a rare pteridophyte in Kalahandi dist.
(Courtesy : S. Chandra and S. Ghosh)

Coldenia procumbens : a potential soil binder
(Courtesy : S. Chandra and S. Ghosh)

Wetland vegetation with dominant *Nelumbo nucifera*
(Courtesy : S. Chandra and S. Ghosh)

Thysanolaena maxima : raw material for broom sticks
(Courtesy : S. Chandra and S. Ghosh)

Shorea robusta in the moist deciduous forest
of Ampani, Kalahandi dist.
(Courtesy : S. Chandra and S. Ghosh)

Butea superba : an attractive liana in the moist deciduous forest
(Courtesy : S. Chandra and S. Ghosh)

A view of dry deciduous forest at Karlapat, Kalahandi dist.
(Courtesy : S. Chandra and S. Ghosh)

PONDICHERRY

R. Rajan
P. Venu

The term biodiversity encompasses the diversity existing in genetic, specific and ecosystem levels in a given area. Generally, the importance of diversity of an area enhances by virtue of location such as distinct geographic boundaries leading to isolation, unique climate, the nature of substrate and the elevation as the diversity assumes significance with uniqueness/rarity of species or ecosystems along with potential utility of its elements and threat factors. As dealt in other states, and Union Territories, this article elaborates the plant diversity with special emphasis on angiosperms. Considerable survey and exploration work was undertaken in Pondicherry and the neighboring areas to document the floral wealth. Four discontinuous geographic regions scattered in three states constitute the Union Territory of Pondicherry. These include the four erstwhile French establishments namely Pondicherry, Karaikal, Mahe and Yanam. Pondicherry and Karaikal are bordered by adjacent south Arcot and Thanjavur districts of Tamil Nadu respectively and cover an area of 482 sq km. Yanam stretches in 30 sq km in area and encircled by East Godavari district of Andhra Pradesh. Mahe region with 9 sq km area is bordered by Cannanore and Kozhikode districts of Kerala. Pondicherry is 160 kms away south of Chennai city while Yanam is 840 kms northeast of Pondicherry on the eastern coast. Mahe stands 650 kms away on the west coast. Pondicherry region is more a flat area with an average elevation of about 15 meters above sea level. Numerous streams of river Gingee and the Ponnaiyar pass through this area. Karaikal region is a delta formed by the distributaries of the river Kaveri. It is limited on the north by the Nandalar and on the south east by the Vettar. 'Mahe' is a small area bounded on the southwest by the Arabian sea, on the north by the river Ponniyar (Moolakadavu) and on the other sides by a stretch of calcareous hills. The river Mahe flows towards the west and divides the region into two parts. The Yanam region is bounded on the east and south by river Godavari which flows into the Bay of Bengal after flowing about 14 km towards south-east. The Yanam town is located at a spot where the river Coringa and the Godavari separate to divide the region in two parts, one on the east and the other on the west. The entire area is flat terrain without any distinct elevations or depressions.

The earliest mention of plant wealth of Mahe region appeared in Rheede's publication on floral wealth of western region in the years (1673-1703). Being under French occupation, a number of French explorers made extensive surveys in the middle of the 18th century. Prominent among them were Pierie Sonnerat (1745-1814), Theodore Leschenault (1773-1826), Charles Brelanger and A.A.M. Reynaud (1825), George Samuel Perrottet (1793-1870) and A. Delessert (1834). In 1828, Leschenault published an account on *'Voyage ant Indes Orientalis'*

In the year 1826, a botanical garden was established in Pondicherry. More than 800 species were introduced by Jacquemont. In due course, the garden got enriched by acquiring a variety of economically important plants under the guidance of Perrottet. Thus, by the end of 19th century, this garden was replete with collection of numerous plants. In the year 1905, Achart published a book titled *"Quizecents plantes dans Inde"* (1500 plants in India). Sri Aurobindo Ashram released a book with illustrations in 1973. Other publications of considerable relevance to the flora of the region include that of Bagnouls and Meher-Homji (1959), Dabholkar (1962), Dabholkar and Tejomurthy (1959), Gopal (1968), Marlange and Meher-Homji (1965), Meher-Homji (1970), Nayar (1977, 1980, 1982), Rao *et al.* (1972, 1975), Rao (1971), Rao and Sastry (1971, 1974), Sastry and Rao (1976), Shankaranarayanan (1959), Shankaranarayanan and Dabholkar (1958), Sidhu (1963) and Venkateswaralu (1944).

Pondicherry Region: This region comprises eleven enclaves along with main entity and lie between 11° 46' 12° 3' N latitude and between 79° 36' 79° 53' E longitude and can be divided into four physiographic zones. The coastal zone comprises newer and older sand dunes and also saline areas of clayey texture near Marakkanam creek. The second zone is of two plateaus called the Pondicherry plateau and the 'Tiruvakkarai plateau and composed of a geological formation called the Cuddalore sand stones. The third zone Valudavur plains lie between these two plateaus. Marshy depressions occur in the plains of Valudavur. The fourth alluvial zone occupies the rest of the Pondicherry region. The main soil types include red ferratlitic, black clayey and the coastal alluvium.

The climate of the region is of tropical type. Mean annual temperatures are around 28°C. The mean temperature in hottest (30.8°C) and coldest months (25.1°C) differ by approximately 5°C. Rainy days, around six to seven weeks spread in two seasons. The advancing of southwest monsoon (June-September) brings 360 mm rainfall over 3 weeks

while the retreating north east monsoon (October-January) (principal rainy season) produces around 710 mm rainfall distributed over 4 weeks. Thus, there is greatly a difference in the amount of precipitation in two seasons though the difference in the period is only one week. Further, the climate being uniform, the differences in the vegetational patterns are essentially owing to soils, water availability and biotic pressures.

River Gingee and Ponnaiyar form the major catchments besides few lagoons, lakes and tanks. River Ginge passes the region diagnoally from the north-west to south-east. Ponnaiyar runs through the southern border of the area.

Saline soils exhibit the association of *Suaeda maritima* and *Suaeda monoica*. Both the species had wider distribution from the Chilka lake of Orissa southward in east coast. Other characteristic species is *Cressa cretica*. *Aeluropus lagopoides* and *Heliotropium curassavicum* are the other species with wider distribution occurring all over Tamil Nadu. In the saline marshy areas *Launaea sarmentosa*, a trailing herb with economic importance and *Geniosporum tenuiflorum*. *G. tenuiflorum* is also common on sandy ground near the sea and its distribution extends to both the coasts.

Coastal sandy soil is characterised by *Catharanthus roseus*. A native of West Indies, *C. roseus* has colonised this habitat along with different species.

On the newer dunes *Spinifex littoreus* association develops with two other species namely, *S. littoreus* and *Cyperus arenarius*. The former is gregarious and dominates the association while the latter is a small stoloniferous herb in east coast. *Launaea sarmentosa* occurs between the communities of saline soil and that of sandy littoral. The following species occur on sandy texture *Canscora diffusa*, *Allamania nudiflora* var. *procumbens*, *Waltheria indica*, *Tephrosia purpurea*, *Mollugo disticha*, *Gisekia pharnaceoides*, *Perotis indica* and *Bulbostylis barbata*. On the older dunes, *Tephrosia purpurea* becomes abundant while other associated elements remain same as for the newer dunes. Some liason species between sandy- littoral soils and ferralitic sandy loam are *Cleome aspera*, *Merremia tridentata*, *Zornia gibbosa* and *Evolvulus alsinoides*. Among the species with wider ecological amplitude which occur as companion species in all the above situations are *Alysicarpus vaginalis*, *Euphorbia rosea* and *Jatropha gossypifolia*.

The communities of *Aristida hystrix* occur on red ferralitic soils along with *Memecylon umbellatum*. In scrub woodlands, *Manilkara hexandra - Chloroxylong swietenia* form distinct community. This community is rich in number of species. Species like *Manilkara hexandra, Pterospermum suberifolium, Drypetes sepiaria, Hugonia mystax, Erythroxylon monogynum, Torenia asiatica, Maba buxifolia, Gmelina asiatica, Pterolobium hexapetallum, Ehretia microphylla* and *Strychnos minor* occur in greater abundance. Other species include *Albizia amara, Chloroxylon swietenia, Dichrostachys cinerea* ssp. *cinerea* var. *cinerea* and *Ixora arborea , Chionanthus zeylanica, Euonymus paniculatus, Zizyphus xylopyrus, Z. oenoplia, Z. glabrata, Cipadessa baccifera, C. fruticosa, Grewia rhamnifolia, G. hirsuta, Phyllanthus reticulatus, Jasminum angustifolium* var. *angustifolium, Jasminum angustifolium* var. *sessiliflorum, Rivea hypocrateriformis, Sarcostemma acidum, Ventilago madraspatana, Atalantia monophylla, Cadaba fruticosa, Cassytha filiformis Cissus quadrangularis* and *Carissa spinarum* .

These communities showed modifications with biotic interference and dominance of *Randia dumetorum, Canthium coromandelicum, Acacia leucophloea* and *Phoenix loureirii* is seen. Increased human activities result in the dominance of *Aristida hystrix, A. funiculata, Heteropogon contortus, Eragrostis viscosa, Allmania nodiflora, Sebastiania chamaelea, Phyllanthus rotundifolius, Rhyncosia aurea* and *Polycarpaea corymbosa*.

Species that occur between ferrallitic soils and alluvial soils are *Cyperus aristatus, Fimbristylis ovata, Urena lobata, Celosia argentia, Trachys mucronata, Catharanthus pusillus, Digitaria sanguinalis* var. *ciliaris, Cleome viscosa, Cyperus compressus* and *Brachiaria ramosa*.

In the sandy alluvial soils *Boerhavia helenae* and *Corchorus aestuans* characterise the communities. The other typical species include *Amaranthus gracilis, Ipomoea pestigridis, Commelina benghalensis, Portulaca quadrifida, Chloris barbata, Eragrostis tenella*. In loamy alluviums, *Eragrostis cilianthes* and *Mariscus clarkei* are major species. The other species include *Corchorus aestuans, Centella asiatica, Sida veronicaefolia, Phyllanthus niruri, Dactylotenium aegypticum* and *Chloris barbata*. In more clayey alluviums, *Trianthema portulacastrum* becomes dominant and form a distinct association with *Cyanotis cucullata* and *Physalis minima*. In dried canal beds of the alluvial zone harbours *Arundo donax* and *Xanthium strumarium*.

The common species that occur on both ferrallitic soils and alluvial soils are *Alysicarpus vaginalis, Jatropha gossypifolia, Justicia prostrata, Asystasia gangetica, Achyranthes aspera, Calotropis gigantea, Desmodium triflorum, Cynodon dactylon, Cyperus rotundus, Croton bonplandianum.*

The black clayey soils bear the dominance of *Curculigo orchioides.* Along with it the common species are *Biophytum sensitivum, Jatropha glandulifera, Caralluma attenuata, Butea monasperma, Martynia annua, Aristolochia bracteolata* and *Merremia emarginata. Vetiveria zizanioides* occurs in the marshy depressions of the black soil zone. This grows very densely with few widely scattered individuals of *Curculigo* and *Biophytum.*

The species that occur between ferrallitic and black clayey soils are *Cassia auriculata, Canthium parviflorum, Borreria stricta* and *Ocimum adscendens.*

In Water saturated soils moisture level varies, depending on flooding. They can be three groups. Soils never or rarely inundated, Soils temporarily inundated and Soil permanently inundated (marshes).

In the first group of soils, *Ruellia tuberosa, Bacopa monnieri* and *Naptunia oleracea* dominate. The other species include *Desmodium gangeticum, Rauvolfia tetraphylla, Chrysopogon aciculatus* and *Rhyncosia minima.*

Elaeocharis geniculata, Monocharia vaginalis and *Blumea mollis, Jussiaea perennis, Bergia capensis* and *Fimbristylis dichotoma* are common to temporarily inundated soils.

In the perennial marshes and ponds *Neptunia oleracea* occurs as the dominant and exclusive species. Other characteristic species are *Nymphaea nouchali* and *Aponogeton natans.*

Karaikal region: This region lies between 10° 49'-11° 01' N latitude and 79° 43' - 79° 52' E longitude and bordered on the east by the Bay of Bengal on three remaining sides by Tanjavur district. It covers an area of 161 sq km with a population around 1 lakh. Karaikal town stand between Nagapattinam and Tarangambadi and is the head quarters of this region. The distributaries of Kaveri river cover the region forming fertile

dalta. The river Kaveri emerging from the Western Ghats near Madikeri in Kodagu district flows through Karnataka and Tamil Nadu before joining Bay of Bengal. Close of Karaikal, this river divides into numerous streams, the main are Kodamurutti, Arasalar, Virasolanar and the Vikramanar. Arasalar and its branches spread through Karaikal, Kodamurutti and Virasolanar also partially serve the irrigation needs of the region.

The entire region is completely under cover of alluvium of variable thickness. Towards the western portion, the alluvium is more clayey while in the area around the Nagore- Tarangambadi road, it is more sandy. The clays are deposited near Karkkangudi, Valattamangalam, Muppatankudi and Ambagarattur. Along the coast line, light brownish black and pink coloured sand occur with an average width of about 0.5 km. The climate of the area is nearly identical to that of Pondicherry. Rice is the main crop cultivated in large areas and sugar-cane as subsidiary one.

The dominant plants along the coast include *Excoecaria agallocha, Clerodendrum inerme, Acanthus ilicifolius, Solanum trilobatum, Pandanus tectorius*. Apart from these dominant species, others occurring in lesser frequencies include *Salicornia brachiata, Aeluropus lagopoides* and *Spinifex littoreus*. Near the sea many species are prevalent and include *Tridax procumbens, Bulbostylis barbata, Aristolochia bracteolata, Pedalium murex, Trianthema triquetra, Opuntia dilleni, Boerhavia diffusa*. The plants that thrive well on the coastal sands are *Cocos nucifera* and the shrubby and spinous *Prosopis spicigera*, is planted for shade along sea coast. Along the irrigation canals, trees namely *Barringtonia acutangula, Pongamia pinnata, Phoenix sylvestris* occur. Among the shrubs and herbs, *Arundo donax* and *Hibiscus vitifolius, Tribulus terrestris, Indigofera enneaphylla, Tephrosia purpurea* occur. *Hemarthria compressa* a perennial grass which grows along the irrigation canals of Karaikal does not occur in Pondicherry. Near streams, *Saccharum spontanum* (excellent fodder) and *Stachytarpheta indica* occur.

In the ponds and pools, the common plants are *Nymphaea pubescens, Lemna polyorrhiza, Ipomoea reptans, Astercantha longifolia* and *Stemodia viscosa*.

Spotted in the hedges are *Jatropha glandulifera, Vitex negundo, Lawsonia inermis, Ficus hispida* and rarely *Zizyphus mauritiana* and in the fallow lands occur are the succulent plants namely *Euphorbia*

antiquorum, Cissus quadrangularis. In the households *Tectona grandis, Moringa oleifera, Azadirachta indica, Terminalia catappa* are seen common.

The principal trees and shrubs grown in the gardens of Karaikal include *Areca catechu, Bougainvillea glabra, Carica papaya, Cassia fistula, Ceiba pentandra, Cicca acida, Corypha umbraculifera, Delonix regia, Ficus religiosa, Laucaena glauca, Caesalpinia pulcherrima* and *Roystonea segia.*

Mahe region: This is located between 11° 42' - 11° 43' N latitude and 75° 31' - 75° 33' E longitude on the Kerala coast, consists of three entities namely Mahe proper, Kallayi and Naluthara enclaves. The town proper lies on the river Mahe close to its joining the sea. The Naluthara enclave lies between the small Ponniyam river on the north and the Kozhikode-Tellicherry road in the south. Kallayi is situated in between these places. The entire region covers an area of 9 sq km and has a population around 23,134 according to the 1971 census. Mahe town is bordered by Badagara taluk of Kozhikode district while the Kallayi and Naluthara are encircled by Cannanore district. The region exhibits two groups of plants. Plants of the first group are characteristic of western humid region and not occur in the eastern region of Pondicherry, Karaikal and Yanam. While the plants of second group are common to both the east and west coast. The more important species that represent and restrict to west coast include are shrubby climbers and trees. Their occurrence is recorded in Nilgiri, Coimbatore and Tirunelveli and South Arcot in different habitats. *Holigarna arnottiana, Leea indica, Osbeckia wynaadensis, Jasminum malabaricum, Ampelocissus arnottiana, Parsonsia alboflavescens, Tabernaemontana heyneana* and *Kaempferia* sp.

Some other plants which exhibit wider distribution include *Mimosa pudica, Lagerstroemia speciosa, Derris scandens, Micrococca mercuralis, Euphorbia thymifolia, Heliotropium indicum, Hedyotis corymbosa, Datura metel, Coldenia procumbens, Clerodendrum thomsonae, Clerodendrum viscosum, Centella asiatica, Blumea mollis, Blumea membranacea, Barringtonia acutangula, Alternanthera sessilis* and *Aristida setaceae, Polycarpon tetraphyllum, Premna latifolia, Stachytarpheta jamaicensis, Stachytarpheta mutabilis, Triphasia aurantiola, Vitex altissima*(*Cercus* sp.) and thorny species like *Memecylon laxiflora* and *Randia malabarica* are poorly represented. Many fruit yielding and other important trees are grown

in fields and gardens. They include: *Cocos nucifera*, *Artocarpus integrifolia*, *Areca catechu*, *Casuarina equisetifolia*, *Mangifera indica*, *Anacardium occidentale* and *Phyllanthus acidus*.

Yanam region: Yanam is situated on the east coast between 16° 42'- 16° 46' N latitude, and between 82° 11' - 82° 19' E longitude bounded on all sides by the East Godavari district. Yanam is different from other three regions both geographically as well as by the nature of its soils. Yanam town lies on a spot where the river Coringa branches off from Godavari. The Coringa divides the town into two parts. The entire region consisting of Yanam town and six villages is treated as a commune. The region covers an area of 20.0 sq km and has a population of 25,000. Sea-water rises along the water course during high tides invading the lowlands of Yanam, specially in September-November particularly Isukatipatta islands and the Adivipalam plain.

There are three main seasons, summer (March-middle of June) and rainy season (June-November) and winter (December-February). Temperatures fluctuate with mean maximum range between 26.66°C in cold weather and 36.10°C hot weather. Maximum precipitation takes place in the months of June-October owing to the S.W. monsoon when the temperature is moderate. Besides there are few showers caused by the north east monsoon in October. The average rainfall comes to 66-94 cms.

VEGETATION

A general account of the vegetation of E. Godavari was given by Rao (1959). The forest communities in Yanam are dominated by different species forming distinct communities. Pure *Avicennia* communities are made of *Avicennia officinalis* with the ground covered by pneumatophores. In some stretches *Avicennia officinalis* and *A. marina* constitute mixed communities. *Acanthus ilicifolius* forms the shrubby layer. Besides, there are elements like *Rhizophora mucronata*, *Ceriops tagal*, *Bruguiera cylindrica* and *Rhizophora conjugata*. All these species occupy exposed habitats in the forest. In these communities, occasionally *Sonneratia apetala* and *Avicennia alba* occur. The ground flora is represented by *Sesuvium portulacastrum* and *Aleuropus repens*. In some areas, there occurs mixed community of *Avicennia -Aegiceras* where the tree layer is represented by *Avicennia officinalis* and *Carapa moluccensis*. The shrub layer is composed of *Aegiceras corniculatus*. Occasionally *Lumnitzera*

racemosa var. *racemosa* and *Ceriops tagal* are also seen. In some places, the ground flora comprises *Suaeda nudiflora* and *S. monoica*.

Lumnitzera community is represented on slightly raised muddy lands regularly inundated by tidal water and consist of *L. racemosa* var. racemosa and is a shrubby open forest with an average height ranging from 3-4 meters. In the *Lumnitzera - Scyphiphora* community the dominant elements are *Lumnitzera racemosa* var. *racemosa* and *Scyphiphora hydrophyllacea*. They occur in fine clayey, black and muddy soils. In *Excoecaria agallocha* community, *Derris uliginosa* is a commonly found twiner. Other species include *Suaeda monoica, S. nudiflora, Dalbergia spinosa* and *Myristicha wightiana*.

A straggling shrub, *Clerodendrum inerme* forms small communities on the banks of streams along with *Sesuvium portulacastrum*.

Halophytic communities: They are two types. Mixed *Suaeda* and pure *Salicornia brachiata*. Mixed communities of *Suaeda nudiflora* and *S. monoica* cover considerable areas. Here the soil is black and comparatively less muddy. *Salicornia brachiata* communities coexist with those of *Suaeda* communities or grow on places where *Suaeda* is unable to flourish due to lack of tidal water. The following are the other important plants found in this area are *Carapa moluccensis, Dalbergia horinda, Derris trifoliata. Rhizophora apiculata, R. mucronata, Ceriops tagal, Ceriops decandra, Bruguiera gymnorrhiza, B. cylindrica, Lumnitzera racemosa, Scyphiphora hydrophyllacea, Sonneratia apetala, Aegiceras corniculatus, Acanthus ilicifolius. Avicennia officinalis, A. alba, Clerodendron inerme, Excoecaria agallocha* and *Sesuvium portulacastrum*.

Flora on fallow lands and crop fields

Principal crops include rice *(Oryza sativa* var. *sativa)*, coconut *(Cocos nucifera)*, groundnut *(Arachis hypogaea)*, chilly (*Capsicum frutescens*), coriander *(Coriandrum sativum)*. The bananas are cultivated in some gardens. Common creepers include *Cayratia trifolia, Merremia emarginata* and *Mukia maderaspatana*. Other common herbaceous plants include *Trianthema portulacastrum, Acalypha indica, Vigna aconitifolia, Ocimum adscendens, Synostemon bacciforme, Cyperus procerus, Gomphrema decumbens, Cleome gynandra, Heliotropium indicum,*

Portulaca quadrifida, Brassica juncea, Boerhavia diffusa, Cardiospermum helicacabum, Cassia occidentalis, Croton bonplandianum.

Medicinal plants

A comprehensive documentation was published by Dabholkar and Tejomurthy (1959) on the medicinal plants of this region. The following are the identified medicinal plants.

Menispermaceae

Cissampelos pareira var. *hirsuta* : A twining shrub and roots are useful in nephritis, dysentery, heart troubles, and urinary disorders.

Cocculus hirsutus : An hirsute shrub. Leaves and roots are useful in rheumatic pains.

Papaveraceae

Argemone mexicana : A prickly annual herb and the oil from the seeds is used in various skin diseases.

Capparaceae

Cleome viscosa : An erect annual herb and the juice of the leaves if used to relieve ear-ache. The seeds are anthelmintic.

Cleome gynandra : A tall herb used as substitute for *Cleome viscosa*.

Violaceae

Hybanthus enneaspermus : A moderate size herb and roots are diuretic.

Polygalaceae

Polygala chinensis : A perennial herb and roots are used in fever and dizziness.

Portulacaceae

Portulaca oleraceae : A prostrate herb and used in scurvy and liver diseases.

P. quadrifida : A small diffuse annual herb and leaves are used in scurvy.

Malvaceae

Sida cordifolia : An erect undershrub and the plant juice is given in rheumatism and gonorrhoea.

S. cordata : A slender prostrate or ascending herb and leaves used in local application in cuts and bruises.

Urena lobata : An erect undershrub. The roots are diuretic and used as external remedy for rheumatism.

Pavonia zeylanica : An erect or undershrub and is used as vermifuge and purgative.

Tiliaceae

Corchorus aestuans : An annual herb and leaves used in stomach disorders.

Oxilidaceae

Oxalis corniculata : A diffuse creeping herb and the leaves are cooling, appetizing and reducing pain in stomach.

Zygophyllaceae

Tribulus terrestris : A procumbent herb and the entire plant and especially the fruit is extensively used in local medicine.

Vitaceae

Cissus quadrangularis : This is a rambling shrub and leaves and young shoots are used in stomachache.

Papilionoideae

Abrus precatorius .: A common twining shrub and seeds are purgative, also used in nervous disorders and cattle poisoning.

Clitoria ternatea : A common climber in hedges and used in urinary disorders.

Desmodium gangeticum : A suberect undershrub and the bark is used as febrifuge.

Indigofera linnaei : A trailing much branched herb and the juice used as antiscorbutic, tonic, diuretic and in veneral infections.

Zornia diphylla : A diffused herb and root is given to children to induce sleep.

Caesalpinioideae

Cassia occidentalis : An annual undershrub with yellow flowers and the plant in used in skin diseases.

Senna tora : A herb with long curved pods and the macerated leaves used for dermatoses and antidote against snake bite.

Cucurbitaceae

Benincasa hispida : It is cultivated widely and used as tonic and diuretic.

Cucumis trigonus : Seeds are used in cases of uterine infections.

Citrullus colocynthis : A trailing scabrid herb and the root is useful in jaundice.

Molluginaceae

Mollugo pentaphylla : A slender herb and used as antiseptic.

Rubiaceae

Hedyotis corymbosa : A very variable herb and the whole plant is used as a bitter tonic.

Hedyotis puberula : Roots and leaves are prescribed in asthma.

Compositae

Eclipta prostrata : An annual and used in jaundice and for various skin diseases.

Tridax procumbens : Stems, leaves and roots are used for healing cuts.

Vernonia cinera : A common weed and the juice of entire plant given in piles.

Sphaeranthus indicus : An aromatic herb and occur in cultivated fields. Used against cough, jaundice, tumors etc. Roots used in piles.

Xanthium indicum : A coarse annual herb and used in urinary disorders.

Plumbaginaceae

Plumbago zeylanica : An erect or subscandent herb and roots used in indigestion.

Apocynaceae

Catharanthus rosea : A shrub commonly cultivated in gardens and used as astringent.

Rauvolfia tetraphylla : Cultivated in gardens. It is sympatholytic in action and abolishes the pressure effects of adrenaline.

Asclepiadaceae

Calotropis gigantea : A large milky shrub and sap, flowers, the rind of the root and leaves are used as purgative.

Leptadenia reticulata : A climbing shrub on hedges and the roots are emetic and expectorant.

Boraginaceae

Trichodesma indicum : An erect annual herb and root paste applied to reduce swellings.

Convolvulaceae

Convolvulus arvensis : A trailing or twining herb and roots are used as purgative.

Evolvulus alsinoides : A prostrate herb and is used in dysentery.

Solanaceae

Datura metel : A branched herb or undershrub in waste places and seeds are used externally for piles, tumors, and skin diseases.

Solanum nigrum : An erect annual herb, often cultivated, the berries used in fevers, diarrhoea, and heart diseases.

S. surrattense : A very prickly diffuse herb or undershrub, roots used locally against small pox.

Physalis minima : A common weed and fruit is laxative and diuretic.

Pedaliaceae

Pedalium murex : A succulent herb and fruits' decoction is used in irritation of urinary organs.

Acanthaceae

Justicia adhatoda : A shruib with foetid smell. Leaves, bark, flowers and roots are used medicinally.

Barleria prionitis : A prickly shrub with yellow flowers and dried bark is used whooping cough.

Andrographis paniculata : An erect herb and all parts of the herb are bitter and used in dysentery and fevers.

Verbenaceae

Vitex negundo : A small tree and the leaves are nervine tonic.

Labiatae

Anisomeloes malabarica : A tall shrub. The oil from the leaves is used in rheumatism.

Leucas aspera : An erect or diffuse annual. Sap of leaves are used in chronic dermatoses and scabies.

Ocimum tenuiflorum : An erect much branched undershrub, seeds are used in diseases connected to genito-urinary organs.

Nyctaginaceae

Boerhavia diffusa : A diffuse herb with pinkish red flowers in waste lands and along roadsides. Roots are laxative, febrifuge and diuretic.

Amaranthaceae

Achyranthes aspera : An erect herb and roots used in night blindness.

Amaranthus spinosus : An erect spinous herb in waste places and roots used in gonorrhoea, eczema.

Aerva lanata : A much branched undershrub with small spikes and used in treatment of headache.

Celosia argentea : An erect glabrous annual and seeds are used in diarrhoea.

Euphorbiaceae

Acalypha indica : an erect herb and leaves are used to control scabies.

Euphorbia hirta : A prostrate and ascending herb in plains and hills Plant is used in children diseases.

Jatropha curcas : A small tree or shrub cultivated and naturalized and root bark used in rheumatism.

Phyllanthus amarus : Fresh roots used as remedy for jaundice.

Ricinus communis : Seed oil used for purgative.

Liliaceae

Gloriosa superba : Tubers used in leprosy, piles and in control of intestinal worms.

Araceae

Amorphophallus campanulatus : Tubers used in dysentery.

Acorus calamus : Rhizome used in bronchitis.

Commelinaceae

Commelina benghalensis : The plant is used as laxative.

Cyperaceae

Cyperus rotundus : Rhizomes are used in many ailments.

Kyllinga monocephala : Rhizomes used as antidote to poisons.

CONSERVATION

The Union Territory of Pondicherry though comes under single administrative control, various regions show considerable similarity in their floral elements with the respective bordered district. Thus the flora of Pondicherry, Karaikal, Yanam and Mahe share considerable similarity with that of South Arcot, Thanjavur, Kozhikode, and East Godavari districts. There is neither significant endemism nor rarity in its elements. However, all the four regions being coastal in nature and are fragile considerable attention and care is to be given before initiating any developmental activities.

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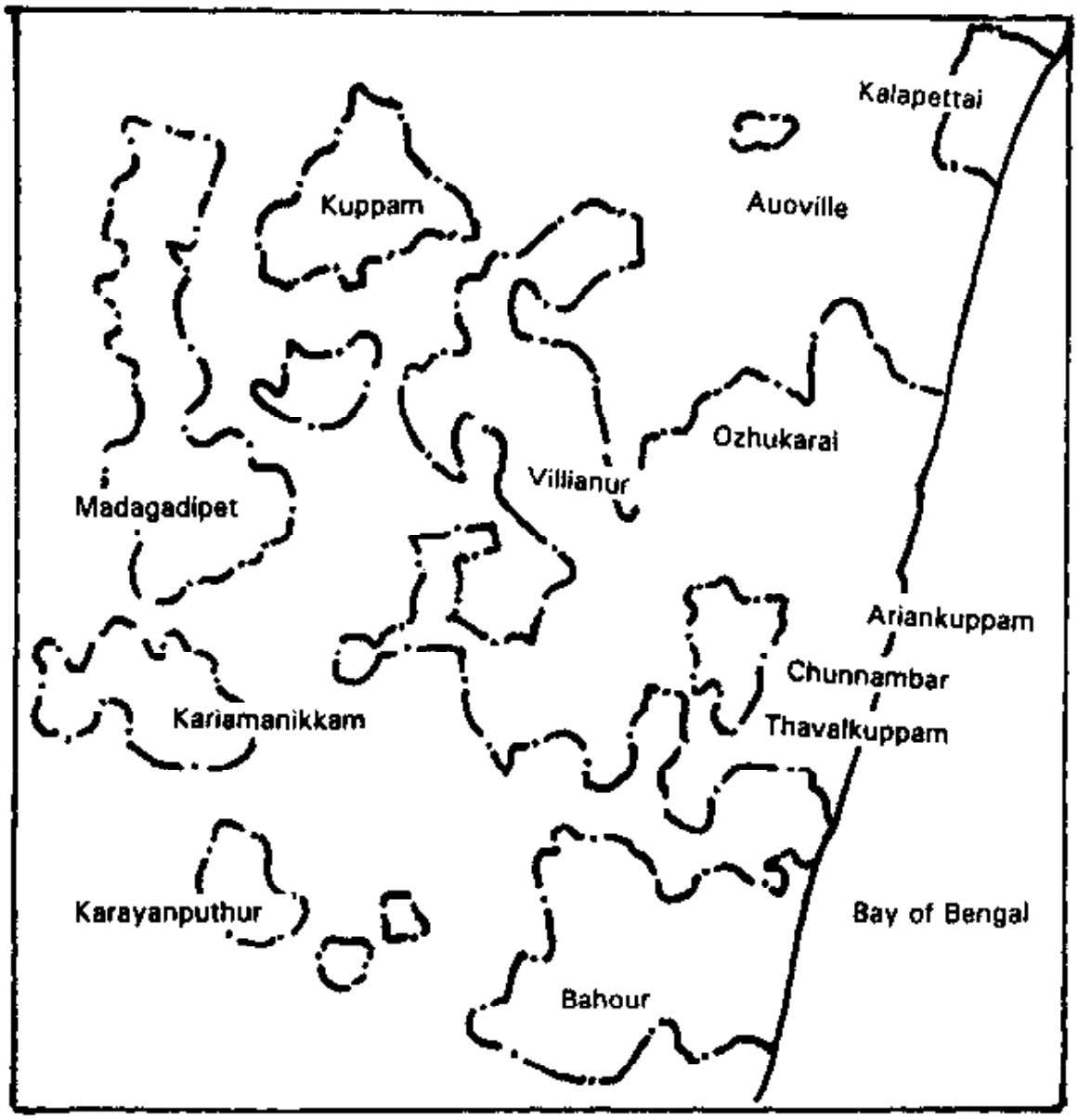

MAP OF PONDICHERRY

PUNJAB

Paramjit Singh

The present state of Punjab situated in the north-western corner of India between 29° 30' - 32° 32' N latitude and 73° 54'-76° 50' E longitude was reorganised and came into being on 1st November 1966. With an area of 50,362 sq km, it is bounded on the west by Pakistan, on the north by Jammu and Kashmir, on the north-east by Himachal Pradesh and on the south by Haryana and Rajasthan. Apart from a few scattered ranges of Shivaliks in the north-east and the topographic discontinuties of the river-courses, the terrain of Punjab is the usual alluvial monotony.

Majority of historians and archeologists are of the opinion that earliest traces of human habitation in India were found in Punjab. Evidences of over 5000 year old civilisation has been found at Ropar. It was in the dense jungles of Punjab that the classical melodious hymns of the Sama Veda reverberated. The early Aryans first came into contact with the people of Punjab and laid the foundations of the Indian civilisation. Interesting references to the life and culture of the people are provided by the Chinese pilgrims Fa-Hien and Hieun- Tsang, who visited Punjab in 5th Century and 7th century AD. The survey of the history of Punjab reveals that the region acted as a meeting point of various cultures and people in Asia. It is the land from where Sikh Gurus spreaded the message of peace, brotherhood and equality for all and the region became a cockpit and confluence in which there was an unending amalgamation of communities and cultures. This amalgamation of various elements is also reflected in the flora of this region. However, the most part of the present day Punjab plains are under extensive and intensive cultivation and irrigated by a network of canals and tubewells. Very little amount of natural vegetation has been left along river courses and in protected forest (*Bir or Rakhs*).

The state of Punjab is mainly drained by Beas, Satluj and Ghaggar. The Ravi runs along the border of Gurdaspur district with Jammu and Kashmir and Pakistan, it finally joins the Chenab after entering Pakistan. The Beas which originates from near Rohtang pass in Pir- Panjal range of the lesser Himalaya, marks the western boundary of the Kapurthala and Hoshiarpur district and joins Satluj in the south-west corner of Kapurthala. The Satluj originates near the Mansarowar lake at a height of 4,630 m, and enters Punjab in Ropar district and passes through Ludhiana and Ferozpur districts

and joins the Beas in the south-west corner of Kapurthala and combined river flows along Firozpur - Amritsar border into Pakistan. River Ghaggar traverses through the southern part of the state and is identified with lost 'Saraswati', relic of a gigantic system which now exists only as an inland drainage stream. It originates in Shivalik hills of Himachal Pradesh in Sirmur district and enter plains near Mubarakpur village of Patiala district, passing through Sangrur district, it enters Hissar district in Haryana. Finally traversing through Sirsa district of Haryana, it loses itself in sands of Thar desert of Rajasthan.

Apart from natural drainage features, the state is served by network of canals, the main canals in the region are (i) The upper Bari Doab Canal which takes off from the Ravi at Madhopur (ii) Sirhind Canal which starts from Satluj at Ropar (iii) The group of inundation canals called grey canals in Ferozpur district, and (iv) The Bhakra canal system.

By and large Punjab consists of Indo-Gangetic alluvium. Except for Gurdaspur district, the area has alluvial soils. In Gurdaspur district soils are loamy, they contain small quantities of lime but the magnesia content is high. The soils of Hoshiarpur are loamy, fairly rich in total phosphoric acid, potash and nitrogen. Sandy loam and silt loam are prevalent in Jalandhar district. The soils of Ferozpur, Bathinda, Fazilka are sandy loam and alkaline, and those of Patiala district are of a loamy nature. On the whole the soils of the Punjab consist of a crust of varying depth on a sandy substratum. Though soils are rich in minerals, they are deficient in organic matter and nitrogen.

Punjab is characterised by very hot summers and markedly cold winters, moderate rainfall, low to medium humidity, strong winds and dust-storms during summer, thunderstorms and hailstorms during March - April. The mean annual rainfall decreases from 90 cm in Shivalik hills to 40 cm in southern part of the state. Another characteristic feature is the great extremes of temperature, with cold winters and very hot summers. In winter the temperature falls at many places below freezing point and frost occurs. On the other hand, heat during the summer is very intense and scorching with the maximum temperature reaching up to 49° C in May - June.

The first known record of the plants of Punjab dates back to the year 1838 and 1842 when Edgeworth published articles on Botanico- agricultural account of the protected Sikh states in *Journal of Asiatic Society of Bengal.* Aitchison (1868) published a list of the plants of Hoshiarpur district and also (1869) catalogued the plants of Punjab. Cleghorn (1864) incorporated his

information on forest in report upon the forest of the Punjab and the western Himalaya. Powell (1868, 72) and Stewart (1869) gave the botanical and vernacular names and uses of economically important trees, shrubs and herbs of erstwhile Punjab. Coventry (1901) published a catalogue of the principal trees and shrubs of Punjab. Bamber (1916) covered Punjab and North-West frontier Provinces of the British India and Kashmir in his flora. Parker's Flora (1918) includes only trees and shrubs of erstwhile Punjab, Hazara and Delhi. Sabnis (1940-41) published a list of the plants of Punjab plains and adjoining hilly areas. After the reorganisation of the Botanical Survey of India in 1954, collections from Punjab plains were made by Northern Circle, Dehradun, culminating in the publication of Flora of Punjab plains by Nair (1978), which includes part of Haryana also Sharma (1990) published a list of plants of reorganised state of Punjab reporting 1879 species of naturalised and indigenous species under 184 families of flowering plants.

On the basis of the publications and the botanical explorations undertaken in recent years, the districts in Punjab can be classified as follows with the prospectus of planning future studies in the under explored regions.

Well explored	:	Ludhiana, Hoshiarpur, Patiala. Ropar, Chandigarh (U.T.).
Fairly exploed	:	Amritsar, Bathinda, Ferozpur, Jalandhar,
Under explored	:	Faridkot, Kapurthala, Sangrur.

Further, the botany and plant herbivore relationship in six wildlife sanctuaries of Punjab needs to be planned and completed on priority basis.

VEGETATION

As might be expected from its geographical position, climatic and biotic factors, the flora of Punjab is not rich. The area under forest is meagre 5% where as dense forest occurs only on one per cent of the area (Anonymous, 1985).

Three floristic subunits can be recognised in Punjab. These are Shivalik hills, Moister plain country and Semi arid Punjab.

These zones frequently overlap in the contiguous areas and consequently some of the districts adjacent to Shivalik hills, although geographically the part of the plains, have sub-himalayan elements in their native flora.

Shivalik hills

These hills delimit the north and north-eastern boundaries of Gurdaspur, Hoshiarpur and Ropar districts. The tract varies in altitude between 300 - 800 m. The vegetation in this zone was very rich with chief tree species being *Shorea robusta, Anogeissus latifolia, Terminalia tomentosa, Bauhinia variegata, Phyllanthus emblica, Desmodium oojenensis, Cassia fistula, Xylosma longifolium* and *Pinus roxburghii.* The remnants of these can still be seen but now most of these hills are characterized by discontinuous thorn scrub and the degraded vegetation, caused by indiscriminate felling, lopping and overgrazing. Throughout the range, flora is represented mainly by thorny and spiny species like *Capparis sepiaria, Flacourtia indica, Maytenus royleanus, Rhamnus persica, Ziziphus nummularia, Z. oenoplia, Acacia nilotica* ssp. *indica, A. catechu, A. leucophloea, A. modesta, Mimosa himalayana, Catunarengam spinosa, Diospyros cordifolia* and *Carissa spinarum.* Non thorny species commonly found on these hills are *Grewia tenax, Azadirachta indica, Dodonaea viscosa, Moringa oleifera, Bauhinia racemosa, Anogeissus latifolia, Woodfordia fruticosa, Ehretia aspera, Adhatoda zeylanica* and *Nyctanthus arbortristis.* Mixed communities of *Lannea coromandelica, Anogeissus latifolia.* and *Nyctanthes arbor - tristis,* are conspicuous in isolated patches. Communities of *Dodonaea viscosa* predominate at several places. In the gorges of seasonal streams *Butea monosperma, Dalbergia sissoo* and *Wendlandia exserta* are common and conspicuous. One often comes across a number of climbers particularly during the rainy season. Special mention may be made of *Cissampelos pareira* var. *hirsuta, Cocculus hirsutus, Tinospora cordifolia, Abrus precatorius, Pueraria tuberosa, Ichnocarpus frutescens, Telosma cordata, Porana paniculata.* In the hedges and bushes *Dioscorea bulbifera, Gloriosa superba* and *Commelina erecta* are often met with in Shivalik hills.

Moister plain country

It includes north-east Punjab and Patiala district of south Punjab. The component districts of this zone are Amritsar, Gurdaspur, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Patiala and part of Ropar. Union territory

of Chandigarh is floristically a part of this tract, which is characterised by altitude variation between 230- 300 m above m.s.l. and with annual average rainfall of 60 cm. Under the tremendous influence of biotic interference, mainly clearing for cultivation, Punjab plain is denuded of natural forest and even the reamnants of these are extremely difficult to locate in this zone. Most of the woody elements of those extinct forest now manage to survive in waste places, among hedges or bushes or in plantations. Landscape is characterized by *Dalbergia sissoo* and *Acacia nilotica* ssp. *indica*. The area is dotted with scattered clumps of *Phoenix sylvestris, Mangifera indica* is commonly planted all over the area, at places mixed with *Syzygium cuminii. Ficus bengalensis* and *Ficus religiosa* form a unique feature of village common lands along with *Melia azedarach and Morus alba, Cereus peruvianus, Opuntia stricta, Ipomoea carnea* ssp. *fistulosa, Euphorbia nivulia, Agave mexicana* and *A. wightii* are common hedge plants in the country side. Locally *Tamarix aphylla, Diospyros cordifolia, Vitex negundo, Euphorbia tirucalli* and *Morus alba* are conspicuous in exposed wastelands. Under similar habitat, in some patches *Butea monosperma* and *Capparis decidua* are also common. In waste places along road sides *Capparis decidua, Ziziphus mauritiana, Butea monosperma, Ehretia laevis, Adhatoda zeylanica* and *Phoenix sylvestris* are common. Either forming thickets or occuring as bushy undergrowth or among the protected plantations are found *Capparis sepiaria, Crateva adansonii* ssp. *odora, Flacourtia indica, Abutilon indicum, A. ramosum, Urena lobata, Murraya koenigii, Azadirachta indica, Ziziphus oenoplia, Caesalpinia bonduc, Mimosa himalayana, Plumbago zeylanica, Carissa spinarum, Ehretia aspera, Adhatoda zeylanica, Clerodendrum phlomidis, Lantana camara, Ficus palmata, Morus alba and Asparagus gracilis*. While *Acacia modesta* may occasionally be common on sandy soil, *Butea monosperma* is characteristic tree of alkaline (Kullar) soil. *Tamarix dioica* are sometimes found along the banks of the rivers. Common climbers in different localities, particularly among hedges, thorny bushes and the plantations are *Cissampelos pareira* var. *hirsuta, Cocculus hirsutus Tinospora cordifolia, Cayratia trifolia, Abrus precatorius, Ichnocarpus frutescens, Leptadenia reticulata, Pergularia daemia, Telosma cordata* and *Rivea hypocrateriformis*.

Semi - arid region

This region covers whole of south and south - west Punjab. It comprises Bathinda, Faridkot, Ferozpur and part of Sangrur districts.

Undulating land surface due to predominantly sandy-soils and sand-dunes is the noticeable feature of this zone. Previously, wherever it existed, the forest comprised of C*apparis decidua, Prosopis cineraria* and *Salvadora oleoides*. The reamnants of these may still be noticed here and there with their original constitution much altered by human agency. Besides, this zone is also landscaped by *Dalbergia sissoo, Acacia leucophloea*. and *A. nilotica*. ssp. *indica*. Shrubs like *Ziziphus nummularia, Crotalaria burhia, Calotropis procera, Leptadenia pyrotechnica, Aerva javanica* and *Tecomella undulata* are common to abundant locally. *Cocculus pendulus* and *Leptadenia reticulata* are the noteworthy climbers.

Wherever, the sand becomes stabilized due to weathering often an open thorny scrub can be seen comprising of *Prosopis cineraria, Capparis decidua, Maytenus emarginatus, Acacia nilotica, A. jacquemontii, Mimosa hamata. Zizyphus nummularia. Calotropis procera. Securinega leucopyrus, Salvadora oleoides,* etc. During rainy season thick carpet of herbaceous plants of the species of *Trianthema, Tribulus, Cenchrus, Fagonia, Eragrostis, Boerhavia, Heliotropium, Tephrosia, Panicum, Tridax, Indigofera, Mollugo, Achyranthes, Aerva, Phyllanthus,* etc. can be seen. Most of these plants complete their life cycle before winter and new herbaceous plants like *Argemone mexicana, Carthamus oxyacantha, Echinops echinatus, Gastrocotyle hispida, Heliotropium ellipticim, Psammogeton canescens, Solanum nigrum* and *Justicia* sp. come up in abundance.

Common perennial climbers among the bushes are *Coccinia grandis, Cocculus hirsutus, C. pendulus, Ephedra foliata, Momordica balsamina, Pentatropis spiralis, Pergularia daemia,* etc.

Wherever sub soil water is present, intensive cultivation is being carried on in semi-arid region of Punjab.

Vegetation of the River sides, Ponds, Lakes and Marshes

The vegetation of riverine tracts usually consists of *Tamarix dioica, Alhagi maurorum, Vetiveria zizanioides, Sporobolus marginatus, Polygonum plebium, Ranunculus scleratus, Anagallis arvensis, Juncus bufonius, Potentilla supina, Gnaphalium indicum, Veronica anagallis - aquatica, V. agrestic, Verbascum chinense, Pulicaria angustifolia,* etc. which have become naturalized along the river sides at many places.

Vegetation of ponds, lakes and canals have free floating plants such as *Aponogeton natans, Lemna paucicostata, L. trisulca, Spirodela polyrrhiza, Wolffia microscopica, Trapa natans* var. *bispinosa, Eichhornia crassipes* and *Azolla pinnata.* Submerged hydrophytes include species of *Vallisneria, Zannichellia, Ceratophyllum, Hydrilla, Potamogeton* and *Najas.* Plants rooted in the mud with floating parts include *Potamogeton nodosus, Ipomoea reptans, Lophotocarpus guyanensis, Segittaria sagittifolia, Nymphaea nouchali* and *Marsilea minuta.*

The margin of canals, lakes and ponds have a rich vegetation consisting of amphibious plants. This reed swamp flora comprises of *Typha elephantina, T. angustata, Echinochloa crusgalli., Scirpus* spp., *Fimbristylis dichotoma,* and species of *Cyperus, Hemarthria, Cynodon, Verbascum, Phyla, Alternanthera, Glinus,* etc.

The vegetation of marshes consists mainly of T*ypha angustata, T. elephantina, Monochoria vaginalis, Sagittaria sagittifolia, Lophotocarpus guayanensis, Bacopa monnieri, Veronica anagallis - aquatica, Hemarthria compressa* and *Fimbristylis dichotoma.*

Tree such as *Tamarix, Acacia, Prosopis, Ficus, Dalbergia* and *Eucalyptus* are often planted along the canal tanks, where they grow very well.

Ruderal Plants

A characteristic ruderal vegetation develops in places which are subjected to change from time to time, such as waste places around villages, towns, old garden sites, along railway lines and roads and in fallow fields. *Xanthium strumarium, Solanum virginianum, Cannabis sativa, Amaranthus spinosus, Erigeron bonariensis, Cassia obtusifolia, Argemone mexicana* and *Croton bonplandianum* are the common plants found in such habitats.

Sometimes escapes of cultivation like *Lycopersicon esculentum, Ricinus communis Coriandrum sativum* and *Sesamum indicum* are also found growing on waste places.

Cultivated Taxa

Most of the area under Punjab is irrigated by network of canals and tubewells and is extensively and intensively cultivated. The Kharif crops include *Pennisetum typhoides* (Indian millet, Bajra), *Sorghum vulgare* (Great millet, Jowar), *Oryza sativa* (Rice, Chawal), *Zea mays* (Corn, Makki), *Gossyptum* (Cotton, Ruin), *Hibiscus cannabinus* (Roselle hemp, San), *Crotalaria juncea* (San hemp, San), *Sesamum indicum* (Sesame, Til), *Vigna unguiculata* (Cowpea, Lobia), *Cajanus cajan.* (Pigeon pea, Thur) *Vigna mungo* (Mung), *Vigna trilobata* (Urad), etc. The Rabi crops include *Triticum aestivum* (Wheat, Gahun), *Hordeum vulgare* (Barley, Jow), *Brassica campestris* var. *sarson.* (Mustard, Sarron), *Linum usitatissmum* (Linseed, Alsi), *Cicer arietinum* (Gram, Chana), *Lens culinaris.* (Lentil, Masur), *Pisum sativum* (Pea, Mattar),*Trigonella foenum-graecum* (Fenugreek, Methi), etc. *Saccharum officinarum* (Sugarcane, Ganna) is planted from January to April and harvested during the following cold season. A number of garden crops are grown during the cold season as well as during summer. The chief cold season crops are *Allium sativum* (Garlic, Lasun), *A. cepa* (Onion, Piaj), *Beta vulgaris* (Beet root, Chikundar), *B. vulgaris* var. *rapa* (Sugar Beet, Shakarkandi), *Daucus carota* (Carrot, Gajar), *Brassica oleracea* var. *botrytis* (Cauliflower, Phool-gobhi), *Brassica oleracea* var. *capitata.* (Cabbage, Bandagobi), *Raphanus sativus* (Radish, Mooli), *Coriandrum sativum* (Coriandur, Dhaniya), *Brassica juncea* (Leaf mustard, Sarson), *Spinacia oleracea* (Spinach, Palak), etc. During the summer, a number of cucurbits are grown. These include *Citrullus lanatus,* (Water melon, Kharbuza), *Momordica charantia.* (Bitter gourd, Karela), *Luffa acutangula, L. aegyptiaca.* (Ghiatori), *Cucumis melo* (Melon, Kharbuza), *C. melo var. momordica (Phunt), C. melo var. flexuosus* (Kakri), *Trichosanthes dioica* (Palwal). Common constituents of the present orchards include *Citrus aurantifolia* (Lime, Nimbu), *Citrus reticulata* (Mandarin), *Mangifera indica* (Mango, Amb), *Prunus persica* (Peach, Aru), *Psidium guajava* (Guava, Amrood), *Punica granatum.* (Pomegranate, Anar), *Vitis vinifera* (Grapes, Angur) and *Ziziphus mauritiana* (Indian Jujube; Ber).

The common weeds associated with these crops are species of *Cleome, Corchorus, Polycarpaea, Justicia, Digera, Celosia, Crotalaria, Trianthema, Aeschynomene, Gisekia, Euphorbia, Heliotropium, Leucas, Desmostachya, Potentilla, Cotula, Anagalis, Sisymbrium, Spergula, Spergularia, Lathyrus, Orobanche, Sonchus, Asphodelus, Polypogon, Lolium, Melilotus, Vicia, Medicago, Trigonella, Cirsium,* etc.

Plantations form one of the most conspicuous aspect of the vegetation of Punjab. Extensive strip and block plantations have been raised throughout Punjab in waste places existing along the railway lines, canals and roads. *Azadirachta indica, Dalbergia sissoo. Acacia nilotica* spp. *indica, Albizia lebbeck, Prosopis juliflora* and *Eucalyptus* spp. (mainly *Eucalyptus tereticornis*) are commonly planted in strip plantations, whereas common constituents of block plantations are *Ziziphus mauritiana, Dalbergia sissoo, Acacia farnesiana, A. leucophloea, A. modesta, A. nilotica* spp. *indica, Prosopis glandulosa, P. juliflora, Eucalyptus* spp., *Syzygium cumini, Broussonetia papyrifera* and *Morus alba.* Except *Eucalyptus* spp., all other plants are capable of regeneration by seeds and are frequently naturalized in the plantations. The regeneration of the planted elements and the successful colonization of the alien flora frequently give the block plantations the look of natural forest.

FLORISTIC DIVESITY

The total angiosperm flora of Punjab including both indigenous and naturalised plants comprise of 1843 species and 43 varieties belonging to 940 genera under 165 families (Sharama, 1990). Table I gives the number of families, genera and species under Dicotyledons, Monocotyledons, Gymnosperms and Pteridophytes.

Table I
Statistical synopsis of the flora

	Families		Genera		Species	
Taxonomic group	No.	%	No.	%	No.	%
ANGIOSPERMS	165	89.67	940	97.50	1843	98.08
Dicot	134	72.82	743	77.07	1406	74.82
Monocot	31	16.85	197	20.43	437	23.26
GYMNOSPERMS	8	4.35	11	1.15	20	1.07
PTERIDOPHYTES	11	5.97	13	1.35	16	0.85
Total	184	100.00	964	100.00	1879	100.00

The ten dominant families are given in table II and compared with adjoining regions and ten dominant genera of Punjab are given in table III.

Table II
Dominant families of Punjab and Adjacent Regions

Sl. No.	Punjab (Sharma, 1990)		Punjab Plains (Punjab and Haryana)	Upper Gangetic Plain	Rajasthan
1.	*Leguminosae (*s.l.*)	212	Leguminosae	Gramineae	Gramineae
2.	Gramineae	163	Gramineae	Leguminosae	Leguminosae
3.	Compositae	142	Compositae	Compositae	Compositae
4.	Euphorbiaceae	62	Cyperaceae	Cyperaceae	Cyperaceae
5.	Cyperaceae	62	Malvaceae	Euphorbiaceae	Acanthaceae
6.	Acanthaceae	45	Acanthaceae	Acanthaceae	Euphorbiaceae
7.	Malvaceae	42	Euphorbiaceae	Labiatae	Convolvulaceae
8.	Convolvulaceae	40	Convolvulaceae	Scrophulariaceae	Scrophulariaceae
9.	Labiatae	39	Scrophulariaceae	Convolvulaceae	Malvaceae
10.	Scrophulariaceae	39	Amaranthaceae	Malvaceae	Labiatae

*Family Leguminosae is treated here *Sensu lato* with Papilionoideae represented by 137 species, Caesalpinoideae by 46 species and Mimosoidae by 29 species.

Table III
Dominant Genera

Sl.No.	Name of the Genera	No of species
1.	*Cyperus*	33
2.	*Ipomoea*	23
3.	*Euphorbia*	21
4.	*Ficus*	17
5.	*Eragrostis*	14
6.	*Indigofera*	13
7.	*Fimbristylis*	12
8.	*Crotalaria*	10
9.	*Scirpus*	10
10.	*Heliotropium*	9

PHYTOGEOGRAPHICAL AFFINITIES

Although the state of Punjab is not as rich in biodiversity as peninsular India or eastern India, but even then the region is of special significance as is evident from the occurrence of so many types of floral elements. Even, a number of new world elements have established very well in their new home.

The analysis of phytogeographical elements in the flora of Punjab has been given in Table IV. These elements can be easily grouped under four main classes namely i/ Indian element, ii/ Eastern element, iii/ Western element and iv/ General element.

The Indian element is not very well represented in the state, probably due to extreme climatic conditions and dry, sandy substratum. Their presence is more in Punjab Shivaliks as compared to semi-arid region .

The percentage of Eastern or Indo-Malayan element is almost double than that of Indian element. The representation of this group is more towards Shivaliks as compared to semi arid Punjab.

The Western element which comprises of African, Mediterranean, Oriental and European species is fairly well represented in the flora of

Punjab. This probably is because of similar climatic conditions in Africa, Mediterranean region and the state.

The General element is most conspicuous and includes cosmopolitan, Temperate and Tropical species. The cosmopolitan species are either naturalized ones or are aquatic in nature.

The occurrence of so many types of floral elements in Punjab is interesting. The overlapping of several floral elements appears to be due to seasonal changes in climate. Indo-Malayan elements generally develops during monsoon period and seek shelter in humid places. Dry and hot conditions favour the African element in extending into semi-arid Punjab. The fair representation of temperate and Mediterranean -Oriental -European element is probably due to cold winter-period which allows it to extend to our area. The new world elements have established themselves very well because of favourable climatic conditions in their new homes. In conclusion, the flora of Punjab can be categorized as a transition zone between warm and humid south Asia and colder, semi-arid, Middle -Eastern countries. The state appears to be a meeting point of the Eastern (23.5%) and western elements (26.2%).

Table IV
Major elements of the flora*

Elements	No. of species	Percentage
Endemic	3 + (1 subsp.)	0.27
Indian	83	7.42
Indo-Malayan	263	23.51
North African-Indian desert (Saharo-Sindian)	106	9.47
Tropical and north African-Indian desert (Sudano-Deccanian)	50	4.47
Tropical Africa - India	43	3.84
Tropics of the old world	209	18.68
Warm countries	13	1.16
Pantropical	114	10.19
Subtropical and Temperate	7	0.62
Mediterranean	22	1.97

Elements	No. of species	Percentage
Oriental	11	0.98
Europe	62	5.54
Cosmopolitan	30	2.62
America	53	4.73
Himalayas	31	2.77
Temperate	19	1.70

* Sharma and Rajpal - 1995

Table V
Analysis of floral flement*

No.	Floral element	No. of sp.	Percentage
I.	INDIAN	117	10.46
	a. Endemic		
	b. Himalayan		
	c. Indian		
II.	EASTERN (Indo - Malayan)	263	23.51
III.	WESTERN	294	26.27
	a. North African - Indian Desert (Saharo - Sindian)		
	b. Tropical and North African-Indian Desert (Sudano - Deccanian)		
	c. Tropical African-Indian		
	d. Mediterranean -Oriental-European.		
IV.	GENERAL	445	39.76
	a. Tropical		
	b. Warm countries		
	c. Temperate		
	d. Cosmopolitan		
	Total	1119	100.00

*Sharma and Rajpal - 1995

ECONOMIC USES

There are number of plants which are used for various purposes and which can play vital role in economic development. *Acacia catechu, Acacia nilotica* subsp. *indica, Tamarix aphylla* are used in the tanning industry. Inedible oils extracted from *Argemone mexicana, Citrullus colocynthis, Azadirachta indica, Cymbopogon martinii, Vetiveria zizanioides* can be economically exploited.

A number of species are used in Ayurvedic and Unani system of medicines, as well as household remedies e.g., *Cocculus pendulus, Viola serpens, Abutilon indicum, Sida cordifolia, Linum usitatissimum, Azadirachta indica, Mangifera indica, Aegle marmelos, Acacia catechu, A. modesta, A. nilotica* ssp. *indica, Mimosa himalayana, Abrus precatorius, Gisekia pharnaceoides, Cuscuta reflexa, Datura stramonium, Solanum surattense, Withania somnifera, Salvadora oleoides, Heliotropium strigosum, Trichodesma amplexicaule, Adhatoda zeylanica, Barleria cristata, Nepeta hindostana, Salvia plebeia, Boerhavia diffusa, Euphorbia helioscopia, Asparagus racemosus.* Plantations of *Eucalyptus* spp., *Acacia nilotica.* ssp. *indica, Albizia lebbek,Prosopis juliflora, Dalbergia sissoo, Broussonetia papyrifera, Populus nigra (cv. italica)* provide substantial early returns with nominal investament. *Dalbergia,Eucalyptus* and *Populus* in particular have become the trees of the farmers.

Table VI
Some useful plants

Name of the species	Uses
Abrus precatorius	Seeds applied in fistula. Roots used as substitute for liquorice.
Acacia catechu.	The extract applied in dying, in medicine as an astringent, externally as ointment on bruises.
A. nilotica ssp. *indica*	Leaves are fodder for goats and sheep. Bark is used in tanning. Gum is given in cough. Timber is hard, strong and durable.

Name of the species	Uses
Achyranthes aspera	Dried plant is given locally to children in colic.
Acorus calamus	Roots cure rheumatism and flatulance.
Adhatoda zeylanica	Leaves are given in coughs.
Aegle marmelos.	Leaves are offered to Lord Shiva. The pulp of the fruits fresh or dried is used in digestive disorders.
Ammania auriculata	The plant used in blisters.
Apium graveolens	Roots are considered alterative and diuretic and given in colic, seeds act as stimulant and cordial.
Argemone mexicana	Oil extracted from seeds is applied on eruptions and ulcers.
Azadirachta indica	Leaves applied on boils. Seed oil and infusion of leaves are used for medicinal purposes.
Bauhinia racemosa	Branches are used as strong rope, leaves are made into plates.
Butea monosperma	Flowers yield a yellow dye. Decoction is given in diarrhoea.
Calotropis Procera	Silky floss of seeds is used to stuff pillows. Bark of the roots is used as medicine.
Capparis decidua	The ripe fruit made as pickle with mustard oil.
Cissampelos pareira.	The roots used in tonic.
Crotalaria burhia	Ropes are made from the bark.
Cuscuta reflexa	Seeds are boiled and used as carminative.

Name of the species	Uses
Datura stramonium	Leaves are applied to boils and ulcers. Seeds are given in asthmatic complaints.
Euphorbia helioscopia	Root is given as anthelmintic. Milky juice is applied on eruptions.
E. parviflora	Given with milk to children for colic.
Malva parviflora	Seeds used in coughs.
Mimosa himalayana	Bruised leaves are applied to burns.
Plantago major	Leaves are applied to bruises.
Saccharum bengalense	Usod for making baskets, chairs.
Tinospora cordifolia	The roots and extract are considered tonic and febrifuge.
Withania coagulans	The seeds are considered stomachic, leaves are given as a febrifuge.
W. somnifera	It is considered aphrodisiac and also given in lumbar pains.

ENDEMISM

Chatterjee (1939) has listed 134 dicot genera as endemic to India. Out of these only few like *Butea.* (Leguminosae), *Ougeinia* (Leguminosae), *Caesulia* (Compositae), *Glossocardia* (Compositae), *Aechmanthera* (Acanthaceae) occur in Punjab. There are only four endemic taxa in the flora of Punjab state. These are

Argyrolobium album (Leguminosae)

Hibiscus hoshiarpurensis (Malvaceae)

Panicum maximum. ssp. pubescens (Gramineae)

Rumex punjabensis (Polygonaceae)

THREATENED AND RARE TAXA

All the endemic taxa listed above come under this category. Moreover, following taxa also need mention here

Anogeissus sericea var. *nummularia*	Combretaceae	Rare
Convolvulus microphyllus var. *deserti*	Convolvulaceae	Rare
Withania coagulans	Solanaceae	Vulnerable
Tecomella undulata	Bignoniaceae	Endangered
Sesamum mulayanum	Pedaliaceae	Vulnerable
Polypogon monspeliensis var. *indicus*	Gramineae	Rare

CONSERVATION

Because of rapidly expanding agriculture and under the influence of biotic factors, the forest area in the state has been constantly under threat. The destruction is not restricted only to the trees species but original plant cover has been thoughtlessly and ruthlessly destroyed for industrialization urbanization and agriculture. The natural forests are the custodians of biodiversity in the region and the source of innumerable articles of daily need. It is imperative, therefore, that the dwindling forest areas must be augmented through proper utilization and conservation. Following are the sanctuaries established for protecting the wild flora and fauna in Punjab.

Abohar Wildlife sanctuary : This is by far the largest protected area of Punjab covering an area of 186 sq km in Ferozpur district near Indo-Pakistan border. The vegetation consists of dry deciduous scrub and semi - arid elements. The sanctuary is the home of Wolf, Desert Cat, Black buck and many species of birds.

Bir bunerheri Wildlife sanctuary : It has an area of 6.5 sq km in Patiala district near the border with Haryana. The vegetation consists of dry deciduous scrub, secondary dry deciduous forest and dry grassland. Wildlife consists of Wolf, Nilgai, Sambhar, Wild boar and number of birds species.

Bir Gurdial Pura Wildlife sanctuary : This is another small sanctuary in Patiala district near the border with Haryana. It covers an area of about 6 sq km.

Bir Motibagh Wildlife sanctuary : This sanctuary is spread over 6 sq km area and is situated in Patiala district. Wildlife includes Wolf, Nilgai, Sambhar, Rhesus monkey and Wild boar.

Harike lake Wildlife sanctuary : With an area of 86 sq km this sanctuary is located around the Harike Wetland in Amritsar district. There is a proposal to upgrade its status to that of a national park. Vegetation consists of dry riverine forest and swamps and marshes. This sanctuary is the house of many resident and migratory species of aquatic birds and reptiles and fishes.

Takhani Rahampur Wildlife sanctuary : It is the smallest wildlife sanctuary of Punjab with an area of around 4 sq km.

Drastic environmental changes in the forests of Punjab have been brought out by man. Between 1972-73 to 82-84 there had been 50% reduction in forest cover. Primary forests have almost disappeared and are being replaced by exotics like *Eucalyptus* and *Populus*. The regeneration of native forest species is nullified by the clearing of ground flora. It is a common phenomenon that nurseries are filled with seedlings of *Eucalyptus* species, and other exotics. Most of the afforestation programmes are urban -oriented with emphasis on ornamental flowers and fruit trees, and when it comes to forest land and waste lands, it is in the form of creating plantations which are revenue oriented. There is urgent need and necessity to rejuvenate the natural ecosystems in the state. If left undisturbed our forests, the repositories of Biodiversity will regenerate themselves as large " forest continuums " and not in isolated patches of parks and sanctuaries.

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RAJASTHAN

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Rajasthan is one of the largest states of India, occupying an area of about 3,42,274 sq km i.e. nearly 11 percent of total area of India, located between 23° 3' 30° 12' N. latitude and 69° 30' 78° 17' E. longitude. Phytogeographically, it forms the eastern extremity of great arid and semi-arid belt of the world; the Great Sahara desert belt passes through the western part of the state. The most striking geological feature is the Aravalli range - the oldest folded mountain range in the world, which intersects the state diagonally end to end north-east to south-west into three-fifth north-western desertic zone and two -fifth eastern semi-arid region. The elevation of Aravalli range gradually decreases in north- east direction, as it is 1772 m at Mt. Abu, 1100 m at Bijapur, 913 m at Harshnath and 792 m at Khetri; the elevation further decreases to 335 m at Dehli beyond the boundaries of the state in north-east direction. Aravalli is composed of metamorphosed rocks of Aravalli, the Raialos and the Delhis. Banded Gneissic complex and Bundelkhand Gneiss, both pre-Aravalli formations, are concealed at great depth indicating that Aravalli and subsequent later rock formations and structures have been bulit up over them.

The north-western region, which is called as Rajasthan desert or Marusthali, occupies an area of about 1,96,150 sq km and is covered with vast stretches of sand and shifting and stabilized sand dunes of various types, magnitude and orientations viz. parabolic, longitudinal, barkhan, transverse, etc. The Jurassic and Eocene rocks protrude here and there above the sandy and hummocky plains of aeolian origin. The soils are typical desert soils and grey-brown desert soils containing 90 -95 percent sand and 10-5 percent clay, high percentage of soluble salts and high pH value. Another important topographical feature of the desert is the presence of salt lakes viz. Sambhar, Degana, Kuchaman and Didwana, which narrate the past geological history of the area.

The area in the north-east, east and south -east of main Aravalli range presents a topography of isolated chain of outliers of Aravallis, undulating tectonic plains and alluvial plains or agricultural plains. Vindhyan hills, which constitute a vast sedimentation formation of sand stones, shales and lime stone, also enter in the south-east and spread out westwards.

The soils are typically red and yellow, ferruginous red, mixed red and black, medium black and alluvial which have good water holding capacity and pH is neutral to alkaline. They have smaller content of lime, potash, iron oxide, phosphorus, nitrogen and humus.

There is no perennial river in the west of Aravalli; the only significant seasonal water course is the Luni river which originates at Ana sagar at Ajmer and ends itself in brine near the Runn of Kutch. In the east of Aravalli, the river Chambal and its tributaries viz. Kali Sindh, Parbati, Banas, Mej, Parvan, etc. form a network in the area. The river Chambal originates in Vindhyas in Madhya Pradesh and joins the river Yamuna in Uttar Pradesh. Another major river is Ban Ganga which rises in Jaipur district and flows eastwards through Bharatpur and Dholpur to join Yamuna in Uttar Pradesh. The river Mahi and its tributaries viz. Anas, Som, etc. form network in the southern part of Rajasthan. The bottom and beds of most of the rivers and tributaries are stony. In the hilly tracts they form deep gorges and in plains the ravines which are very conspicuous in Kota, Sawaimadhopur and Dholpur districts.

Except salt lakes as described above, there are no natural fresh water lakes in Rajasthan. The man-made major artificial lakes viz. Jaisamand, Udaisagar, Pichhola and Fateh sagar in Udaipur district, Ana sagar, Pushkar, Visal sagar and Faisagar in Ajmer, Balsamand, Sardar Samad and Kailana in Jodhpur, Jaisamand in Alwar, Nakki at Mt. Abu, Gajner in Bikaner, Aklara sagar and Ummed sagar in Kota district are chiefly used for irrigation and drinking water and, therefore, frequently cleared by way of weed removal. In Rajasthan the man-made wetlands occupy an area of 1,00,217 ha. and natural wetlands about 14,027 ha. only. There are several neglected, rather small tanks, ponds, ditches and low lands spread all over the state which present variable emporia for wetland biodiversity.

The climate of desertic zones in the west of Aravalli is characterized by extremes of temperature-mean maximum 33.4°C and mean minimum 18.9°C, low rainfall 342 mm mean annual, high evapo-transpiration i.e. 1868 mm mean annual, low relative humidiy i.e. 35 to 60 percent and high wind velocity i.e. 10.7 km/hr average annual. Such climatic conditions are rather adverse to support any appreciable biodiversity. The climate in the east of Aravalli is semi-arid with mean annual maximum and minimum temperatures 30°C and 15°C respectively, mean annual rainfall 850mm, relative humidity 50-60 per cent and mean annual wind

velocity about 7.5 km/hr. Such a climate is suitable for comparatively dense dry deciduous vegetation.

VEGETATION

The characteristic diversity in the vegetation of the state is due to variable climatic, edaphic and topographic conditions which have attracted the attention of botanists and plant geographers since long back. The earliest recorded information on botanical exploration in Rajasthan is about Jacquemont's journey in 1832 from Dehli to Bombay via Ajmer and Neemuch. Later King (1879), Brandis (1874), Duthie (1886, 1903 -29), Macadam (1890), Adams (1899), Blatter and Hallberg (1918 -21), Parker (1918), etc. botanised the area. During recent years a large number of publications dealing with flora, floral composition and ecology, etc. have been published which are reviewed by Jain (1972), Bhandari (1978), Majumdar (1979), Shetty and Pandey (1979) and Sharma (1980). Shetty and Singh (1987-93) have further enriched our knowledge regarding the phytodiversity of Rajasthan. As such so far more than 80 per cent of the total area of the state has been well explored. The districts like Banswara, Barmer, Bhilwara, Bikaner, Bundi, Hanumangarh, Churu, Jaisalmer, Jaipur, Jalore, Jhalawar, Jodhpur, Kota, Nagaur, Pali, Sawaimadophur, Sri Ganganager, Tonk, Udaipur have been thoroughly explored, while the districts viz. Ajmer, Alwar, Bharatpur, Dausa, Jhunjhunu, Sikar, Sirohi have been partly explored i.e. more than 50 per cent. The districts of Dholpur, Chittorgarh and Dungarpur have, however, been very poorly explored i.e. less than 25 per cent and, therefore, priority should be given on the study of phytodiversity of these districts. The main agencies engaged in exploration work in Rajasthan include Botanical Survey of India, different Universities located at Jodhpur, Jaipur and Udaipur and some Colleges located in the state.

For the sake of convenience, the vegetation of Rajasthan can be divided into following heads

1. The Western sandy desert

The vegetation in arid regions is sparse consisting mainly of stunted, thorny or prickly shrubs and perennial herbs capable of draught resistance. Trees are few and scattered. The ephemerals come up during rainy season, complete their life cycle before the advent of summer and major

area is once more transformed into open sandy plain, desolate and barren. The vegetation of Thar desert is edaphic controlled and sand-dunes and sandy plains form the most spectacular landscape where shrubs like *Calligonum polygonoides, Calotropis procera, Capparis decidua, Clerodendrum phlomidis, Haloxylon salicornicum* and *Lycium barbarum* form associations of their own or with scattered tree species of *Acacia senegal, Prosopis cineraria, Salvadora oleoides*, etc. Besides these, *Aerva javanica, Citrullus colocynthis, Crotalaria burhia, Dipterygium glaucum, Farsetia hamiltonii, Indigofera argentea, I. cordifolia, Leptadenia pyrotechnica, Melhania denhamii, Sericostoma pauciflorum, Tephrosia falciformis*, etc. are the main undershrubs and woody herbs which fairly grow in abundance. The common grasses which play an important role in binding the sand are *Cymbopogon jwarancusa, Dactyloctenium aegyptium, D. scindicum, Lasiurus sindicus, Latipes senegalensis, Panicum antidotale, P. turgidum*, several species of *Aristida* and *Cenchrus*. Among sedges *Cyperus arenarius* and *C. conglomeratus* need special mention for sand-binding.

The base of dunes and interdunal gaps support more luxuriant vegetation described above due to greater availability of moisture. Some additional species viz. *Acacia jacquemontii, Tecomella undulata, Ziziphus nummularia, Prosopis juliflora*, etc. may also be encountered in such habitats.

The free dunes or unstabilised dunes are least covered with vegetation; the pioneer species to colonise these dunes are *Cyperus arenarius, Cenchrus biflorus, Crotalaria burhia, Aerva javanica, Leptadenia pyrotechnica, Citrullus colocynthis*, etc. The obstacle sand dunes formed at the foot of isolated hills and rock outcrops on windward side become established more quickly due to availability of large amount of water flowing down the hills. They present a mixture of typical sand-dune and rocky vegetation where *Anogeissus pendula, Balanites aegyptiaca, Grewia tenax, Maytenus emarginatus, Ephedra ciliata*, etc. associate the typical sand-dune vegetation described above.

Many isolated hills of low elevation, rocky ridges and rock outcrop of various origin are also scattered throughout the Indian desert viz. Jaisalmer plateau, Barmer hills, Jalore hills, Kailana-Jodhpur-Mandore plateau. The most characteristic lithophyte on such habitats is *Euphorbia caducifolia* which forms thick shrubbaries supporting climbers like *Sarcostemma viminale*. In addition, the trees and shrubs like *Acacia*

senegal, Anogeissus pendula, Capparis decidua, Commiphora wightii, Grewia tenax, Maytenus emarginatus are also encountered. Many other climbers viz. *Abrus precatorius, Commicarpus verticillatus, Melothria maderaspatana, Rhynchosia minima, Rivea hypocrateriformis,* etc. further enrich the flora of rocky habitats. The undershrubs and herbs show rather greater diversity in comparision to sand-dune habitats viz. *Achyranthes aspera, Anticharis senegalensis, Barleria acanthoides, B. prionitis, Cleome brachycarpa, Corbichonia decumbens, Corchorus depressus, Lepidagathis trinervis, Lindenbergia indica, Schweinfurthia papilionacea, Seddera latifolia, Sida cordata, Tridax procumbens,* etc. Among grasses *Enneapogon brachystachyus, E. elegans, Melanocenchris jacquemontii, Oropetium thomaeum, Stipagrostis hirtigluma,* species of *Aristida* etc. are characteristic of rocky and hilly habitats.

The gravelly plains maintain a mixture of lithophytic and sandy vegetation since gravel forms a thin layer on thick sand profile as a result of sorting action of wind. The common tree species in gravelly habitats include *Prosopis cineraria, Salvadora oleoides, Capparis decidua, Maytenus emarginatus,* etc. They are very widely distributed and are under great biotic pressure. The growth of shallow rooted undershrubs and herbs which feed on gravel resembles very exactly the lithophytic vegetation of rocky and hilly tracts with some characteristic additions of plant species like *Cleome viscosa, C. scaposa, Heliotropium strigosum, Limeum indicum, Monsonia senegalensis, Odontanthera varians, Salvia aegyptia, Tephrosia purpurea,* etc. Some herbaceous plants of gravel are prostrate and star-like viz. *Euphorbia clarkeana, E. granulata, Indigofera cordifolia, Mollugo cerviana, M. nudicaulis,* etc. The grass-legume association is also very prominent in some gravelly habitats.

The other important habitats in western sandy desert are saline low-lands and depressions. The Sambhar lake, Pachpadra, Lunkaransar, Kuchaman, Didwana, the northern tip of the Runn of Kutch butting into Barmer and Jalore districts are the some important saline habtitats which maintain characteristic phytodiversity viz. *Chenopodium album, Cressa cretica, Haloxylon salicornicum, Limeum indicum, Peganum harmala, Portulaca oleracea, Salsola baryosma, Sesuvium sesuvioides, Suaeda fruticosa, Trianthema portulacastrum, Zygophyllum simplex,* etc. and grasses like *Aeluropus lagopoides, Eleusine compressa, Sporobolus marginatus,* etc.

2. The Aravalli range

The second physiographic region of botanical interest is the Aravalli range which runs diagonally across the state from Champaner in Gujarat in the south-west to near Dehli in the north-east for a distance of about 692 km. Within Rajasthan, the range runs from Khed Brahma in the south-west to Khetri in the north-east. On Khetri hills (792 m) the vegetation is scrubby and highly degraded. The top of hills are practically barren, while on slopes where some sand and moisture accumulate, the trees and shrubs like *Acacia leucophloea, A. senegal, Balanites aegyptiaca, Capparis decidua, Euphorbia nivulea, Grewia tenax, Justicia adhatoda* and *Securinega leucopyrus* may be noticed. On Harshnath hills (913 m) south-west wards, the floral composition resembles Khetri hills up to 600 m, but above it the plant species of *Calotropis, Clerodendrum, Justicia,* etc. are replaced by *Dichrostachys cinerea, Euphorbia neriifolia, Triumfetta rhomboidea,* etc. in association with few tree species like *Anogeissus latifolia, A. pendula, Prosopis cineraria, Wrightia arborea,* etc., which are stunted at lower elevations. Further south-westwards at Kho (920 m), Raghunathgarh (1055m) and Todgarh, the scrub vegetation merges to some extent with deciduous type. The vegetation of these hills include *Anogeissus pendula, Acacia leucophloea, Bauhinia racemosa, Boswellia serrata, Commiphora wightii, Dichrostachys cinerea, Mimosa hamata, Rhus mysorensis, Securinega leucopyrus, Sterculia urens,* etc.

From Bijapur forest range (1100 m) to further south-west wards, the hills are covered with mixed deciduous forest dominated by *Anogeissus pendula* in association with *Aegle marmelos, Anogeissus latifolia, Bauhinia racemosa, Boswellia serrata, Butea monosperma, Cassia fistula, Diospyros melanoxylon, Mitragyna parvifolia, Wrightia tinctoria,* etc. Mt. Abu (1727m) at south-western border of the state is the highest peak where vegetation falls into fairly distinct elevational zones. The cheif components upto 1300m are the same as between Bijapur and Mt. Abu, but above it the vegetation gradually changes to subtropical evergreen type with characteristic species like *Carvia callosa, Crateva nurvala, Flacourtia indica, Girardinia zeylanica, Jasmimum humile, Kydia calycina, Lannea coromandelica, Mallotus philippensis, Mangifera indica, Rosa brunoni, R. involucrata, Syzygium cumini, Trema orientalis,* etc.

3. The area in the east of Aravalli

Several parallel outliers of Aravalli from Ajmer onwards spreading to south and south-east, Bhorat plateau (1225 m) spreading over Udaipur

and Dungarpur districts, Chappan plateau (350-700 m) over Chittorgarh and Banswara districts, Deccan plateau over Kota, Bundi and Jhalawar districts, Vindhyan scarpland (350-580 m) between Banas and Chambal rivers spreading over Bharatpur, Dholpur and Sawaimadhopur districts, north eastern hilly region (300-800 m) over Alwar and Banas basin (582m) spreading over Ajmer, Tonk, Jaipur and southern part of Alwar constitute the third physiographic unit of biological interest. The vegetation on the outliers is mixed deciduous type typical to Aravalli hills as described earlier. However, at certain places *Boswellia serrata* dominates on Bhorat plateau with some interesting associates like *Albizia odoratissima, Holoptelea integrifolia, Cassia auriculata, Annona squamosa, Dyerophytum indicum, Spermadictyon suaveolens, Woodfordia fruticosa,* etc. On Chappan plateau additional interesting prominent species include *Bauhinia racemosa, Dalbergia latifolia, Phyllanthus emblica, Adina cordifolia, Hymenodycton excelsum, Lagerstroemia parviflora, Madhuca indica, Terminalia arjuna,* etc. The Deccan plateau further maintains *Buchanania lanzen, Dendrocalamus strictus,* etc. The vegetation of Vindhyan scarpland is characterized with degarded and stunted trees and shrubs like *Acacia leucophloea, A. nilotica* ssp. *india, Balanites aegyptiaca, Kirganelia reticulata, Meytenus emarginatus, Salvadora oleoides,* etc. In the north-eastern hilly region *Euphorbia neriifolia, Terminalia bellerica, Commiphora wightii, Tecomella undulata, Colebrookea oppositifolia* are rather more abundant than other habitats. The Banas basin, however, maintains typical mixed dry deciduous vegetation of Aravallis.

The area in the east of Aravalli receives enough rainfall and maintains a large number of permanent and temporary tanks, ponds and puddles; some of them like Sambhar lake and Pichola lake are of international importance and have been selected for conservation under National wetland management programme. These habitats provide variable emporia for various life forms viz. free floating (*Pistia, Utricularia,* etc.), suspended submerged (*Ceratophyllum, Hydrilla, Najas, Nechamendra, Zannichellia,* etc.), rooted submerged (*Ottelia, Vallisneria, Potamogeton,* etc.), amphibious emerged (*Aeschynomene, Hydrolea, Limnophila, Sagittaria, Typha, Polygonum,* etc.) The species of *Nymphaea, Nymphoides, Potamogeton* and *Ipomoea* represent the group of aquatics having floating leaves or shoots. Besides these, a number of species which prefer marshy lands to grow on viz. *Ammannia baccifera, Phyla nodiflora, Coix lacryma-jobi, Hemarthria compressa,* species of *Paspalidium* and *Paspalum,* etc. further enrich the floristic wealth of the state.

The weed diversity is also very interesting in this state as highest weed density of winter weeds may be noted during January and February with typical species like *Asphodelus tenuifolius, Chenopodium album, Euphorbia dracunculoides, Fumaria indica, Lepidium sativum, Lathyrus aphaca, Melilotus alba, M. indica, Oxalis corniculata, Striga angustifolia,* etc. However, the weeds associated with summer crops are few; the important ones are *Alhagi maurorum, Gomphrena celosioides, Solanum nigrum, S. virginianum, Tribulus terrestris,* etc. The density and frequency of weeds is highest during rainy season; the characteristic species are *Aerva lanata, Alysicarpus longifolia, Caesulia axillaris, Celosia argentea, Cyperus rotundus, Launaea procumbens, Leucas cephalotes, Oldenlandia corymbosa, Oxalis corniculata, Vernonia cinerea,* etc. It is interesting to note that majority of weeds are annual and therophytes. With the advent of Indira Canal in the desert area, the weed diversity has been further enriched by a number of Himalayan elements viz. *Antirrhinum orontium, Arenaria serpyllifolia, Astragalus tribuloides, Centaurium centaurioides, Astrocotyle hispida, Hypercuom procumbens, Kochia indica, Lophochloa pumila, Malcolmia africana, Oenanthe javanica, Psammogeton canescens,* etc.

FLORISTIC DIVERSITY

The state of Rajasthan is considerably rich in floral diversity as about 1911 species belonging to 780 genera under 154 families of higher plants grow over here. Gymnosperms are represented only by *Ephedra ciliata.* Among angiosperms, dicotyledonous plants show maximum diversity from specific level (72.98%) to family level (79.22%).

Table I
Statistical synopsis of the floral diversity

Taxonomic group	Families		Genera		Species	
	No.	%	No.	%	No.	%
ANGIOSPERMS	153	99.35	779	99.87	1910	99.95
Dicots	122	79.22	602	77.15	1395	72.98
Monocots	31	20.13	177	22.72	515	26.97
GYMNOSPERMS	1	0.65	1	0.13	1	0.05
Total	154	100.00	780	100.00	1911	100.00

Though monocotyledons are very poorly represented in the area, the family Poaceae maintains highest diversity in the area containing 296 species under 102 genera. The polypetalous family Fabaceae of dicots finds second place in the state with 173 species and 49 genera. Among gamopetalous group of dicot plants, Asteraceae maintains highest diversity with 125 species and 62 genera The family Euphorbiaceae (59 species and 17 genera) exhibits maximum diversity among the Monochlamydaceous group of angiosperms.

Table II
Ten dominant families

Family	Genera	Species
Poaceae	102	296
Fabaceae	49	173
Asteraceae	62	125
Cyperaceae	15	100
Acanthaceae	30	85
Euphorbiaceae	17	59
Convolvulaceae	12	58
Scrophulariaceae	26	54
Malvaceae	11	53
Lamiaceae	15	43

Among the genera again monocot genus *Cyperus* (33 species) maintains highest diversity and dicotyledons stand at second place. However, contrary to families, the gamopetalous genus *Ipomoea* (28 species) stands on the second place and polypetalous genus *Indigofera* on the third position. The genus *Euphorbia* (19 species) shows maximum diversity in Monochlamydaceous group.

The table III indicates that there is no direct relationship between different taxonomic levels and the degree of phytodiversity. The families

like Burmanniaceae, Cannaceae, Musaceae, Iridaceae, Ruscaceae, Smilacaceae, Juncaceae, Pandanaceae, Butomaceae, Aponogetonaceae and Zannichelliaceae, among monocots and Magnoliaceae, Berberidaceae, Cochlospermaceae, Nelumbonaceae,Bixaceae, Residaceae, Vahliaceae, Averrhoaceae, Haloragaceae, Simaroubaceae, Balanitaceae, Barrigtoniaceae, Punicaceae, Trapaceae, Passifloraceae, Caricaceae, Begoniaceae and Alangiaceae in dicots maintain minimum diversity as they are represented by single species. Futher, the families like Sphenocleaceae, Spigeliaceae, Hydrophyllaceae, Gesneriaceae, Martyniaceae, Basellaceae, Phytollacaceae, Piperaceae, Lauraceae, Proteaceae, Santalaceae, Cannabinaceae, Casuarinaceae and Ceratophyllaceae also maintain minimum floristic diversity i.e. more than 28 percent families are floristically monotypic.

Table III
Genera maintaining maximum diversity

Name of the genera	No. of Species	Position of family in the list of dominant families
Cyperus	33	4
Ipomoea	28	7
Indigofera	27	2
Eragrostis	23	1
Crotalaria	20	2
Euphorbia	19	6
Fimbristylis	19	4
Acacia	17	-
Alysicarpus	16	2
Heliotropium	15	-

The maximum diversity within a species was noted in *Pavonia arabica, Convolvulus auricomus, Tribulus terrestris, Alysicarpus rugosus, Amaranthus hybridus, Barleria prionitis, Justicia diffusa, Polygonum*

plebeium, Pupalia lappacea and *Veronica anagallis-aquatica* which have two or more varieties besides the autonyms.

The gene level diversity is more prominent in *Cucumis melo, Citrullus lanatus, Tephrosia purpurea, Cenchrus* species and *Ziziphus mauritiana,* which is phenotypically reflected in size and shape of fruit, flower colour etc. indicating possibilities of natural hybridization.

The phytodiversity ratio of species between Monocotyledons to Dicotyledons is 1:2.7, of genera 1 : 3.4 and of families 1: 3.9. The phytodiversity ratio of genera to species is 1: 2.4, which is rather low in comparision to the corresponding ratio for whole India (1:7). However, it is more or less comparable to the ratio for flora for Gangetic Plain region (1:2.2) and for Gujarat state (1:2.4). It confirms the general rule that, within the same floral region, the smaller the flora, the smaller the species genus ratio i.e. poor phyto-diversity.

PHYTOGEOGRAPHICAL ANALYSIS OF FLORISITIC DIVERSITY

The vegetation of Rajasthan presents a mixture of four distinct phytogeographical elements as under (Singh, 1978).

Indian element	32.56 %
Perso-Arabian element (Western)	30.55 %
Indo-Malayan element (Eastern)	12.76 %
General element	24.22 %

The phytogeographical analysis revealed that Indian element dominates other adventive taxa as it forms 32.56% part of the flora of Rajasthan. It mainly consists of the species coming from Kutch, Sindh, Saurashtra, Maharashtra and neighbouring Gangetic plains. The resemblance in the list of ten dominant families furhter supports the above veiw (Table IV). The Himalayan and N.E. Indian species are poorly represented and most of them grow at Mt.Abu and in subtropical evergreen patches of forest in the east of Aravalli.

Table IV
Floristic diversity of India, Rajasthan and other neighbouring states - position of ten dominant families

Rajasthan	India	Gangetic Plain	Gujarat
Poaceae	Poaceae	Poaceae	Fabaceae
Fabaceae	Orchidaceae	Fabaceae	Poaceae
Asteraceae	Fabaceae	Cyperaceae	Cyperaceae
Cyperaceae	Asteraceae	Asteraceae	Asteraceae
Acanthaceae	Rubiaceae	Scrophulariaceae	Acanthaceae
Euphorbiaceae	Acanthaceae	Malvaceae	Malvaceae
Convolvulaceae	Euphorbiaceae	Acanthaceae	Euphorbiaceae
Scrophulariaceae	Lamiaceae	Euphorbiaceae	Convolvulaceae
Malvaceae	Apiaceae	Convolvulaceae	Scrophulariaceae
Lamiaceae	Brassicaceae	Lamiaceae	Lamiaceae

The Perso-arabian element (Western element) constitutes 30.55 % part of floristics of Rajasthan. It includes the species migrated from Africa, Mediterranean region, Madagascar, North Africa, Arabia, Persia, Turkey, Indus plain, Sudan and other Asian countries. The Perso-arabian element dominates over other adventive elements including the Indo-Malayan element throughout the state except Mt. Abu. However, the percentage of Western element decreases gradually as one proceeds from west to east. The ratio of Eastern to Western element in the west of Aravalli varies from 1:4.4 to 1:6, while in the East of Aravalli it varies from 1:1.7 to 1: 3. Therefore, if Drude's conclusions that Aravalli range constitutes the line of demarcation between Indo-Malayan and Perso-arabian element is correct, one should get Indo-Malayan element in dominance in the east of Aravalli. The facts are contrary, therefore, authors suggest the line of demarcation between these two elements some where in the east of Rajasthan beyond the limits of the state.

The reasons for dominance of Western element in the state may be (1) large scale destruction of vegetation resulting in exposure of soil where the original natural flora is gradually replaced by pioneer xerophytic elements of Perso-arabian and African origin in the modified plant climate resembling the climate of Libyan desert and Cyrenaica (Das and Sarup, 1961), (2) the absence of any remarkable barrier on the western

boundary of the state to check the migration of Western elements towards Indian desert and (3) decreasing altitude of Aravalli range and gaps at certain places which make the Aravalli as an imperfect barrier in the migration of plant species.

The Indo-Malayan element (Eastern element) constitutes 12.76 % part of the flora. It includes the species coming from Malaysian Peninsula, China, Burma, Thailand Indonesia, Indo-China and other Central, Eastern and South-east Asian countries.

The percentage of eastern element decreases from east to west as it is 24 - 33 % in N.E. India, 23-31 % in southern India (Western and Eastern Ghats), 22 % in Central India, 18.8 % in Eastern Rajasthan which further decreases to 8.7 % in the west of Aravalli in desert area. The probable reasons for it may be the presence of a land connection and the resemblance of plant climate between N.E. India and Malaysian penninsula. The absence of any marked barrier in the west of Eastern India facilitates its migration in futher westwards direction. However, rising temperature and low rainfall towards western parts of the country considerably decrease the percentage of settlement of Eastern element. Aravalli range further checks the westwards movements of Indo-Malayan element and as such the percentage of Eastern element decreases from 18.8 % in the east of Aravalli to 8.7 % in the west of it. The recent rise of Himalaya and Siwalik have also put some check on the invasion of Central and East Asian elements.

The general element finds third position in Rajasthan i.e. 24.22 % . It includes a large number of cosmopolitan plants and exotics introduced mainly from Europe, Mexico, West Indies, East- Indies, America, Java, China, Japan, Philippines, Panama, Cuba, New Granada, Chile, France, Argentina, Brazil, etc. The highest percentage of this element was recorded in south-eastern part of Rajasthan (41.82 %) and lowest in northern part (17 %). The Australian element is very poorly represented in this state.

ENDEMISM

Mt. Abu, the highest peak (1727 m) between W. Himalaya and Nilgiri hills and the Rajasthan desert in the west of Aravalli are two main centres for speciation because of the characteristic topography, geology, edaphic and climatic factors.

Table V
Endemic taxa

Name of the species	Distribution
Abutilon bidentatum var. *major*	Barmer, Jaisalmer(Amar Sagar), Jodhpur.
A. fruticosum var. *chrysocarpa*	Jaisalmer (Vijorai, Mohangarh).
Alysicarpus monilifer var. *venosa*	Jaisalmer (Bara bag).
Barleria prionitis var. *dicantha*	Alwar (Kankwari), Barmer, Bhilwara (Bhilon ki Jhopri), Jhalawar, Pali, Tonk.
Cenchrus prieurii var. *scabra*	Barmer (Jogi dhora), Jaisalmer (Chandan), Jodhpur.
C. rajasthanensis	Jaisalmer (Nachna), Jodhpur (Waglab).
Cleome gynandra var. *nana*	Jaisalmer (Amarsagar), Jodhpur
Convolvulus auricomus var.*ferruginosus*	(Lorditank). Barmer, Jaisalmer, Jodhpur.
C. blatteri	Jaisalmer.
Dicliptera abuensis	Mt. Abu.
Digitaria pinnata var. *shettyana*	Jalore (Sareh Mandir).
Farsetia macrantha	Barmer (Mataji temple).
Ipomoea cariaca var. *semineglabra*	Jaisalmer (Vinjorai).
Lindernia bracteoides	Mt. Abu.
Merremia rajasthanensis	Barmer (Behind Mataji temple), Jodhpur (Sardar samad).
Oldenlandia clausa	Mt. Abu.
Pavonia arabica var. *glutinosa*	Barmer, Jaisalmer, Jodhpur (Kailana).
P. arabica var. *massuriensis*	Jodhpur (Massuria hill).
Pulicaria rajputanae	Barmer, Jaisalmer, Jodhpur.
Strobilanthes hallbergii	Mt. Abu.

Name of the species	Distribution
Veronica anagallis-aquatica var. *bracteosa*	Mt. Abu.
Ziziphus truncata	Jaisalmer (Amarsagar), Jodhpur (Balasamad).

Out of 134 dicot genera listed by Chatterje (1939) as endemic to India, only few like *Ougenia, Butea, Caesulia, Glossocardia, Petalidium, Bremekampi* and *Goniocaulon* occur in Rajasthan. Further, it is important to note that all the endemics of Rajasthan are in threatened stage due to several biotic and climatic factors and need urgent conservation.

The taxa still confined to type localities viz. *Convolvulus blatteri, Farsetia macrantha, Alysicarpus monilifer* var. *venosa, Ipomoea cariaca* var. *semine-glabra, Pavonia arabica* var. *massuriensis, Digitaria pinnata* var. *shettyana, Lindernia bracteoides, Dicliptera abuensis, Oldenlandia clausa, Strobilanthes hallbergii* and *Veronica anagallis-aquatica* var. *bracteosa* need special attenation. Any physical disturbance in the type ecosystems may result in the extinction of germplasm of these species. Due to the lack of natural barriers in most of the cases, *in-situ* conservation is a difficult task particularly in the desertic zones where ecosystem is very fragile. The goal may, however, be achieved through their *ex-situ* conservation and multiplication of germplasm by biotechnological methods.

THREATENED AND RARE TAXA

One of the important cause of threat to some species is their over exploitation for various purposes. The seeds of *Citrullus colocynthis* yield a non-volatile oil which has found a reputable place in soap industry. The mature fruits are collected on commercial scale and are not only being used in local industries but also exported to neighbouring states. Since this species reproduces by seeds, its populations are shrinking and are on the verge of extinction. No conservation measures have so far been taken to over come the problem. However, the cultivation of *C. colocynthis* as a creeping base crop with rainy season crops like Bajra may not only remove the danger of extinction but also be of economic significance since it will also bind the soil and hold the moisture. Competition with the crop

is not expected since it is a deep tap-rooted species and crop has shallow fibrous roots.

Commiphora wightii well known for gun-resin called 'Gugal', is not only being tapped for extraction of resin in unscientific way but also the chemicals are applied on incisions to obtain more and more yeild on commercial scale, which finally lead to the death of plant. The gradual climatic changes have retarded the growth and seed production. The plant is also used by local inhabitants for fire-wood. All these factors, operating together, have brought this taxon on the doors of extinction in its entire range of distribution. So far no conservation measures have been taken in this area, however, this taxon may be conserved by introducing this species in protected areas, by preserving the germplasm in seed banks and replacing the seeds every year since they have low viability, by protecting the habitats of its thick populations. This species may also be multiplied vegetatively and may be grown as a crop.

Ephedra ciliata is being used as a fire-wood on large scale. A study revealed that number of female individuals in a population is also rather low which results in inadequate reproduction. As such the populations are shrinking to a great extent in its entire range of distributions from India to Syria.

Tecomella undulata, locally called "Marwar Teak", is the main source of timber in the desert. Observations have revealed that its regeneration power is also very low. Under such conditions, the servival of this taxon is also unlikely if such factors will continue operating. Maximum afforestation is, therefore, most essential to balance the ecosystem.

Further, about eight taxa presumed to be rare and threatended earlier by Pandey *et al.* (1981) due to their confinement to single locality in Rajasthan desert have developed wide range of adaptations during course of time and have migrated eastwards to semi-arid climate in Rajasthan and adjoining states and some of them westwards to Pakistan. These taxa include: *Ammannia desertorum, Anogeissus sericea* var. *nummularia, Euphorbia jodhpurensis, Melhania futteyporensis* var. *major, M. mangifolia, Psoralea odorata, Sida tiagii, Tribulus rajasthanensis,* etc. The danger of extinction of such elements is rather low. However, the life of these taxa may be further insured by multiplying the germplasm and introducing them in the botanical gardens.

WILD RELATIVES OF CULTIVATED PLANTS

The wild genetic material having potentiality for the improvement of crops and other cultivated plants is considered as important as endemics and threatened and endangered plants in the biodiversity convention. Unfortunately very little information is available regarding wild relatives and as such difficulties in utilization and conservation of such genetic wealth are being realised during present days. The study of floristic diversity of Rajasthan revealed that for 46 species of crops and other cultivated plants there are about 65 species of wild relatives which may be utilized for exchange of genetic material.

Table VI
Important crop plants and their wild relatives

Name of the species	Wild relatives
Abelmoschus esculentus	*Abelmoschus ficulneus* and *A. manihot*
Allium cepa	*Dipcadi serotinum*
Amaranthus caudatus	*Amaranthus hybridus, A.spinosus, A. tricolor, and A. viridis*
Cajanus cajan	*Atylosia sericea* and *A. scarabaeoides*
Capsicum annuum	*Capsicum frutescens*
Carissa congesta	*Carissa spinarum*
Carthamus tinctorius	*Carthamus oxyacantha*
Citrullus lanatus	*Citrullus colocynthis*
Clitorea ternatea	*C. biflora*
Corchorus capsularis	*Corchorus aestuans, C. olitorius and C. trilocularis*
Cucumis melo	*Cucumis prophetarum*
C. sativus	*Cucumis callosus, C. setosus*
Curcuma longa	*Curcuma amada* and *C. angustifolia*
Echinochloa frumentacea	*Echinochloa crus-galli*

Name of the species	Wild relatives
Eleusine corocana	*Eleusine indica*
Ficus carica	*Ficus palmata and F. pumila*
Hibiscus cannabinus	*H. caesius*
Lablab purpureus	*Canavalia ensiformis* and *C. virosa*
Luffa acutangula	*L. acutangula* var. *amara*
L. cylindrica	*L. echinata*
Medicago sativa	*Medicago laciniata*
Momordica charantia	*Momordica balsamina, M. cochinchinensis and M. dioica*
Moringa oleifera	*M. concanensis*
Morus alba	*M. indica*
Murraya paniculata	*M. koenigii*
Nicotiana tabacum	*Nicotiana plumbaginifolia*
Oryza sativa	*Oryza rufipogon*
Panicum sumatrense	*Panicum psilopodium* and *Digitaria cruciata*
Pennisetum americanum	*Pennisetum purpureum*
Pisum sativum	*Lathyrus sativus*
Portulaca pilosa ssp.*grandiflora*	*Portulaca pilosa* sp. *pilosa*
Saccharum officinarum	*Saccharum spontaneum*
Setaria italica	*Setaria verticillata*
Solanum melongena	*Solanum incanum* and *S. virginianum*
Sorghum bicolor	*Sorghum helepense* and *S. verticilliflorum*
Syzygium cumini	*Syzygium jambos*
Talinum paniculatum	*Talinum portulacifolium*
Trachyspermum ammi	*Carum balbocastanum*
Trichosanthes anguina	*Trichosanthes cucumerina* and *T. dioica*

Name of the species	Wild relatives
Trifolium alexandrinum	*Trifolium resupinatum*
Trigonella foenum-graecum	*Trigonella corniculata*
Vigna dalzelliana	*Vigna aconitifolia* and *V. umbellata*
V. radiata	*Vigna trilobata*
Zea mays	*Coix aquatica and C. gigantea*
Ziziphus mauritiana	*Ziziphus oenoplia, Z. rugosa* and *Z. xylopyrus*

On the basis of occurrence of maximum number of spontaneous hybrids, it may be concluded that cereals and legumes show maximum cytogenetical relationship with wild plants. The diversity in fruit shape, size, pulp etc. and seed characters in Cucurbitaceous crops also indicate possibilities of natural hybridization and thus occupy third place. Moreover, 3.7 per cent of total flora have agri-horticultural potentiality in Rajasthan. The maximum diversity was noted for vegetable types and cereals and millets. Fruit trees also occupy reputable place, however, fibre yielding plants, spices, fodder and oil-seeds have rather poor cytogenetic affinities with wild forms.

ECONOMIC IMPORTANCE

The importance of biodiversity of a region also very much depends on its economic potentiality which determines the priority areas for conservation and input and output ratio of the expenditure done on the conservation of the ecosystem. The vegetation of Rajasthan though floristically not so diversified as that of N.E. India, Eastern Himalaya and Eastern and Western Ghats, yet a good percentage of wild flora provides food, fodder, fiber, medicines, stuffing material, alcohol and several micro-forest products like gum and resin, dye, Kattha and Cutch, oil, etc. to the local people and some of them have commercial potentiality. The uses of many more species are still hidden in the depth which will be exposed in future for the human welfare. The economically most important species in Rajasthan are as under

Food plants : The vegetation of Rajasthan contains a number of plants which are rich in nutritious contents and are consumed as food not

only during famine, but also during ordinary period. The important edible wild fruits are *Annona squamosa, Capparis decidua, Grewia subinaequalis, Aegle marmelos, Feronia limonia, Ziziphus mauritiana, Z. nummularia, Tamarindus indicus, Syzygium cumini, S. jambos, Citrullus lanatus, Cucumis melo* var. *momordica, Alangium salvifolia, Xeromphis spinosa, Madhuca indica, Mimusops hexandra, Salvadora oleoides, Cordia gharaf, Rivea hypocrateriformis, Physalis minima, Solanum nigrum, Phyllanthus emblica, Ficus benghalensis, F. palmata, Phoenix sylvestris, etc.* The seeds of *Sterculia urens, Schleichera oleosa, Buchanania lanzen, Coix lachryma-jobi, Echinochloa colonum, E. crusgalli, Panicum miliare, P. antidotale, Setaria glauca, S.tomentosa, S. verticillata, Brachiaria ramosa, Cenchrus biflorus, C. setigerus, Dactyloctenium aegyptium,* etc. are eaten raw or grounded to flour and baked. Quite a good number of wild species provide fruits which are cooked as vegetable viz. *Moringa oleifera, Canavalia gladiata, Lathyrus sativus, Phaseolus trilobatus, Cassia tora, C. obtusifolia, Prosopis cineraria, Momordica balsamina, M. dioica, Carissa congesta, Cordia dichotoma* The rhizomes of *Nelumbo nucifera,* tubers of *Ceropegia bulbosa, Dioscorea bulbifera* and *Cyperus esculentus* are also commonly cooked as vegetable. The tender leaves and shoots of *Fumaria indica, Portulaca oleracea, Amaranthus caudatus, A. viridis, A. spinosus, Digera muricata, Chenopodium album, C. murale, Commelina benghalensis, Dendrocalamus strictus,* etc. provide vegetables to the local inhabitants.

Non edible oil : Some plants yield non edible oil which is used in medicines, varnishes, paints, as lubricant in machinery, for soap making etc. The important species are *Argemone mexicana, Alhagi maurorum, Citrullus colocynthis, C. lanatus, Salvadora oleoides, Vitex negundo, Euphorbia dracunculoides, Ricinus communis, Cyperus rotundus, Cymbopogon martinii, Vetiveria zizanioides,* etc.

Gum and Resin : The chief components which yield gum and resin include: *Boswellia serrata, Commiphora wightii, Butea monosperma, Acacia nilotica, A. senegal, Prosopis cineraria, P.juliflora,* etc.

Tannin : The main tannin yeilding plants are *Tamarix aphylla, T. dioica, T. troupii, Ziziphus mauritiana, Tamarindus indicus, Acacia leucophloea, Acacia nilotica* ssp. *indica, Albizia lebbeck, Anogeissus acuminata, A. pendula,* etc.

Dye : The chief dye yielding species are *Cocculus pendulus, Peganum harmala, Abrus precatorius, Butea monosperma, Indigofera coerulea, I. tinctoria, Wrightia tinctoria, Arnebia hispidissima, Striga gesnerioides, Achyranthes aspera, Kirganelia reticulata, Phyllanthus fraternus,* etc.

Fibre : The fibre is a very important item of commerce and industry. In Rajasthan besides fibre crops of *Linum usitatissimum, Gossypium* species, *Hibiscus cannabinus* and *Crotalaria juncea,* etc., several wild plants are used by the local people to meet their demand for fibre. The main fibre yielding species are *Abutilon indicum, Aeschynomene indica, Agave americana, Bombax ceiba, Butea monosperma, Calotropis procera, Cassia auriculata, Corchorus capsularis, C. olitorius, Cordia dichotoma, C. gharaf, Crotalaria burhia, Cryptolepis buchananii, Cryptostegia grandiflora, Desmostachya bipinnata, Grewia tiliaefolia, Helicteres isora, Hibiscus vitifolius, Ichnocarpus frutescens, Imperata cylindrica, Leptadenia pyrotechnica, Pandanus fascicularis, Pavonia zeylanica, Phoenix sylvestris, Saccharum benghalense, Urena lobata,* etc.

Timber : For building articles, agricultural equipments, furniture, sports goods, boxes, packing cases, tool handles and varied house hold articles, the main commerical source of timber are *Dalbergia sissoo, Albizia lebbeck, Tecomella undulata, Tectona grandis, Bambusa arundinacea* and *Dendrocalamus strictus,* etc. However, several other species also yield valuable timber and are used by the local people and at lower scale in the timber industry viz. *Acacia catechu, A. leucophloea, A. nilotica* ssp. *indica, A. senegal, Adina cordifolia, Aegle marmelos, Albizia odoratissima, Anogeissus latifolia, Azadirachta indica, Boswellia serrata, Bridelia retusa, Butea monosperma, Cordia dichotoma, Dalbergia latifolia, D. paniculata, Diospyros melanoxylon, Holarrhena pubesecns, Holoptelea integrifolia, Hymenodictyon excelsum, Lagerstroemia parviflora, Madhuca indica, Mitragyna parvifolia, Prosopis cineraria, Soymida febrifuga, Tamarindus indica, Terminalia arjuna, T. bellerica, Wrightia tomentosa, etc.*

Fire-wood: Exploitation of plants for fire-wood has caused serious threat to some species viz. *Ephedra ciliata, Commiphora wightii* and *Tecomella undulata.* The villagers usually trek long distances to collect fuel-wood for their domestic needs and, thus, unaware of consequences, put heavy pressure on the vegetation. The other plants commonly

consumed as fire-wood due to high calorific values include *Euphorbia caducifolia, Salvadora oleoides, Capparis decidua, Prosopis cineraria, P. juliflora, Acacia nilotica* ssp. *indica, A. tortilis, Ziziphus nummularia, Anogeissus pendula* and *Calligonum polygonoides.*

Besides many other tree species, during fire-wood crisis shrubs and woody herbs like *Leptadenia pyrotechnica, Calotropis procera, Grewia tenax, Haloxylon salicornicum, Aerva javanica, Crotalaria burhia, Tephrosia purpurea,* etc. are also not exempted by the local inhabitants due to limited biomass in the state. Along the Aravalli hills, *Holoptelea integrifolia, Pongamia pinnata, Hardwickia binata, Albizia lebbeck, Butea monosperma, Cordia rothii* are mainly exploited for fire-wood.

Medicine : The therapeutic properties of plants have created world-wide interest about medicinal plants which lead to new source of drug for wide modern usage. Due to the constant association with forest environment, the tribals and other local people of Rajasthan have also accured considerable knowledge of plants and their utility for medicinal purposes. The medicinal uses of many of the plants may, however, not be known outside their restricted community. The important plants which have pharmacological potentiality include *Cocculus pendulus, Argemone mexicana, Cleome brachycarpa, C. gynandra, C. viscosa, Cadaba fruticosa, Capparis decidua, Portulaca oleracea, Bergia suffruticosa, Abutilon indicum, Sida cordifolia, S. ovata, Corchorus depressus, C. tridens, Grewia tenax, Fagonia cretica, Peganum harmala, Tribulus terrestris, Zygophyllum simplex, Oxalis corniculata, Balanites aegyptiaca, Boswellia serrata, Commiphora wightii, Abrus precatorius, Alhagi maurorum, Butea monosperma, Phaseolus trilobatus, Tephrosia purpurea, Cassia auriculata, Acacia nilotica* ssp. *indica, A. senegal, Prosopis cineraria, Citrullus colocynthis, Glinus lotoides, Dicoma tomentosa, Echinops echinatus, Salvadora oleoides, S. persica, Calotropis procera, Pergularia daemia, Enicostema hyssopifolium, Heliotropium eichwaldi, Evolvulus alsinoides, Datura metal, Solanum nigrum, S. surattense, Withania somnifera, Striga gesnerioides, Tecomella undulata, Pedalium murex, Adhatoda zeylanica, Barleria prionitis, Clerodendrum phlomidis, Vitex negundo, Ocimum americanum, Boerhavia diffusa, Achyranthes aspera, Suaeda fruticosa, Aristolochia bracteolata, Euphorbia caducifolia, E. hirta, Phyllanthus fraternus, Asparagus racemosus, Cyperus rotundus, Dactyloctenium aegyptium,* etc.

The analysis of density and abundance of economically important species for availability of raw material revealed that some species may be utilized on commercial scale and may add to the economy of the state. These species are *Calotropis procera* (bast fibre from stem for ropes and cordages), *Saccharum bengalense* (leaves as fibre for ropes), *Aerva javanica* (white woolly flowers as stuffing material), *Capparis decidua* (unripe fruits for pickle), *Phyllanthus emblica* (fruits for pickle and medicine), *Madhuca indica* (flowers for industrial alcohol), *Anogeissus latifolia* and *A. pendula* (leaves for tannin), *Cassia auriculata* (stem bark for tannin), *Acacia senegal* (gum-arabic from stem), *Diospyros melanoxylon* (edible fruits and leaves for biris), *Buchanania lanzen* (seeds as dry fruit), *Acacia nilotica* ssp. *indica* (gum from stem), *Prosopis cineraria* (gum from stem), *Commiphora wightii* (resin from stem for medicines), *Acacia catechu* and *A. chundra* (katha from heart wood), *Citrullus colocynthis* (non-edible oil from seeds for soap industry, medicine), *Plantago ovata* (seeds for medicine), *Balanites aegyptiaca* (diosgenin from roots and fruits for medicine), etc.

MAJOR THREATS

The loss of phytodiversity in Rajasthan is mainly due to its inherent eco-cycle and a number of endogenous and exogenous processes, which accelerate the erosion resulting in habitat destruction and depletion of valuable germplasm stock. Recurring drought is one of the main natural causes for loss to the biodiversity, particularly in the desert area. When drought reoccur in successive years, it results in famine and as such the vegetation cover comes under great pressure since animals eat every blade of grass and last bit of greenery, leaving behind skeleton of plants for the gatherers of fire-wood in eroded habitats. Due to the destruction of habitats more palatable and productive plants are nudged out by less desirable species.

Further, the animal husbandary is the main occupation in Rajasthan and number of domestic animals is much beyond its carrying capacity. The hungry herds of camel, sheep, cows and goats graze on freely and thus deteriorate the natural vegetation. Rearing livestock is one of the functional specialities of this state since certain castes and communities totally rely upon domestic animals for their sustenance. It is important to note that due to intense grazing, a serious change is coming about in the vegetation as a number of xerophytic plants of Afro-Arabian origin have

invaded the desertic zones of the state and their populations are on the march towards semi-arid areas in the east.

In addition, the phytodiversity is also subjected to ever-growing human population which exserts pressure on vegetation for food, fodder, fibre, micro-forest products, medicines, fire-wood, timber and various other items of domestic use. Clearing of forest for agriculture has resulted in the loss of considerable forest cover every year in the state.

Various developmental activities viz. construction of roads, railway lines, industries, hydro-electric projects, thermal power projects, etc. further produce threat to the floristic diversity. The military occupations and exploration for oil and minerals have also been responsible for habitat destruction and loss of biodiversity.

CONSERVATION STRATEGIES

Conservation has been recognised as one of the most important aspects of preserving biodiversity to maintain the most fragile ecological processes and life support system and to ensure sustainable utilization of the species and ecosystem. According to one estimate, atleast one species is being lost every day. None of us can evaluate the potential of the species we have lost so far and no human effort can ever recreate them. Therefore, the conservation of biodiversity is increasingly getting support from scinetific as well as the non scientific fields. The recent discoveries of gugulip from *Commiphora wightii* and diosgenin from *Balanites aegyptiaca* have created awareness among the people of Rajasthan to keep inviolate samples of as many types of germplasm as possible.

In-situ conservation : Since most of the threatened plants occur as components of biotic or bio-edaphic communities in open sites, restoring climax vegetation in such habitats through judicious protection measures is required without further loss of time. Equally important would be to rehabilitate fast-depleting types in ecotonal zones to ensure their stability and massive alteration of the natural ecosystems. For *in-situ* conservation of biodiversity a wide action has been taken in Rajasthan as four National Parks viz. Keoladeo National Park (Bharatpur), Ranthambhore National Park (Sawaimadhopur), Desert National Park (Jaisalmer) and Siriska Tiger Reserve National Park (Alwar) and about

12 wild-life sanctuaries namely Darrah Game Sanctuary (Kota), Jawahar Sagar (Kota), National Chambal Sanctuary (Kota), Kumbhalgarh (Udaipur), Jaisamand (Udaipur), Mt. Abu Sanctuary (Sirohi), Sita Mata (Chittorgarh), Van Vihar (Dholpur), Tal Chapper (Churu), Ramgarh Vishdhari (Bundi), Jamwa Ramgarh (Jaipur), Bhensroad (Chittorgarh) have been established to put a check on fast changing habitats and degradation of ecosystems. For more effective and wide protection of germplasm, however, more and more protected areas like Saphari National Park (Jodhpur) need to be identified through detailed floristic and ecological survey and mapping.

Ex-situ conservation : Most of the threatened species in Rajasthan are very widely scattered and in the absence of any geographical barrier, the *ex-situ* conservation of such elements is a rather stupendous task. An alternative to this is to multiply and conserve such germplasm in the botanical gardens where identical climatic and edaphic conditions may be created. In Rajasthan, recently Botanical Survey of India has established a botanical garden at Jodhpur for this purpose where depleting plant species may be multiplied by various methods and may disseminate their seeds and propagules for self propagation under semi-natural conditions. The department of Botany, J.N.V. University, Jodhpur has also been playing a vital role in the multiplication of depleting germplasm through tissue culture techniques and by re-introducing them in natural habitats through various agencies.

Through gene banks : In addition to *in-situ* and *ex-situ* conservation, long term storage of seeds as gene bank can also be undertaken. The similar cold storage modules as developed by NBPGR, New Delhi, should be established for maintaining the biodiversity. It is also necessary to have a well conceived production programme for the conservation of those threatened plants that usually don't produce viable seeds in large quantities like *Farsetia macrantha, Commiphora wightii, Ephedra ciliata,* etc.

No research alone can help to restore this biodiversity loss unless there is a political will and we educate the local population that short term gain of natural resources today will turn out to be major catastrophe of tomorrow. The principles of sustainable utilization of resources should be followed by the state Government and public then only we can expect fruitful conservation of biodiversity in this state where famine is a common phenomenon and people are forced to cause loss to the biodiversity for their survival.

Besides above, proper training to the habitat managers and data base information network system about the depleting plant resources and threatened habitats may also help a lot in successful conservation and management.

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Unstabilised barren sand-dune in western Rajasthan desert.
(Courtesy : A.S. Khan)

Partially stabilised sand-dunes in western Rajasthan desert covered with *Cyperus - Crotalaria - Aerva* and *Leptadenia - Citrullus - Calotropis* association
(Courtesy : A.S. Khan)

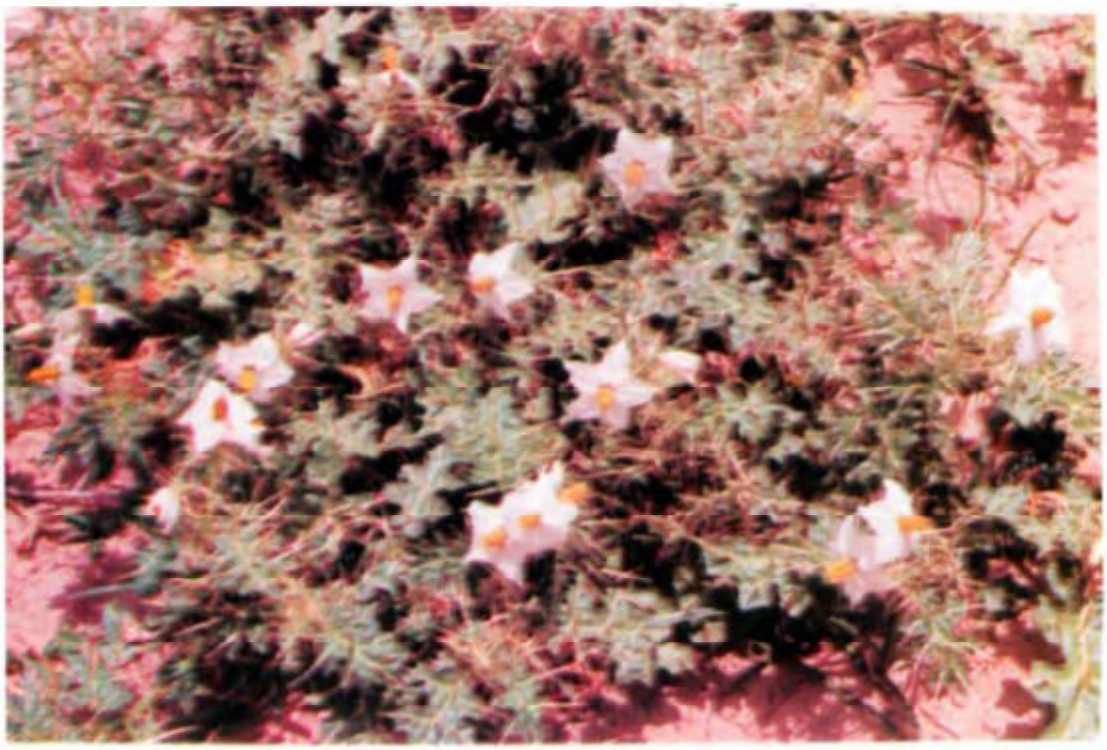
Euphorbia caducifolia : growing on rock outcrop and small hillocks in the desert
(Courtesy : A.S. Khan)

Dichrostachys cineraria : often forms dense pure stands in dry deciduous forest
(Courtesy : A.S. Khan)

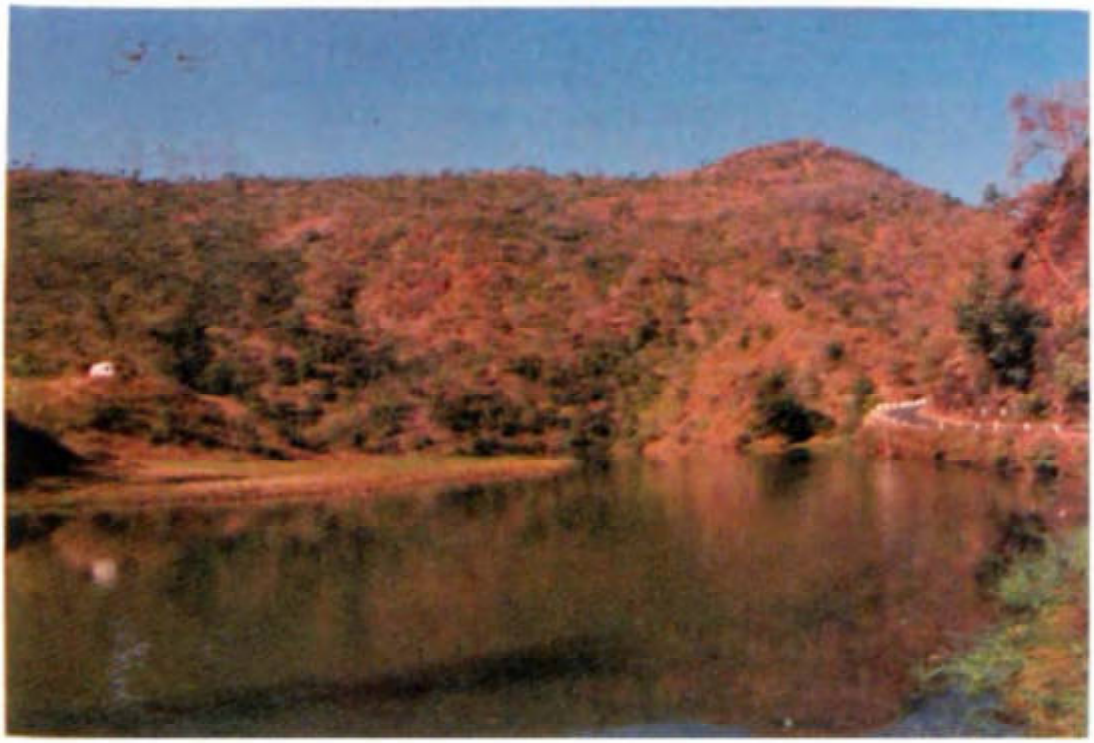
Mixed dry deciduous forest on Aravalli hills
dominated by *Anogeissus pendula*.
(Courtesy : A.S. Khan)

Mixed dry deciduous degraded forest on Aravalli outlines
(Courtesy : A.S. Khan)

Melhania futteyporensis var. *major* : a rare plant struggling for survival
(Courtesy : A.S. Khan)



Solanum virginianum : wild relative of *S. melongena* showing gene level diversity
(Courtesy : A.S. Khan)



Degraded forest in catchment area of Pichola lake : the main source of siltation to the wetland
(Courtesy : A.S. Khan)

Habitat destruction and depletion of germplasm due to climatic and biotic factors
(Courtesy : A.S. Khan)

Prosopis cineraria : a state tree and boon to local people due to its economic values
(Courtesy : A.S. Khan)

Barren Aravalli hill range giving appearance of sand-dunes :
a typical degraded habitat due to over
exploitation of forest cover
(Courtesy : A.S. Khan)

Habitat destruction due to mining activities.
(Courtesy : A.S. Khan)

Tecomella undulata : a characteristic timber species under threat
(Courtesy : A.S. Khan)

SIKKIM

Paramjit Singh
A.S. Chauhan

Sikkim - a small beautiful state of India-located between 27° 05 28° 09 N latitude and 87°57' - 88°56 E longitude, having an area of around 7096 sq km is known as paradise of naturalists. It is a horse - shoe shaped wedge between Nepal in the west, Bhutan in the east and Tibet in the north and north-east. In the south it is bordered by West Bengal's Darjeeling district. The mountain chains which run southwards from the main Himalayan ranges form the natural boundaries of Sikkim; the Chola range dividing it from Tibet in north-east and Bhutan in the south-east; the Singalela range likewise separating it from Nepal in the west, with the east-west axis of the great Himalayas forming the barrier between Sikkim and Tibet in the north. Mountain passes along these ranges over the years have sustained a two way traffic of traders, pilgrims and adventurers from Tibet and Central Asia. The most renowned of these passes are Nathu La (4392 m), Jelep La (4388 m), Donkia La(5520 m), Kongra La (4809 m.).

The topography of Sikkim is quite varied. The elevation ranges from *ca* 250 to 8598 m, with almost no flat piece of land anywhere. Mt. Khanchendzonga (8598 m) the world's third highest mountain, is sacred to the Sikkimese as their guardian diety and considered as the holiest of the holy.

Teesta and Rangeet are two main rivers which flow in a north to south direction through,gorges and valleys along whose ridges and slopes there is higher concentration of population (Total population 4,06,457 as per 1991 Census).

Such mountainous land, as Sikkim provides a great variety of habitats, and this is reflected in the richness of its flora and fauna. The animals in the state are estimated to comprise 144 species of mammals, like Bhral, Clouded leopard, Snow leopard, Leopard cat, Red Panda, Musk deer, Great Tibetan Sheep, Tibetan Antelope, Tibetan Fox, Wild Ass, over 1000 species of Butterflies and moths. Flowering plants comprise about 4500 species, fern and fern allies account for more than 350 species.

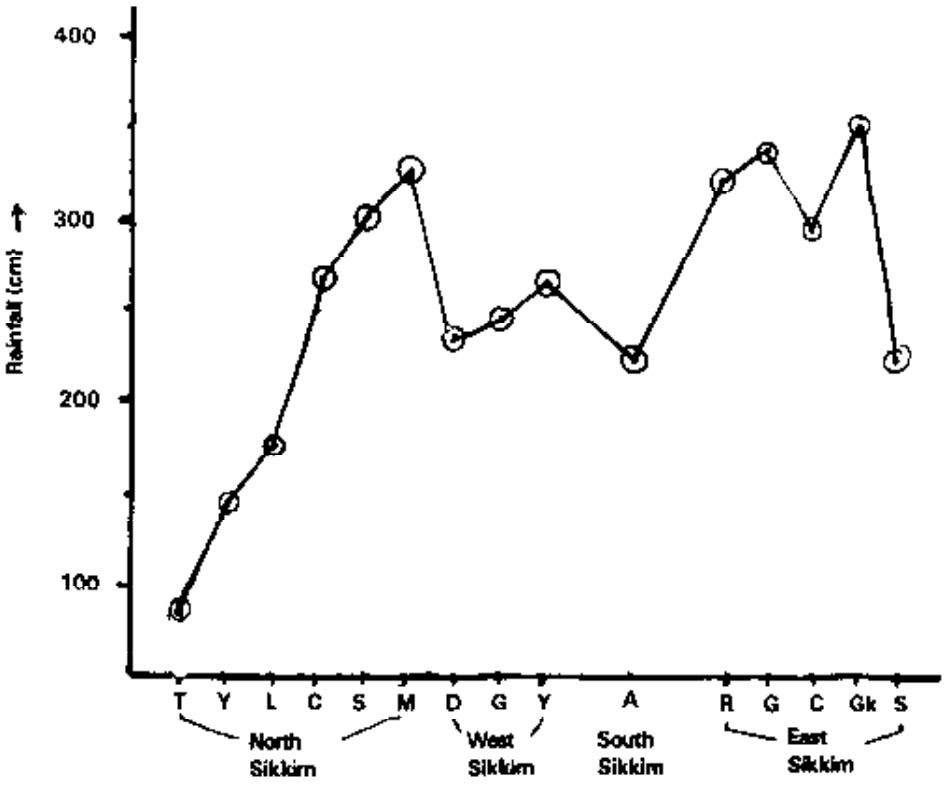
The vegetation changes from tropical and subtropical much of which has already been cleared for cultivation, however, wherever it survives, it is dominated by Sal-upwards through middle hills with much coniferous and Oak forest of temperate character to the higher slopes with sub-alpine scrub and stony alpine 'meadows' generally related to the high mountain flora of the north temperate zone.

Sikkim encompasses the lesser Himalaya. Central Himalaya and the Tethys Himalaya (Raina and Srivastava 1981). Major part of Sikkim is covered by Precambrian rocks which are geologically, 'younger units of palaeozoic age' The Southern area has sedimentary and metasedimentary rock. The physical configuration of Sikkim is partly due to its geological structure. The north eastern and western portions of the state are constituted of hard massive gneiss rock capable of resisting denudation. The south and central region are chiefly formed of comparatively soft thin slates and half schistern rock which denudes very easily.

The trend of the mountain system as a whole is east-west direction. The boundary ridges, however, run in a more or less north- south direction, i.e. Singalila and Chola ridge, and another north-south ridge in the central portion seperates the Rangeet Valley from the Teesta valley. The glaciers are as low as 4000 m and those near Khanchendzonga may be as low as 3700 m. The perpetual snow line is about 5000 m above msl.

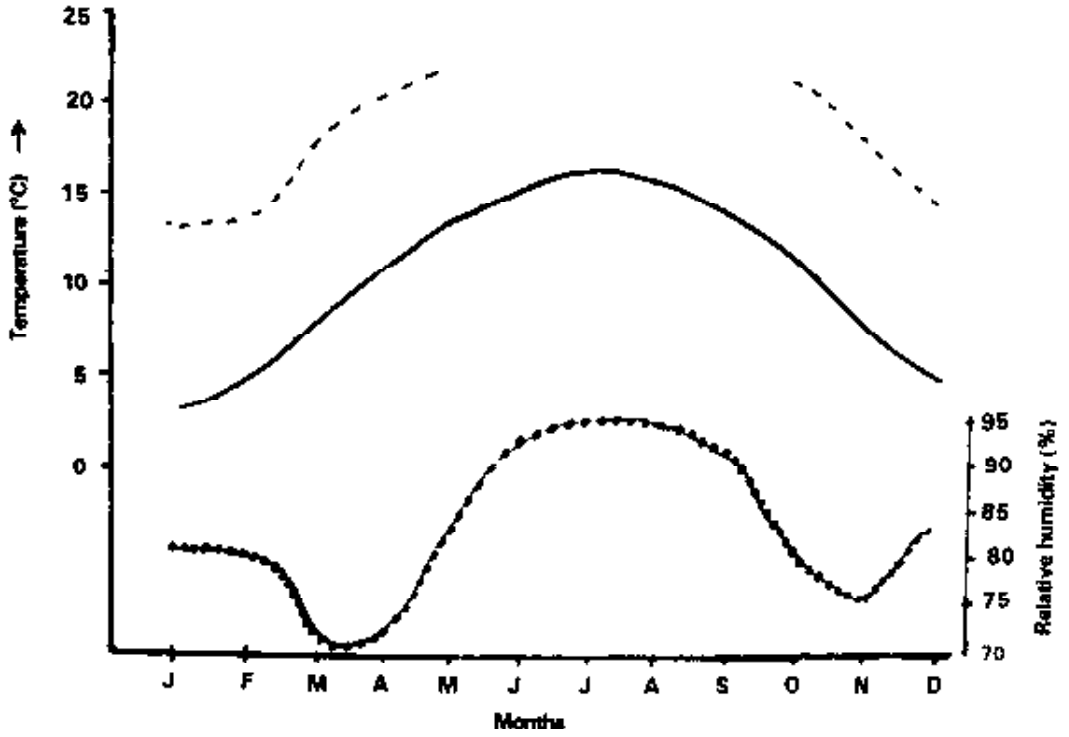
Sikkim has been known to be the most humid region in the whole range of the Himalaya, because of its proximity to the Bay of Bangal and direct exposure to the south-west monsoon. The rainfall varies from 200 - 500 cm in most of its inner valleys except for its northern most region which receives scanty rainfall.

Throughout the year, but particularly from June to September, monsoon brings heavy rainfall the state. Lower hills and valleys enjoy a subtropical climate, warm in winter, hot and extremely humid in summer. Towards the interior the climate becomes gradually more temperate with cool winters and hot summers and often heavy rainfall. In the northern part of the state summers are short and cool, and the winters with considerable snowfall and frost. Table **Ia, Ib** shows annual rainfall in different districts of Sikkim and mean daily, maximum and minimum temperature and relative humidity.



Legends :
North Sikkim : T = Thangu, Y = Yumthang, L = Lachen, C = Chungthang, S = Singhik, M = Mangan.
West Sikkim : D = Dentam, G = Gayzing, Y = Yoksum,
South Sikkim A = Damthang.
East Sikkim. R = Rongli, G = Gnathang, C = Changu, Gk = Gangtok, S = Serathang.

Ia. Annual Rainfall in different districts of Sikkim.



Ib. Mean daily maximum (-------) and minimum (_____) temperature (^{o}C) and Relative humidity (.....) at Gangtok. (Source: Anonymous, 1992).

VEGETATION

Sikkim has attracted the attention of many botanist. From very early times, particularly in 19th and early 20th centurie, it was visited by eminent botanists like J.D. Hooker, C.B. Clarke, G. King, W.W. Smith, G.H. Cave, J.M. Cowan, R. Pantling, G. A. Gammie, D. Prain, B. Osmaston, I.H. Burkill and others. (Hooker, (1849 51, 1854), Anderson (1869), King and Pantling (1898), Smith and Cave (1911), Champion (1936, 1968).

The state supports luxuriant tropical, temperate and alpine vegetation. Its unique geographical position, varied topography, high annual precipitation, make the area one of the richest botanical treasure houses of the country. The vegetation of Sikkim can be broadly classified as follows

1. Tropical forest
2. Subtropical forest
3. Temperate forest and
4. Alpine forest

1. Tropical forest

The vegetation occuring up to 900 m consists mainly of tropical moist deciduous to semi-evergreen species with Sal(*Shorea robusta*) as a dominant species. These forest occur at low altitude bordering with West Bengal in Teesta and Rangeet valleys. The characteristic species of these forest are *Aglaia lawii, Alstonia neriifolia, A. scholaris, Artocarpus* spp. *Bombax ceiba, Chukrasia tabularis, Duabanga grandiflora, Eugenia kurzii, Ficus* spp., *Mangifera sylvatica, Pterospermum acerifolium, Shorea robusta, Terminalia* spp., *Tetrameles nudiflora*. The shrubs and undershrubs of tropical zone are *Barleria cristata, B. strigosa, Buddleja asiatica, Clerodendrum japonicum, C. viscosum, Coffea benghalensis, Justicia procumbens, Pavetta indica, Phlogacanthus thyrsiflorus*, etc. Amongst the lianas and climbers a few can be mentioned such as, *Beaumontia grandiflora, Bauhinia vahlii, Chonemorpha fragrans, Cryptolepis buchananii, Entada rheedei* ssp. *sinohimalensis*, etc. Formerly there were magnificent Sal forest along the Rangeet, but they had to give way to the need for agriculture land for growing population. Still in some tracts along Teesta and Rangeet rivers these forest are common.

Interestingly, at some places in dry valleys of South Sikkim, Chir pine (*Pinus roxburghii*) Forest - which are generally found in subtropical to temperate regions elsewhere can also be seen thriving well with associated species like *Shorea robusta, Cycas pectinata, Ficus oligodon, Grewia sapida. Phoenix humilis, Rhus parviflora, Woodfordia fruticosa,* etc. Along the river banks *Saccharum, Oroxylum indicum and Meizotropis buteiformis* are quite common.

2. Subtropical forest

These forest are confined at elevation from 800 m - 1500 m especially along the Teesta and Rangeet rivers and their tributaries. These are mainly mixed forest comprising of. *Adina cordifolia, Alangium chinense, Alnus nepalensis, Bischofia javanica, Callicarpa arborea, Castanopsis indica, Eurya cerasifolia, Fraxinus floribunda, Ficus* spp., *Gynocardia odorata, Helicia nilagirica, Macaranga denticulata, Magnolia hodgsonii, Michelia velutina, Mangifera sylvatica, Saurauia nepalensis, Vernonia volkameriifolia,* etc. Interestingly some species like *Engelhardtia spicata, Exbucklandia populnea* and *Schima wallichii*, are also seen in these forest. These tree species show profuse growth, reaching upto height of 30 m. As such no single species can be said to be dominant in these forest . Predominant shrubs in these forests are, *Buddleja asiatica, Clerodendrum* spp. *Embelia floribunda, Mussaenda roxburghii, Melastoma malabaricum* and *Vitex negundo,* etc. Climbing species of *Piper, Smilax, Tetrastigma, Cissus* and *Rhapidophora* are common in the area. Ferns and fern allies along with species of orchids constitute predominant epiphytic flora of this region. These forest also harbour rich germplasm of Orchids. The thickets of *Calamus, Musa* and *Pandanus*, form dense patches in humid and exposed areas along with bamboo thickets. Tree fern, *Cyathea* is found here and there in moist shady places. Exotic weeds like *Eupatorium* sp. *Lantana* sp. and *Mikania micrantha* grow profusely in disturbed forest areas.

3. Temperate forest

These forest are found between 1500 - 3500 m altitude in Lachen and Lachung Valley. These forest can be further classified into (a) Broad leaved forest and (b) Coniferous forest.

(a) Broad leaved forest

The main components of broad leaved tree species in Sikkim are *Acer campbelli, Betula utilis, Engelhardtia spicata, Exbucklandia populnea, Ilex dipyrena, Juglans regia, Populus ciliata, Prunus nepalensis, Malus sikkimensis, Quercus lineata, Q. lanata, Q. lamellosa, Q. oxydon, Q. glauca, Lithocarpus pachyphylla, L. elegans*, etc. Oak forest are characteristic feature of this zone. Laurels are not uncommon in this zone.

Shrubby vegetation is quite dense in temperate forest and comprise of *Berberis umbellata, B. wallichiana, Elaegnus umbellata, Gaultheria fragrantissima, Piptanthus nepalensis, Princepia utilis, Rhododendron grande, R. falconeri, Hippophae salicifolia, Maddenia himalaica, Pieris formosa, Rubus macilentus, Rosa sericea, Viburnum erubescens , Zanthoxylum oxyphyllum,* etc. Several herbs like *Anemone vitifolia, Arisaema consanguineum, A. jacquemontii, Ajuga lobata, Aster tricephalus , Cardamine impatiens, Chrysosplenium nepalense, Clintonia alpina, Disporum pullum, Fragaria vesca, Galium mollugo, Hemiphragma heterophyllum , Panax pseudo- ginseng, Swertia chirayita, Primula denticulata, Tiarella polyphylla, Valeriana wallichii* are common in these forest. The climbers include *Aristolochia griffithii, Celastrus stylosa, Hedera helix, Holboellia latifolia, Jasminum dispermum, Leptocodon gracilis*. Besides, *Coelogyne ochracea, Saccolabium gammatum* and species of *Cymbidium,* and *Vaccinium*, etc. constitute the epiphytic flora of these forest.

(b) Coniferous forest

The predominant trees in coniferous forest are *Abies densa Larix griffithiana, Picea spinulosa, Tsuga dumosa* and *Juniperus* sp. These forest are common in Lachen Valley, Zemu Valley, Lachung Valley and Yumthang Valley. At some places in North and West Sikkim pure strands of *Taxus wallichiana* can also be seen.

The undergrowth in these forest comprises of *Acer caudatum, Berberis wallichiana, Enkianthus deflexus, Euonymus frigidus* and species of *Gaultheria, Lonicera, Prunus, Rhododendron, Ribes, Rosa, Rubus* and *Spiraea,* etc. The predominant shrubs are constituted by several species of *Rhododendron*. It has been observed that at several cleared places

Maddenia himalaica, Pieris formosa, Piptanthus nepalensis and *Viburaum erubescens* form the dominant component in these forest.

In higher temperate zones pure Rhododendron forest are also common and constitute the unique feature in the vegetation of Sikkim.

Plantation of *Cryptomeria japonica* have been extensively raised on degraded areas between 1500-2400 m altitude. These plantation support very little undergrowth.

4. Alpine forest

This zone ranges from 3500 - 5000 m. The lower altitudes of this zone support shrubby species of *Rhododendron, Berberis, Cotoneasters. Diapensia himalaica, Euonymus, Gaultheria, Salix* and *Vaccinium*, etc., while *Rhododendron anthopogon* and *R. setosum* form dense tussocks near the sub- alpine mountain tops. Among the herbaceous flora species of *Aconitum, Arenaria, Anaphalis, Astragalus, Bryocarpum, Cassiope, Corydalis, Epilobium, Lychnis, Meconopsis, Pedicularis, Potentilla, Polygonatum, Primula, Rhodiola, Sedum and Rheum*, etc. are common. Besides, the plants of great medicinal value, viz. *Aconitum ferox, A. gammiei, A. bisma*, etc. are common in Zemu Valley, in Lachen Valley and Lachung Valley.

At higher elevations of Alpine Zone, as in areas like Thangu in Lachen Valley or Yome-samdong in Lachung Valley, the vegetation comprises typical alpine moorland where tree growth is completely arrested. The stunted bushy growth along these slopes consists of tough clumps of *Juniperus squamata, Rhododendron lepidotum, R. anthopogon, R. setosum, Salix calyculata, S. oreophila, S. lindleyana, Myricaria germanica, Cotoneaster microphylla, Berberis concinna, B. macrosepala, Rosa sericea, Lonicera tomentella*, etc. and interesting *Rhododendron nivale*, which bears the honour of being the most alpine woody plant in the Himalayas growing up to an altitude of 5400 m.

Llonakh Valley situated in extreme north-west and Chholamau plains in northeast of the state have unique flora of its kind. It has more affinity with Tibetan than Himalayan flora. The open flats which are nothing but sort of extention of plateau, abound in dwarf woody prostrate species of

Berberis, Spiraea, Lonicera, Hippophae and *Salix*, etc. Among the herbaceous species, the Arenarias are the most striking with their hemispheric mounds covered with white flowers. *Poterium filiforme, Primula sikkimensis, P. tibetica*, and species of *Pedicularis* flourish in the moist areas. On drier flats species of *Saussurea, Delphinium, and Arabis glandulosa, Leontopodium hasstioides , Anaphalis xylorhiza, Lancea tibetica, Elsholtzia eriostachya*, etc. spring up from April to July every year. Among the grasses and sedges, species of *Carex, Kobresia, Eleocharis, Elymus, Festuca, Stipa, Poa*, etc. are commonly seen in the area. In screes, sheltered from the wind by boulders, dwarf Rhododendrons with Junipers and some herbaceous species, like *Anemone, Callianthemum, Draba, Saxifraga, Sedum, Rhodiola, Gentiana* and *Allium*, etc. can be seen in this region. In the marshy lands *Callitriche verna, Dilophia salsa, Glaux maritima, Hippuris vulgaris, Ranunculus aquatilis, Przwelskia tangutica*, and fine clumps of yellow *Pedicularis* are commonly found. On the higher cliffs the vegetation consists of species of *Braya, Cortia, Draba, Lonicera hispida, Meconopsis horridula, Saussurea* sp., *Saxifraga imbricata , S. ramulosa, S. saginoides, Leontopodium monocephalum, Tanacetum gossypinum, Waldheimia glabra* and *Salix lindleyana*, etc.

FLORISTIC DIVERSITY

The floral diversity of Sikkim is fascinating because of species richness and diverse community structure. Approximately 4500 species of flowering plants have been estimated to find representation in this region. As many as 362 species of ferns and fern allies have been reported from Sikkim himalayas (Mehra and Bir, 1964). An analysis of Gymnosperms also show considerable presence in Sikkim (Table II) (Singh *et al.*, 1995). An analysis of ten dominant families of flowering plants clearly indicates the floristic richness of this state (Table III). Intensive survey in Khanchendzonga National Park, Pangolakha range (East Dist.); Dombyong Valley, Lashes valley, Tankara La, Sakyong Valley, Tolung, Zemu and Llonakh Valley (North Dist.); Karchi, Hilley R.F., (West Dist.); Tendong, Melli, Chitam R.F., Mainam R.F., (South Dist.) would further increase the knowledge about our flora of Sikkim. Table IV shows the genera which are predominantly represented in Sikkim.

Table II
Number of genera and species of gymnosperms

Genera	No. of Species		Percentage
	India	Sikkim	
Abies	4	2	50
Cupressus	3	1	33
Cycas	4	1	25
Ephedra	8	1	13
Gnetum	5	1	20
Juniperus	5	3	60
Larix	1	1	100
Picea	3	1	33
Pinus	7	2	28
Podocarpus	2	1	50
Tsuga	1	1	100
Taxus	1	1	100

Table III
Ten dominant families of flowering plants

Sl.No.	Family	No. of Species		Percentage
		India	Sikkim	
1.	Orchidaceae	1229	494	45
2.	Asteraceae	803	280	26
3.	Poaceae	1291	271	22
4.	Leguminosae (*s.l.*)	1141	201	20
5.	Cyperaceae	545	143	27
6.	Rosaceae	432	138	28
7.	Scrophulariaceae	368	112	26
8.	Rubiaceae	616	110	17
9.	Lamiaceae	435	95	21
10.	Euphorbiaceae	523	94	21

Table IV
Genera predominantly represented

Name of the genera	No. of Species		Percentage
	India	Sikkim	
Bulbophyllum	90	43	48
Calanthe	23	17	74
Coelogyne	39	17	44
Cymbidium	23	16	70
Dendrobium	90	36	40
Gentiana	54	33	61
Juncus	44	36	82
Pedicularis	100	43	43
Polygonatum	16	12	75
Primula	102	56	55.
Rhododendron	55	35	64
Saussurea	65	30	46
Saxifraga	80	50	32
Swertia	35	19	54

The flora of Sikkim is very rich both in luxuriance and diversity. The plant diversity of lower reaches of the area is well known, while the total number of taxa found at higher elevations, especially in the Khanchendzonga National Park, still remains *Terra incognita.* The region abounds in a number of primitive taxa, viz. *Exbucklandia, Houttuynia, Magnolia, Michelia* and several species of Annonaceae, Myrsinaceae, Piperaceae, Lauraceae, etc. It also harbours botanical curiosities like *Balanophora involucrata, B. dioica, B. polyandra, Helwingia himalaica, Rhopalocnemis phalloides, Aeginatia indica, Pinguicula alpina, Drosera peltata, Ephedra gerardiana* var. *sikkimensis, Utricularia,* spp. etc. It is imperative to mention here that inspite of its terrestrial contiguity with surrounding area, it harbours considerable number of endemics, e.g. *Anemone demissa* var. *monantha. Ranunculus sikkimensis, Uvaria lurida* var. *sikkimensis, Berberis umbellata* var. *branii, Mahonia sikkimensis, Podophyllum sikkimensis* and *Rhododendron sikkimensis, Astragalus zemuensis, Caragana spinifera, Anaphalis cavei. Anaphalis hookeri, A. subumbellata, Bluma sikkimensis, Cacalis chola, Cremanthodium*

palmatum ssp. *benthamii*, *Crepis atropappa*, *Inula macrosperma*, *Jurinea cooperi*, *Lactuca cooperi*, *Ligularia kingiana*, *L. pachycarpa*. Besides, some of the representative endemic species of Eastern Himalayas, which also occure in Sikkim, such as *Abies densa*, *Agapetes incurvata*, *A. sikkimensis*, *Betula utilis*, *Dipsacus atratus*, *Eriobotrya hookeriana*, *Geum macrosepalum*, *Larix griffithiana*, *Lindera heterophylla*, *Liparis perpusilla*, *Lloydia flavonutans*, *Maddenia himalaica*, *Meconopsis grandis*, *M. superba*, *M. villosa*, *Myricaria albiflora* , *Primula whitei*, *Rhododendron baileyi*, *R. camelliaeflorum*, *R. ciliatum*. *R. glaucophyllum*, *R. grande*, *R. lanatum*, *R. lindleyi* , *R. wallichii*, *R. wightii*, *Rubus fragarioides*, *Saussurea conica*. Besides, follwing genera, viz. *Bryocarpum*, *Gamblea*, *Lepidostemon*, *Parajaeschkaea*, *Paroxygraphis*, *Pleurospermopsis*, *Sphaerosacme*, *Treutlera* endemic to Eastern Himalaya are also represented in Sikkim.

Sikkim is also equally rich in Orchidaceae and Asteraceae, being represented by *ca* 490 and 280 species of these families, respectively. Some ornamental taxa, which are prized all over the world are *Aerides fieldingii*, *A. multiflora*, *A. odorata*, *Anoectochilus sikkimensis*, *Arachnis cathcartii*, *A. clarkei*, *Arundina graminifolia*, *Calanthe masuca*, *Coelogyne corymbosa*, *C. cristata*, *Cymbidium cyprifolium*, *C. elegans*, *C. iridioides*, *C. munronianum*. *Cyperipedium elegans*, *C. himalaicum*, *C. macranthon*, *Dendrobium chrysanthum*, *D. chrysotoxum*, *D. densiflorum*, *D. formosum*, *D. hookerianum*, *D. nobile* , *D. sulcatum*, *Paphiopedilum fairieanum*, *P. venustum*, *Phaius flavus*, *P. mishmiensis*, *P. tankervilliae*, *Pleione maculata*, *P. praecox*, *Rhynchostylis retusa* and *Vanda* ssp. Due to over exploitation most of these orchids have dwindled considerably in their natural habitats and several of these are seen only in Orchidaria or in private orchid nurseries.

These forest are also rich in wild species of cultivated plants such as species of *Amomum*, *Atylosia*, *Cinnamomum*, *Coffea*, *Piper*, *Musa*, *Mangifera*, *Saccharum*, *Elymus*, *Hordeum*, etc.

The state also hosts several rare and endangered taxa. These are being depleted at an alarming rate, perhaps due to sensitive dispersal mechanism, severe biotic interferences and competition with exotic weeds. Therefore, the state has already been identified as one of the HOT SPOT areas of the country. Some examples of such taxa are, *Aconitum novoluridum*, *Calamus inermis*, *Cyathopus sikkimensis*, *Magnolia globosa*, *Soulia vaginata*, *Cypripidium macranthon* , *C. elegans*, *C.*

himalaicum, Angiopteris evicta, Arachnis cathcartii, A. clarkei, Cyathea gigantea, Livistona jenkinsiana, Phoenix rupicola, Impatiens tuberculata, Begonia gemmipara, B. rubella, B. scutata, Codonopsis affinis, Nardostachys grandiflora, Paphiopedilum fairieanum, Rhododendron nivale. R. lanatum, Hoya edeni, Treutlera insignis, Primula glabra, Liparis distans and species of *Saussurea* spp., etc.

PHYTOGEOGRAPHY

Hooker (1906) attributed the floristic diversity of the Indian subcontinent "To the immigration of plants from widely different bordering countries, notably Chinese and Malayan on the east and south, of Oriental, European and African on the west and of Tibetan and Siberian on the north" In the light of the above, some interesting phytogeographic elements in the flora of Sikkim are discussed below. These elements are purely descriptive and a full assessment of floristic elements can be made only after external distribution of all the taxa of Sikkim are worked out and analysed on a non selective basis.

South East Asian-Malaysian elements

The floral elements of Myanmar, Thailand, Indo-China, Malaya, Malaysia and Indonesia are found in the Tropical and Sub tropical forest. These elements include *Actinidia callosa, Ampelocissus barbata, Bischofia javanica, Calamus* sp., *Cycas pectinata, Debregeasia longifolia, Duabanga grandiflora, Engelhardtia spicata, Eria paniculata, , Exbucklandia populnea, Lithocarpus elegans, Mangifera indica, Musa balbisiana, Myrica esculenta, Oroxylum indicum, Podocarpus neriifolius* and *Magnolia hodgsonii.*

Sino Himalayan Japanese elements

The close links between temperate floras of the Himalaya, China and Japan have been recognised since long. Each of these regions has numerous endemic taxa and many other taxa extend over two or three of the regions, or are replaced by closely allied taxa in others. The Himalayan region is typical in this respect, in having both many endemic taxa and many other ranging east to China and Japan. The endemic taxa of each region could be classed as Himalayan, Chinese or Japanese phytogeographic elements, but so many other taxa overlap between the regions that such boundaries appear to be quite arbitrary and have little meaning. Some

elements range eastwards only to south-east Tibet, others into China and few as far as Japan and similarly extend to varying degrees at their western limits. Thus, overall pattern is perhaps better pictured as a series of overlapping ranges than as clearly defined geographical elements within these regions. (Grierson and Long 1983).

The following are six examples of main patterns of distribution within the Himalayan -Chinese - Japanese phytogeographical elements found in Sikkim.

Taxa distributed from Western Himalaya to Japan

This group contains a smaller number of taxa. Some of the species are *Cardiocrinum giganteum, Cornus macrophylla, Houttuynia cordata, Hypoxis aurea, Luzula plumosa, Malus baccata, Monotropastrum humile, Pleurospermum, Rhus javanica, Streptolirion volubile, Symplocos paniculata*, etc.

Taxa distributed from Western Himalayas to China

This is one of the two largest groups in the flora of Sikkim. The examples are *Acer oblongum , Acronema , Allium pratii, Alnus nepalensis, Anemone rupicola, Arisaema tortuosum, Astilbe rivularis, Coriaria nepalensis, Cotonearter microphyllus, Daphne bholua, Desmodium elegans, Deutzia compacta, Elsholtzia fruticosa, Fragaria nubicola, Galeola lindleyana, Gaultheria trichophylla, Hedera nepalensis, Holboellia angustifolia, Ilex dipyrena, Iris decora, Juniperus recurva, J. squamata, Leptocodon gracilis, Leycesteria formosa, Myrsine semiserrata, Nardostachys grandiflora, Ophiopogon intermedius, Paris polyphylla, Photinia integrifolia, Piptanthus nepalensis, Pleione praecox, Podophyllum hexandrum, Princepia utilis, Prunus cerasoides, Pyrus pashia, Quercus semecarpifolia, Rhus succedanea, Ribes takare, Rosa sericea, Rubus biflorus, R. calycinus, Sabia campanulata, Sauraia nepaulensis, Schefflera elata, Sinocrassula indica, Spiraea bella, Streptopus simplex, Triosteum himalayanum.*

Taxa distributed throughout the Himalaya and absent from China and Japan

This is also quite prevalent group in the flora of Sikkim. The illustrative species of this group are *Acer sterculiaceum, Anisadenia*

saxatilis, Arisaema intermedium, Cortia depressa, Delphinium brunonianum, Deutzia staminea, Edgaria darjeelingensis, Eriobotrya dubia, Fragaria daltoniana, Gypsophila cerastioides, Jasminum nepalense, Lindera pulcherrima, Lonicera obovata, Mahonia napaulensis, Parnassia nubicola, Pinus roxburghii, Potentilla lineata, Rhododendron anthopogon, R. barbatum, R. campanulatum, Rhus wallichii, Rosa macrophylla, Rubus nepalensis, R. paniculatus, Schisandra grandiflora, Sorbus cuspidata, Sorbus foliolosa, S. microphylla, Spiraea canescens, Thermopsis barbata, Tsuga dumosa.

Taxa distributed from the Eastern Himalaya to Japan

Most of the taxa of this group do not extend to China and western Himalaya and are restricted to Eastern Himalaya to Japan area, for example *Enkianthus, Helwingia, Rodgersia, Stachyurus, Tiarella polyphylla.*

Taxa distributed from the Eastern Himalaya to China

The illustrative examples are as follows. *Allium sikkimensis, Aspidocarya uvifera, Betula alnoides, Campylandra aurantiaca, Cardamine griffithii, Cassiope selaginoides, Chrysosplenium griffithii , Cinnamomum obtusifolium, Coelogyne corymbosa, Diapensia himalaica, Entada rheedei* spp. *sinohimalensis, Gentiana stylophora,* Ilex fragilis, I. intricata, Itea macrophylla, Leycesteria gracilis, Litsea cubeba L. kingii. L. sericea, Luzula effusa, Meconopsis napaulensis.

Taxa distributed in E. Himalaya only.

Amongs the Sino-himalayan-japanese elements, this group is one of the dominant groups. Some of the examples are discussed under the title endemic taxa.

Peninsular elements

These elements are mainly represented in tropical belt and are relatively few in number, examples are *Bauhinia vahlii, Dendrophthoe falcata, Ficus benghalensis, Murraya koenigii, Plumbago zeylanica, Thunbergia coccinea* and *Woodfordia fruticosa.*

Tibetan elements

The Tibetan elements is mainly xerophytic and greatly differs from that of Himalayan mainly because of low rainfall and high altitude. Some of these Tibetan elements extend into North Sikkim, e.g. *Allium fasciculatum, Arabis glandulosa, Arenaria bryophylla, Braya tibetica, Chesneya nubigena Cortiella hookeri, Dracocephalum speciosum, Ephedra gerardiana, Hippophae tibetana. Hypecoum leptocarpum, Kobresia schoenoides, Lancea tibetica, Phlomis rotata, Przewalskia tangutica, Rheum spiciforme, Saussurea gossypiphora, S. obvallata*, etc.

Euro-siberian elements

Number of temperate and alpine zone species of Sikkim are of European and Siberian origin. The Himalayan region is separated from Euro- siberian region by the Tibetan and central Asian plateau but a number of its characteristic species and genera reappear in the temperate and alpine zone of mountain regions of South and East Asia. A few such examples found in Sikkim are *Cimicifuga foetida, Cucubalus bacciferus, Polygala sibirica, Potentilla anserina, Thlaspi arvense, Veronica anagallis, Viola biflora*,

Arctic - alpine elements

These species are widespread in Arctic regions and also found at high altitudes on some of the high mountain ranges of Europe and Asia including Sikkim Himalaya, in disjunct fashion, e.g. *Bistorta vivipara, Carex atrofusca, C. microglochin, Juncus triglumis, Koenigia islandica, Oxyria digyna, Pinguicula alpina, Sagina saginoides, Thalictrum alpinum*, etc.

ENDEMISM

Chatterjee (1939) made detailed studies on the endemism in the indian flora He observed that number of endemics in Himalaya are 3165 out of a total of 6850 endemics in India. In other words, Himalaya has a very high percentage of Indian endemics (about 46 %). Several species which were described from Sikkim, and thought to be endemic, have been collected from other parts of Himalaya later on. The number of species growing exclusively in Sikkim has yet to be determined. It is estimated that around 3% of the plants are endemic in Sikkim. Full assessment of

endemic taxa can be made only after external distribution of all the taxa of Sikkim are worked out and analysed. However, a few examples are mentioned below.

The genus *Brachycaulos* is exclusively endemic to Sikkim and genus *Cyathopus* is endemic to Sikkim and Western Bhutan whereas the following endemic genera of the eastern Himalaya also occur in Sikkim. Some of such genera are, *Aucuba* (Cornaceae), *Bryocarpum* (Primulaceae) *Gamblea* (Araliaceae), *Lepidostemon* (Brassicaceae), *Parajaeschkaea* (Gentianaceae), *Paroxygraphis* (Ranunculaceae), *Pleurospermopsis* (Apiaceae), *Risleya* (Orchidaceae), *Sphaerosacme* (Meliaceae) and *Treutlera* (Asclepiadaceae). Endemic plants of Sikkim are represented on Table V.

Table V
Endemic plants

A. Plants strictly endemic to Sikkim	
Acronema pseudotenera	Apiaceae
Anaphalis cavei	Asteraceae
A. hookeri	Asteraceae
A. subumbellata	Asteraceae
Anemone demissa var. *monantha*	Ranunculaceae
Angelica nubigena	Apiaceae
Arenaria thangoensis	Caryophyllaceae
Astragalus zemuensis	Leguminosae
Berberis umbellata var. branii	Berberidaceae
Blumea sikkimensis	Asteraceae
Cacalis chola	Asteraceae
Calamus inermis	Arecaceae
Caragana spinifera	Leguminosae
Carex kingiana	Cyperaceae
Codonopsis affinis	Companulaceae
Coelogyne treutleri	Orchidaceae
Cremanthodium palmatum ssp. *benthamii*	Asteraceae
Crepis atropappa	Asteraceae
Inula macrosperma	Asteraceae
Juncus sikkimensis	Juncaceae

Jurinea cooperi	Asteraceae
Lactuca cooperi	Asteraceae
Ligularia kingiana	Asteraceae
L. pachycarpa	Asteraceae
L. yakla	Asteraceae
Mahonia sikkimensis	Berberidaceae
Podophdyllum sikkimensis	Podophyllaceae
Ranunculus sikkimensis	Ranunculaceae
Rhododendron sikkimensis	Ericaceae
Uvaria lurida var. *sikkimensis*	Annonaceae

B. Eastern Himalayan endemics in Sikkim

Abies densa	Pinaceae
Agapetes incurvata	Ericaceae
A. sikkimensis	Ericaceae
Betula utilis	Betulaceae
Dipsacus atratus	Dipsacaceae
Eriobotrya hookeriana	Rosaceae
Geum macrosepalum	Rosaceae
Larix griffithiana	Pinaceae
Lindera heterophylla	Lauraceae
Liparis perpusilla	Orchidaceae
Lloydia flavonutans	Liliaceae
Maddenia himalaica	Rosaceae
Meconopsis grandis	Papaveraceae
M. superba	Papaveraceae
M. villosa	Papaveraceae
Myricaria albiflora	Tamaricaceae
Primula whitei	Primulaceae
Rhododendron baileyi	Ericaceae
R. camelliaeflorum	Ericaceae
R. ciliatum	Ericaceae
R. glaucophyllum	Ericaceae
R. grande	Ericaceae
R. lanatum	Ericaceae
R. lindleyi	Ericaceae

R.wallichii	Ericaceae
R. wightii	Ericaceae
Rubus fragariodes	Rosaceae
Saussurea conica	Asteraceae

ECONOMIC PLANT

The rich and diverse plant wealth of Sikkim provides a rich source of food, medicine, oil, fuel and other products consumed by mankind. Some of the important plant species are mentioned below, according to their utility.

Wild edible Plants: In Sikkim traditional crops like Rice, Buckwheat. Maize and Patato are grown on terraces whereas millets are raised by Lepchas on mountain slopes. Vegetables like Cabbage, mustard, beans, potato and native herbs are also cultivated to some extent in the temperate zone. Only wild arum, wild onion,barley and some himalayan herbs are available in alpine zones where Bhutias survive. The native plants used for human consumption can be described under following categories.

Leafy vegetables: Whole plants or young shoots and flower buds of *Bauhinia variegata, Mussaenda roxburghii, Phlogacanthus thysiflorus, Musa balbisiana, Casearia glomerata, Begonia rubrovenia, Smilacina oleracea, Dendrocalamus hamiltonii, Embelia gamblei* are commonly used as leafy vegetable. *Hottuynia cordata, Tupistra nutans, Cissus repens, Indigofera atropurpurea, Vaccinium vacciniaceum* are some common plants used by Lepchas of Sakyong valley whereas species of *Impatiens, Polygonum, Aconogonum, Bistorta* and *Rheum* are much relished by Bhutias.

Edible fruits: These include fruits eaten raw or cooked and include species like *Clausena willdenowii, Actinidia strigosa, Saurauia napaulensis, Schisandra grandiflora, Holboellia latifolia, Decaisnea insignis, Rosa macrophylla, Evodia fraxinifolia, Podophyllum hexandrum, Ampelocissus latifolia, Cayratia carnosa. Cissus adnata, Cissus repens, Tetrastigma bracteolatum, Vitis heyneana.*

Edible seeds: Kernels of *Juglans regia, Castanopsis* spp., *Quercus* spp., *Dendrocalamus hamiltonii, Aglaia edulis*, aril of *Baccaurea spida*,

Taxus wallichiana and pulp of *Benthamidia capitata* are also relished by natives.

Seeds as source of edible oil: *Bombax ceiba, Bassia butyracea* Roxb, *Abroma augusta, Bauhinia vahlii, Princepia utilis, Corylus ferox* and *Hodgsonia macrocarpa* are common species used for edible oil.

Beverages: are made from *Coffea benghalensis, Camellia kissii* Wallich, *Eurya acuminata, Rhododendron arboreum*, whereas sweet sap of *Arundinaria* spp., and *Bambusa* species are also exploited in making wine. Cultivated finger millet *Eleucine indica*, is the common source of traditional drink "CHIYANG" in Sikkim.

Medicinal Plants

Sikkim harbours rich diversity of medicinal plants which are being used in different ways by local inhabitants for example *Abies densa, Aconitum heterophyllum, A. palmatum, Artemisia nilagirica, Asparagus racemosus, Astilbe rivularis, Begonia laciniata, Berberis aristata, Bergenia purpurascens, Betula utilis, Cissampelos pareira, Costus speciosus, Curculigo orchioides, Dicentra thalictrifolia, Dichroa febrifuga, Drymaria cordata, Ephedra gerardiana* var. *sikkimensis, Heracleum nepalensis, Iris nepalensis, Juniperus recurva, Huperzia serrata, Nardostachys grandiflora, Picrorhiza scrophulariflora, Podophdyllum hexandrum, Potentilla fulgens, Pratia begonifolia, Rheum australe, Rhus insignis, Rumex nepalensis, Skimmia laureola, Swertia chirayita, Valeriana hardwickii, V. jatamansi, Zanthoxylum alatum*, etc. The common names and uses of some important species are presented in Table VI.

Table VI
Medicinal Plant

Name of the species with vernacular name	Family	Uses
Aconitum ferox Bikh, Bikhma (Nep.)	Ranunculaceae	Roots used in rheumatism
Acorus calamus Bhojo (Nep.)	Araceae	Fresh rhizome is applied on the forehead during fever, also used in skin disease.

Name of the species with vernacular name	Family	Uses
Artemisia nilagirica Titaypatee (Nep.)	Asteraceae	Extract used on cuts and bruises to stop bleeding, mostly used in nose bleeding.
Astilbe rivularis Bodu Okhati (Nep.)	Saxifragaceae	Flowers are edible, Roots are used to cure dysentry and diarrhoea.
Bergenia ciliata Pakhanbed (Nep.)	Saxifragaceae	Chewed during diarrhoea and vomiting.
Centella asiatica Gotpatta, Ghoratapray (Nep.)	Apiaceae	Decoction of aerial parts taken orally to cure blood pressure.
Clematis buchanania Pinasay Lahara (Nep.)	Ranunculaceae	Mashed roots are used to cure nasal congestion.
Dichroa febrifuga Basak (Nep.)	Hydrangeaceae	Decoction of leaves taken orally to cure fever.
Drymaria cordata Abijal (Nep.)	Caryophyllaceae	Juice considered as laxative and antifebrile.
Eupatorium cannabinum Banmara, Kalijhar (Nep.)	Asteraceae	Leaves extract used on cuts and bruises to stop bleeding and infecion
Ficus semicordata Rai Khaniu, Khasray Khaniu (Nep.)	Moraceae	Latex from bark is applied on boils.
Fraxinus floribunda Lnakoore (Nep.)	Oleaceae	Bark applied on gout after boiling. Book exudate used as laxative.
Heracleum wallichii Chimping (Nep.)	Apiaceae	Fruits made into paste and used in cough. Root is said to be tonic.

Name of the species with vernacular name	Family	Uses
Litsaea cubeba Siltimmur, Timur(Nep.)	Lauraceae	Fruits used dried or fresh in stomach disorders.
Nardostachys grandiflora Jatamansi (Nep.)	Valerianaceae	Underground portion is used to cure hair loss, epilepsy, palpitation.
Oroxylum indicum Totala (Nep.) Paksam (Bhut.)	Bignoniaceae	Seeds are considered pious and used in religious ceremonies by Bhutias. Dry seeds used in throat infections.
Panax pseudo-ginseng	Araliaceae	Roots are considered aphrodiasic.
Paederia foetida Biri (Nep.)	Rubiaceae	Extract of fruits is used during toothache.
Phytolacca acinosa Jaringo (Nep.)	Phytolaccaceae	Fresh leaves used orally during bodyache.
Picrorhiza scrophulariflora Pennell. Kutki (Nep.)	Scrophulariaceae	Dried roots used to cure fever, also used as catharitic, purgative and dyspepsia.
Podophyllum hexandrum Papri (Nep.)	Podophyllaceae	Roots decoction is used as purgative.
Przewalskia tangutica	Solanaceae	Dried roots used to cure swelling and spasms.
Pteris biaurita Thaday Uniu (Nep.)	Pteridaceae	Extract of stems applied on cuts and wounds to stop bleeding and infection.
Rheum emodi Padamchal (Nep.)	Polygonaceae	Roots are used as a purgative and astringent tonic.

Name of the species with vernacular name	Family	Uses
Rhus semialata Bhakimlo (Nep.)	Anacardiaceae	Extract of dried fruits used in diarrhoea and dysentry
Rumex nepalensis Halhaley (Nep.)	Polygonaceae	Extract of roots used in liver complaints. Also used to cure loss of hair.
Swertia chirayita Karst. Chirowto (Nep.)	Gentianaceae	Decoctions of leaves and stems used orally in fever.
Thysanolaena maxima Amliso (Nep.)	Poaceae	Root paste applied to Check boils.
Urtica dioica Sisnu (Nep.)	Urticaceae	Root paste applied on minor bone fractures and dislocations.
Viscum articulatum	Loranthaceae	Paste of the entire plantis applied on minor bone fractures.

MAJOR THREATS

The diverse forest along with perennial streams support magnificent fauna consisting of Snow leopard, Clouded leopard, Marbled cat, Black bear, Red panda, Red fox, Tibetan wild ass, Yaks. Over 400 types of birds, over 450 types of butterflies and moths. This diversity is being threatened to some extent in certain areas due to easy accessibility, large scale extraction of medicinal herbs, illegal poaching and encroachment in the natural habitat. In some instances where cardamom cultivation is in practice, people abandon the forest area after few crops of the cardamom as a result forest turns into unproductive waste land. In some places forest fire, landslides have also played a vital role in dwindling of certain taxa. These factors along with the timber exploitation and grazing have resulted in genetic erosion of the land races in some areas of the region. The area is well populated with the total population of 4,06,457 as per 1991 census

amounting to about 77 persons per sq km Lachung and Lachen Valley have cent percent tribal population, Bhutias and Lepchas being the main tribes living in the area. Trade in medicinal plants legally as well as illegally is important source of cash earning for local people in these valleys. Out of large number of plant species collected, mention may be made of *Picrorhiza scrophuliflora*, *Nardostachys grandiflora*, *Aconitum* spp., *Swertia chirayita*, *Podophyllum hexandrum wallichiana*. It is reported that one family sells medicinal plants worth Rs. 10,000/- in a year. It is also estimated that during 1990-91 around 31,000 kg. of *Nardostachys*, 10720 kg. of *Aconitum* sp. and 6200 kg. of *Picrorhiza* have been extracted from the wild habitats in Sikkim (Rai and Sharma, 1994). This extraction is also causing threat to the vegetation of the areas especially in higher reaches. As the state is strategically located, there is a strong deployment of the armed forces in the area. Their activities have also contributed to some extent in depletion of the flora at higher altitudes. However, there is increased awareness among Army and they have started taking up eco-restoration works at fragile areas of hill ecosystem.

Besides, uneven competition with exotic weeds, sensitive dispersal mechanism and inability to sustain critical level of population due to production or germination of less number of seeds have made native plants extremely prone to various degrees of threats. Red Data Book of Indian Plants Vol. I - III (Nayar and Sastry, 1987, 1988, 1990) have recorded following species from Sikkim, which need immediate attention for conservation. (Table V)

Table V
Some Endangered Plants in the Sikkim Himalaya

Name of the species	Family	Status
Acer hookeri var. *majus*	Aceraceae	Endangered
A. osmastoni	Aceraceae	Endangered
Aconitum ferox	Ranunculaceae	Vulnerable
Acronema pseudotenera	Asteraceae	Indeterminate
Angelica nubigena	Apiaceae	Indeterminate
Aphyllorchis parviflora	Orchidaceae	Rare
Arenaria thangoensis	Caryophyllaceae	Vulnerable

Name of the species	Family	Status
Begonia rubella	Begoniaceae	Rare
B. satrapis	Begoniaceae	Rare
B. scutata	Begoniaceae	Rare
Bulleyia yunnanensis	Orchidaceae	Rare
Calamus inermis	Arecaceae	Endangered
Calanthe alpina	Orchidaceae	Rare
C. mannii	Orchidaceae	Rare
Carex kingiana	Cyperaceae	Indeterminate
Ceropegia hookeri	Asclepiadaceae	Endangered
C. lucida	Asclepiadaceae	Endangered
Cissus spectabilis	Vitaceae	Endangered
Codonopsis affinis	Campanulaceae	Rare
Coelogyne treutleri	Orchidaceae	Extinct.
Cotoneaster simonsii	Rosaceae	Indeterminate
Cymbidium eburneum	Orchidaceae	Vulnerable
C. hookerianum	Orchidaceae	Vulnerable
C. whiteae	Orchidaceae	Endangered.
Cypripedium elegans	Orchidaceae	Rare
C. himalaicum	Orchidaceae	Rare
Didiciea cunninghamii	Orchidaceae	Endangered
Dioscorea deltoidea	Dioscoreaceae	Vulnerable
Diplomeris hirsuta	Orchidaceae	Vulnerable
Juncus sikkimensis	Juncaceae	Rare
Lagerstroemia minuticarpa	Lythraceae	Rare
Lactuca cooperi	Asteraceae	Endangered.
Livistona jenkinsiana	Arecaceae	Endangered
Lloydia himalensis	Liliaceae	Rare
Nardostachys grandiflora	Valerianaceae	Vulnerable
Ophiorrhiza lurida	Rubiaceae	Rare
Paphiopedilum fairrieanum	Orchidaceae	Endangered
P. venustum	Orchidaceae	Vulnerable
Panax pseudo ginseng	Araliaceae	Vulnerable

Name of the species	Family	Status
Phoenix rupicola	Arecaceae	Rare
Picrorhiza kurrooa	Scrophulariaceae	Vulnerable
Pimpinella tongloensis	Apiaceae	Endangered.
P. wallichii	Apiaceae	Endangered
Pternopetalum radiatum	Apiaceae	Indeterminate
Rhopalocnemis phalloides	Balanophoraceae	Rare
Zeuxine pulchra	Orchidaceae	Endangered

CONSERVATION

To Conserve the rich biodiversity of this region, there is urgent need to create a network of continums of protected areas. At present Khanchenjunga National Park, Fambonglho Wildlife Sanctuary, Shingba Rhododendron Sanctuary, Varshey Rhododendron Sanctuary, Kyangnosla Wildlife Sanctuary, Mainom Wildlife Sanctuary are examples of isolated patches of protected areas in Sikkim and even these areas are under various degrees of biotic pressure. There are some botanical gardens in the state wherein both *ex-situ* conservation measures are being attempted e.g. Jawahar Lal Nehru Botanical Garden, Rumtek, Botanical Garden, Saramsa and Orchid Sanctuary, Deorali. Moreover various sacred groves located in different parts of the state like Kabi Sacred grove (North Sikkim), Khechiperi sacred grove (West Sikkim), Tandong Sacred grove (South Sikkim) and Churten Sacred grove (East Sikkim), being part of cultural heritage of the people of Sikkim, are playing an important role in conservation of natural biodiversity of the region.

History of Sikkim indicates that Lepchas the original inhabitants of this region, have been forest dwellers and lived in harmony with nature. Earlier workers remarked with astonishment on the knowledge of these people about the plants and animals. For most of the plant species they have a different local name. Since early part of this century agriculture and other communities came as a steady wave to colonize these hills and settled here. Population increase at a rate of 28.47 % between 1981 and 1991 has put a lot of pressure on forest areas. More human habitations have come up throughout the state and network of roads has been created to connect even remote hemlets in the forest areas. The increase in

population is leading to unplanned and unprecedented growth of town centres and plantations putting a strain on the natural resources of the area. Too much emphasis on tourism is also adversly affecting the natural vegetation. In addition over exploitation for commercial purpose has caused the depletion of some species of natural vegetation. For instance *Nardostachys grandiflora*, *Swertia* sp., *Aconitum* sp. and *Picrorhiza* sp. have been over extracted from the wild habitats in Sikkim.

The state of Sikkim harbours rich and varied flora and fauna. This diversity and heterogeneity of plant life is manifest with high degree of economic potential. Some of these plants are being threatened due to various authropogenic and biotic factors. Conservation prudent management of the genetic stocks like those of Orchids, Rhododendrons, Canes and Bamboos and various other economic plants as well as rare and endemic plants is urgntly called for. It is forewarned that unless *in situ* conservation methods are practised at the potential germplasm sites in species rich areas, it will be extremely difficult to safeguard the rich diversity of this beautiful state.

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Subtropical forest in south Sikkim

Rhododendron fulgens in east Sikkim

Impatiens pradhanii in west Sikkim

Heracleum nepalense in west Sikkim

Rheum nobile : north Sikkim
(Courtesy : G.P. Sinha)

Abies spectabilis : female cones, west Sikkim

TAMIL NADU

V. Chithra
V.J. Nair

Tamil Nadu with a geographical area of 1,30,058 Sq km is situated on the south eastern side of Indian Peninsula. The State lies between 8°5'-13°35'N Latitude and 76°15' 80°20'E Longitude. It is bounded on the north by Karnataka and Andhra Pradesh, on the south by the Indian Ocean, on the east by the Bay of Bengal, in the west by the Arabian Sea and the States of Kerala and Karnataka. The state occupies 4.08 percent of the total area of the country. It has a coast line of 990 Km and a land boundary of 1200 Km. A chain of twenty coral islands namely Shingle, Krusadai, Pullivasal, Pulli, Manauli, Musal, Muli, Valai, Talairi, Appa, Shuli, Uppu Tanni, Kairya, Vilangu, Koswari, Van and Pandyan and several reefs extend along the northern shore of the Gulf of Mannar. These are collectively known as Rameswaram and Krusadai group of islands. These islands are of a calcareous framework of dead corals and coral reefs. The southernmost island-Pandyan Tivu is now connected to the mainland by a major port "New Tuticorin" The famous pilgrimage centre, Rameswaram is situated in the Gulf on the island of Pamban. Some of them are separted from one another by only short distances of shallow waters. During low tide when water recedes the demarcation between them disappears.

The State is now divided into the following 22 districts. Chengai MGR, Coimbatore, Dharmapuri, Kanyakumari, Madurai, Dindugal-Anna, Nagapattinam-Quaid E Millat, Nilgiri, N. Arcot-Ambedkar, Periyar, Pudukkottai, Ramanathapuram, Kamarajar, Pasumpon Thevar Thirumagan, Salem, S. Arcot-Vallalar, Tiruchirappalli, Thanjavur, Tirunelveli-Kattabomman, Thiruvannamalai-Sambuvarayar, Chidambaranar, Viluppuram-Ramasamy Padayachi.

The geographical area of the State has a roughly rhomboidal appearance with the longer diagonal of it stretching from Pulicat lake in the north to Kanyakumari in the south and the shorter diagonal from Gudalur in the west to Point Calimere in the east.

The landmass of the State falls under two natural divisions, viz. the eastern coastal plain and the hilly region along the north and the west.

(i) The coastal plain : It can be sub-divided into (a) the coromandel plain comprising the districts of Chengai MGR, South Arcot-vallalar and North Arcot-Ambedkar (b) the alluvial plain of the Kavery delta extending over Thanjavur and part of Tiruchirapalli districts (c) the dry Southern plains in Madurai, Ramanathapuram, Kamarajar, Dindigul-Anna, Kanyakumari, Pasumpon Thevar Thirumagan and Tirunelveli-Kattabomman Districts (d) the inner plains comprising districts of Dharmapuri, Salem, North Arcot-Ambedkar and Madurai. Along the coast, at places like Mahabalipuram, Mandapam and Kanyakumari outcrops of rocky head-lands are present. A narrow belt of sand dunes rising to about 10 m is found on the Tuticorin coast. Further south in Tirunelveli-Kattabomman, red sand hills, locally known as 'teris' rise to 50 m above mean sea level. Typical coral-reefs occur at Pamban islands- at the head of the Gulf of Mannar on the east coast.

(ii) The hilly region along the north and the west : Along the whole length of the western part, at a distance from the sea varying from 80 to 160 Km runs the range of Western Ghats, a steep and rugged mass averaging 1220 m above the sea level and rising to 2554 m at Mukurti and 2637 m at Doddabetta in Nilgiris. It has tropical evergreen, semi-evergreen and deciduous forest, as well as Savannahs intermixed with cultivated lands and settled areas in the valleys. The Eastern Ghats from Andhra Pradesh cut across the State to meet the Nilgiri hills. The 'Palghat gap' about 25 Km in width is the only marked break in the W. Ghats. To the south of this gap, the range is called Anamalai and Cardamon hills. On the east of W. Ghats are Pulneys which are an offshoot of Anamalais. Kodaikanal, a famous hill station, is situated on Palni hills. Other prominent groups of hills are Javadi, Shevaroys, Kalrayans and Pachamalais. All these form a chain of low, flat-topped hills. Nilgiris and Anamalai are hill groups with the maximum height.

Slopes of Western Ghats are the sources of many rivers which flow eastwards towards the Bay of Bengal. Of these, Palar, Cheyyar, Ponnaiyar, Kavery, Meyar, Bhavani, Amaravati, Vaigai, Chittar and Tamaraparni are perennial rivers, whereas, Vellar, Noyal, Suruli, Gundar, Vaipar, Varparai and Varshali are non-perennial ones. All these rivers are rain fed. Kavery which rises from Brahmagiri in Coorg is the biggest river of the State. It travels the entire breadth of Tamil Nadu and forms a large delta at its mouth in Thanjavur district making it the "granary of Southern India" Tambaraparni also has deltaic deposits at its mouth.

Along the coast, here and there, there are but a few lakes, lagoons and marshy lands. The Buckingham canal, which connects river Krishna in Andhra Pradesh with Chennai, passes through some of them. Veeranam lake in South Arcot is one of the biggest lakes in the State.

VEGETATION

The great plant wealth and diversity of Tamil Nadu is due to the immense variety of climate, altitude and edaphic factors. Vegetation of the State can be broadly divided into four categories:

I Coastal vegetation
II Island vegetation
III Vegetation of the interior plains
IV Vegetation of the hills and mountains.

The vegetation dealt under each category is based on Champion and Seth (1968), modified in the light of additional information available.

I COASTAL VEGETATION

The entire coast of Tamil Nadu, is chiefly sandy with outcrops of rocky headlands at Mahabalipuram, Mandapam and Kanyakumari. There are some tidal creeks and flats at the riverine mouths of which the Vellar and Kavery complex are significant. At the mouths of the rivers and numerous creeks, extensive mud and saline flats with the formation of proestuarine vegetation is noticeable particularly at Pichavaram, Tuticorin and adjoining areas. Coral reefs are found at Mandapam, Tuticorin and Kanyakumari where the substratum is hard with high percentage of Calcium carbonate. The coastal vegetation can be subdivided into Strand, Estuarine types (Rao and Sastry 1972, 1974 and Rao et al. 1975) and Coastal tropical dry evergreen forest types (Nair and Vivekananthan 1983).

1. Strand vegetation

This can be further classified into strand sand, strand rock and strand coral types. Each sub-type is typical in its discontinuous plant groupings, edaphic characteristics and the indicator plants.

Strand sand

In this type, soils are coarse sandy with the pH ranging from 6.7 to 7.3. The vegetation here has four zones (Rao et al. 1975).

(i) Open pioneer zone: *Cyperus arenarius, Gisekia pharnaceoides, Glinus oppositifolius, Hydrophylax maritima, Ipomoea pescaprae, Launaea sarmentosa, Polycarpaea corymbosa, Rothia indica, Sesuvium portulacastrum, Spinifex littoreus, Tribulus terrestris,* etc. are common.

(ii) Closed herbaceous zone: Soils are fine sand or rarely coarse sand. pH ranges from 7 to 7.2. *Alternanthera pungens, Atriplex repens, Blumea obliqua, Boerhavia diffusa, Borreria articularis, Chloris barbata, Croton bonplandianum, Euphorbia* spp., *Geniosporum tenuiflorum, Glinus oppositifolius, Heliotropium curassavicum, Leucas* sp., *Mollugo nudicaulis, Pennisetum pedicellatum, Setaria pumila, Trachys muricata, Vernonia cinerea,* etc. are common.

(iii) Middle mixed zone or bushy zone: Soils are loamy sand. pH ranges from 7 to 7.2. *Caesalpinia bonduc, Calotropis gigantea, Carissa spinarum, Cassia auriculata, Clerodendrum inerme, Indigofera oblongifolia, Jatropha glandulifera, J. gossypifolia, Tephrosia purpurea, Waltheria indica,* etc. are commonly found.

(iv) Inner woodland zone: Soils are loamy sand or clayey loam with the pH ranging from neutral to 7.3. *Borassus flabellifer, Calophyllum inophyllum, Carissa spinarum, Drypetes sepiaria, Mimusops elengi, Pandanus fascicularis. Phoenix pusilla, Prosopis cineraria, Reissantia indica, Scutia myrtina, Thespesia populnea, Toddalia asiatica,* etc. are some of the common plants of this zone. At some places *Anacardium occidentale, Casuarina equisetifolia* and *Cocos nucifera* are cultivated. This woodland zone almost approaches the Carnatic umbrella thorn forest of Champion and Seth (1968).

Strand rock

The vegetation can be classified under four heads.

(i) Exposed rocky low-lying reefs: Soils have a pseudo-crumb structure and rich Calcium carbonate percentage (68.81%). Usually the

pH is around 7.8 and the organic matter content is very low. Red, brown and green marine algae are common in this area. The marine angiosperms usually found here include *Cymodocea rotundata, C. serrulata, Enhalus acoroides, Halophila ovalis, H. stipulacea* and *Syringodium isoetifolium.*

(ii) Rocky relief: It consists of mostly exposed rocky lateritic boulders with thin mantle of sand in crevices or weathered surfaces. This type is found at Kanyakumari and its neighbourhood. *Atriplex repens, Boerhavia diffusa, Cenchrus ciliaris, Chloris virgata, Chlorophytum laxum, Cyperus pachyrrhizhus, Fimbristylis cymosa, Halopyrum mucronatum, Indoneesiella echioides, Ipomoea asarifolia, Phyllanthus maderaspatensis, Scilla hyacinthina, Tridax procumbens,* etc. are commonly found.

(iii) Less rocky to gravelly or sandy areas: The soils are coarse sand. pH value is 6 to 7. *Aristolochia bracteolata, Atriplex repens, Cassia nigricans, Ipomoea pescaprae, Launaea sarmentosa, Polycarpaea corymbosa, Portulaca quadrifida, P. pilosa, Urginea congesta,* etc. are the common plants met with in such areas.

(iv) Inner woodland zone: *Lantana camara* var. *aculeata, Lepisanthes tetraphylla, Sapindus emarginatus,* etc. are common.

Strand coral

It can be divided into four zones.

(i) Open pioneer zone: Soils are coarse sand. pH value varies from 6.1 to 7.2. *Avicennia officinalis, Atriplex repens* and *Salicornia brachiata* are commonly found.

(ii) Raised coral rocks with crannies: Soils are coral sand. pH is from 7.2 to 8.2. *Halopyrum mucronatum, Polycarpaea spicata* and *Sporobolus tremulus* are the common species.

(iii) Closed herbaceous zone: Soils are coarse sand mixed with coral sand. pH is from 7 to 7.6. *Eragrostis riparia, Fimbristylis cymosa, Scaevola plumieri, Sporobolus spicatus* and *S. virginicus* are common.

(iv) Inner woodland zone: Plant groups characteristics of this zone are similar to those of inner woodland zone described under 'strand sand'

2. Estuarine vegetation

This type of vegetation is generally called as 'mangrove' According to Champion and Seth (1968) it is termed as tidal swamp forest. Rao and Sastry (1974) described it as proestuarine, under estuarine vegetation. In Tamil Nadu typical estuarine vegetation is absent. The Kavery estuarine complex is a composite type of proestuarine vegetation covering an area of nearly 14,897 hectares comprising Chatram, Coleroon, Kille, Muthupet, Pichavaram and Talaignayar. Here one encounters a vegetation mosaic responding to the nature of the relief and ebb and flow of tides. Proestuarine vegetation can be divided into the following sub-types.

(i) Tidal mangroves: The substratum is muddy relief under tidal influence and the soil is clayey of considerable depth varying from semifluid mud to stiff clay. Soil aeration is very poor. The components are shrubs and trees. *Aegiceras corniculatum, Avicennia marina, A. alba, A. officinalis, Ceriops decandra, Rhizophora apiculata* and *R. mucronata* are commonly found.

(ii) Euhaline: This includes typical salt tolerant shrubs and herbs growing under wet or dry conditions. Soils are sandy loam or silty loam with mild to strong alkalinity and containing fairly high amount of organic matter. *Acanthus ilicifolius, Aeluropus lagopoides, Arthrocnemum indicum, Clerodendrum inerme, Cressa cretica, Salicornia brachiata, Sesuvium portulacastrum, Suaeda maritima* and *S. monoica,* etc. are common plants.

(iii) Prohaline: In this sub-type there is a mixing of salt-water from the sea and freshwater from the rivers resulting in conditions favourable for the growth of salt tolerant fresh water plants such as *Barringtonia racemosa, Bruguiera cylindrica, Cerbera manghas, Dalbergia spinosa, Derris trifoliata, Excoecaria agallocha, Scyphiphora hydrophyllacea* and *Sonneratia apetala.*

3. Coastal tropical dry evergreen forest type

Restricted to the coastal region from Tirunelveli northwards are the tropical dry evergreen forest. These are low forest with trees of 9-12 m height forming a complete evergreen canopy. Leaves are coriaceous and the crowns spreading. The forest may have deciduous elements and is without a marked canopy layer. Common woody plants found in such forest

are *Atalantia monophylla, Breynia vitisidaea, Calophyllum inophyllum, Canthium parviflorum, Carissa spinarum, Drypetes sepiaria, Ehretia aspera, E. microphylla, Erythroxylum monogynum, Lannea coromandelica, Manilkara hexandra, Mimusops elengi, Mundulea sericea, Murraya paniculata, Pleurostylia opposita, Pterolobium hexapetalum, Sapindus emarginatus and Walsura trifolia*. Large climbers are *Canavalia gladiata, C. virosa, Mucuna atropurpurea* and *M. pruriens*. Some of the other common elements are *Canthium dicoccum, Capparis zeylanica, Cayratia carnosa, Hygonia mystax, Leptadenia reticulata, Memecylon umbellatum, Toddalia asiatica, Tylophora indica* and *Xeromphis malabarica*. Parasites like *Cassytha filiformis, Dendrophthoe falcata* and *Viscum orientale* are frequently found. *Vanda tessellata* is a common epiphytic orchid. This forest type is found in Vedharanyam and Talaignayar R.F., Thanjavur (Daniel, 1967; Sebastine and Ellis 1967; Blasco and Legris 1974).

II ISLAND VEGETATION

Vegetation of Rameswaram and Krusadai group of islands consists of forest of tropical thorny umbrella type, degraded to low open scrub formation due to severe biotic and climatic causes (Rao et al. 1963). It can be mainly grouped under two categories namely mangrove and strand formations. Based on their edaphic features these can be further subdivided into the following distinct units.

1. Foreshore sandy habitat

The soils are loose and light, coarse sandy and coloured dull white. Their main constituents are shell fragments and disintegrated coral rocks. *Atriplex repens, Ipomoea pes-caprae* (dominating strand creepers), *Scaevola plumieri, Sesuvium portulacastrum* and *Spinifex littoreus* are commonly found in such areas.

2. Inland sandy habitat

The soils resemble that of foreshore sandy habitat, but better protected than it and support more luxurient vegetation. *Borassus flabellifer, Breynia rhamnoides, Calotropis gigantea, Cassytha filiformis, Clerodendrum inerme, Dodonaea viscosa, Indigofera oblongifolia, Pandanus* sp., *Salvadora persica, Thespesia populnea,* etc. are the common plants encountered here.

3. Salt marsh habitat

Salt marshes are usually with a white incrustation of salts. Total soluble salts and Sodium chloride contents are very high. Only plant communities and associations highly tolerant to salts grow in this habitat. *Apluda mutica, Arthocnemum* spp., *Atriplex repens, Avicennia officinalis, Eremopogon foveolatus, Fimbristylis* sp., *Salicornia* sp., *Sporobolus tremulus* and *Suaeda* sp. are common.

4. Mangrove habitat

The soil is semi-muddy coral sand with some cohesion. It contains hardy roots and decomposing foliage. *Avicennia officinalis, Bruguiera conjugata, Ceriops tagal, Lumnitzera* sp. and *Rhizophora* sp. are common. Sometimes, when muddy shore is replaced by coral stone, *Pemphis acidula* (indicator of coral rock) is seen adjacent to the mangrove zone.

5. Maritime habitat

The soil is sandy with some decomposed and decomposing organic matter from the flora and fauna present there. Numerous algae and a few phanerogams are found there. *Enhalus acoroides, Cymodocea* spp. and *Halophila* spp. are encountered.

III VEGETATION OF THE INTERIOR PLAINS

The vegetation of the plains at the foot or on the undulating slopes of hills and hillocks in the rocky area bordering the coastal plain comes under Southern tropical thorn forests of Champion and Seth (1968). These are often called as 'Scrub jungles' They are found in Chengalpattu, North and South Arcot, Pudukkottai, Tiruchirappalli, Tirunelveli and less so in Salem and Coimbatore Districts. In these scattered forests, trees hardly reach 10 m in height and are often armed with spines and prickles. Most of the plants manifest several xeromorphic features. The common trees are *Acacia chundra, A. horrida, A. leucophloea, A. nilotica* ssp. *indica, Albizia amara, Azadirachta indica, Chloroxylon swietenia, Dalbergia spinosa, Dichrostachys cinerea, Limonia acidissima, Plecospermum spinarum, Strychnos nux-vomica, S. potatorum, Wrightia tinctoria* and *Ziziphus* spp. The shrubs commonly met with are *Cadaba fruticosa, Capparis zeylanica, Carissa congesta, Cassia auriculata, Flacourtia indica, Maytenus emarginata, Pisonia aculeata, Scutia myrtina,*

Securinega leucopyrus and *Toddalia asiatica*. The common climbers are *Cardiospermum canescens, C. halicacabum, Ceropegia candelabrum, C. juncea, Cissus quadrangularis, C. repanda, Cissampelos pareira* var. *hirsuta, Dioscorea* spp., *Leptadenia reticulata, Pergularia daemia* and *Ventilago madraspatana*. During rainy season, a variety of herbaceous plants like *Achyranthes aspera, Allamania nodiflora, Apluda mutica, Aristida setacea, Blumea mollis, Cleome angustifolia* and species of *Cymbopogon, Glinus, Indigofera, Leucas, Mollugo* and *Oldenlandia* are seen

Tropical thorn forest of Tamil Nadu are differentiated into Southern thorn forest, Carnatic umbrella thorn forest, Southern Euphorbia scrubs and Southern thorn scrubs (Champion and Seth 1968). In Southern thorn forest, species of *Acacia, Mimosa* and *Ziziphus* are predominantly met with. In Carnatic umbrella thorn forest *Acacia planifrons* is common. These forests are found in Kanyakumari, Madurai, Ramanathapuram and Tirunelveli. Southern *Euphorbia* scrub is full of fleshy Euphorbias. *Barleria buxifolia, Calotropis gigantea, Euphorbia antiquorum, E. tirucalli* and *Opuntia dillenii* are common. Southern thorn scrubs are found in the plains like Chennai and its environs. Sandal bearing scrubs are met with in Sirur R.F. of Nilgiris.

IV VEGETATION OF HILLS AND MOUNTAINS

1. Dry Deciduous forest (Southern dry mixed deciduous forest of Champion and Seth 1968).

These forest are found at about 400 m and above. The canopy is closed. Most of the species are deciduous. The undergrowth is usually dense. The common trees are *Albizia amara, A. odoratissima, Anogeissus latifolia, Butea monosperma, Chloroxylon swietenia, Dalbergia* sp. *Pterocarpus marsupium, Shorea roxburghii, Strychnos nux-vomica, Terminalia* spp., etc. The bamboo, *Dendrocalamus strictus* is often found. *Dodonaea viscosa, Securinega virosa, Strobilanthes* spp. are some of the shrubs found in these forest. The common climbers are *Combretum albidum, Hiptage benghalensis, Toddalia asiatica* and *Ventilago madraspatana. Cycas circinalis* is occasional. Species of *Abutilon, Achyranthes, Aristida, Bulbostylis, Cleome, Cymbopogon, Cyperus, Digitaria, Heracleum, Heteropogon, Themeda, Tribulus*, etc. form the ground layer.

2. South Indian moist deciduous forest

This type lies below the zone of semi-evergreen and evergreen forest. The trees reach a height of 30-36 m and are deciduous. Bamboos are common. Epiphytes are rare. *Bombax ceiba, Dillenia pentagyna, Mitragyna parviflora, Tectona grandis, Terminalia* spp. *Vitex* spp. and *Ziziphus xylopyrus* are the common trees. *Cycas circinalis* is occasional. *Helicteres isora, Lantana camara* var. *aculeata* and *Ziziphus oenoplia* are common shrubs. Common climber is *Ipomoea* spp. Common grass is *Imperata* sp.

3. Semi-evergreen forest (Tirunelveli semi-evergreen forests of Champion and Seth 1968).

This type occurs on slopes of hills and mountains usually up to 1000 m. Canopy is of 2 or 3 storeys. Epiphytic orchids are present. Climbers and canes are common. Top canopy consists of *Artocarpus* spp. *Dalbergia latifolia, Hopea* spp., etc. The second storey consists of species of *Actinodaphne, Aglaia, Bischofia, Drypetes* and *Symplocos*. Species of *Glycosmis, Ixora, Lasianthus, Leea, Memecylon, Pavetta*, etc. form the shrubby vegetation. The common climbers are *Butea parviflora, Cynanchum tunicatum, Entada pursaetha* and species of *Calycopteris, Dioscorea, Strychnos*, etc. *Bambusa arundinacea* and *Ochlandra travancorica* are also common.

4. Wet evergreen forest (Southern hill-top tropical evergreen forest and West Coast tropical evergreen forest of Champion and Seth 1968).

This type is found up to an altitude of nearly 1500 m on the slopes of hills and mountains that receive heavy rainfall. It is primarily met with in Anamalais, Kanyakumari and Tirunelveli hills. The trees attain a height of 45 m or more with long, clean boles. There are three or four storeys. The canopy is very dense. Epiphytic orchids, aroids, ferns, mosses and lichens are common. Climbers are conspicuous, spreading over tree canopies. The ground vegetation is generally absent. Species of *Calamus, Pandanus* and Palms are found near water-courses. Grasses are generally absent. The top canopy is formed by *Hopea* sp., *Aglaia eleagnoidea, Artocarpus* spp., *Calophyllum* spp., *Canarium strictum, Cullenia exarillata, Filicium decipiens, Palaquium ellipticum, Persea macrantha* and *Tetrameles nudiflora*, etc. The trees of the second storey are

Actinodaphne malabarica, Cinnamomum verum, Diospyros bourdillonii, Gomphandra tetrandra, Scolopia crenata, etc. The common shrubs are species of *Ixora, Nothopegia, Pavetta* and *Strobilanthes.* The common climbers are *Ancistrocladus, Calycopteris, Dioscorea, Entada, Erythropalum* and *Pothos.* Herbaceous vegetation consists of *Begonia, Disperis, Impatiens, Ophiorrhiza,* etc. Along water courses and on moist slopes *Schumannianthus virgatus* is abundant. Species of *Coelogyne, Dendrobium, Oberonia, Pholidota* and *Vanda* are some of the common epiphytic orchids. Species of *Angiopteris, Arachniodes, Asplenium, Bolbitis, Leptochilus, Pteris* and *Trichomanes* are the common ferns. *Cyathea* spp. (tree ferns) and *Lycopodium* are occasional. *Selaginella* species are common on rocks and trees.

5. **Sholas** (southern montane wet temperate forest of Champion and Seth 1968).

The montane forest above 1000 m, mostly confined to moist and sheltered valleys, glens and hollows as in the Anamalais, Nilgiri and Pulney are called 'Sholas' The trees are evergreen and usually short-boled. *Ilex denticulata, I. wightiana, Michelia nilagirica, Syzygium* spp., *Vaccinium leschenaultii, V. neilgherrense* and *Viburnum punctatum* are the common trees. *Eurya nitida, Rhododendron nilagiricum, Rhodomyrtus tomentosa, Ternstroemia japonica* are found on the fringes of sholas. Species of *Berberis, Disporum, Gaultheria, Mahonia, Valeriana,* etc. are some of the other plants found in Sholas. *Abelmoschus angulosus, Arundinaria* sp., *Elatostema* sp., *Impatiens* sp., *Lasianthus* sp., *Psychotria* sp., etc. form the undergrowth. The common pteridophytes are *Asplenium aethiopicum, A. laciniatum* and species of *Polystichum* and *Selaginella.* Lithophytic and epiphytic orchids include *Aerides ringens, Coelogyne mossiae, C. nervosa, Dendrobium nanum, Eria dalzellii, E. pauciflora, Oberonia* spp., etc. Common parasites are *Helixanthera* spp. and *Korthalsella japonica.* Shola forest are considered as the climatic climax type by many workers.

6. **Grasslands**

Grasslands can be divided into two categories.

Low level grasslands

These are found up to 1000 m altitude and are very scattered and intermixed with local forest. They are exposed to considerable biotic interference. The dominant species are *Arundinella ciliata, A. mesophylla,*

Chrysopogon orientalis, C. zeylanicus, Cymbopogon coloratus, C. flexuosus, Digitaria ciliaris, Eragrostis tenuifolia, Eulalia trispicata, Ischaemum timorense and *Themeda cymbaria*. The common trees found scattered among these grasses are *Mundulea sericea, Phoenix humilis* var. *pedunculata* and *Terminalia chebula*. The common shrubs are *Hedyotis purpurascens* and *Uvaria rufescens*. Species of *Biophytum, Crotalaria, Cyanotis, Fimbristylis, Leucas, Phyllanthus, Rhynchosia, Striga* and *Vernonia* are some of the herbaceous elements. Orchids like *Habenaria perrottetiana* and *Pecteilis gigantea* are common. *Didymocarpus tomentosus, Eriocaulon cinereum, E. melaleucum* etc., are found on mossy rocks. *Burmannia pusilla* and *Utricularia striatula* are seen on very moist substratum.

High level grasslands (southern montane wet grasslands of Champion and Seth 1968; Shrub-Savanna of Meher-Homji 1967, 1969).

Grasses, herbs and shrubs are found mixed up in varying proportions in this type of vegetation; it covers large areas on the mountain tops. *Agrostis peninsularis, Arundinella purpurea, A. vaginata, Bromus ramosus, Chrysopogon zeylanicus, Dichanthium polyptycum, Indochloa oligantha, Isachne bourneorum* and *Tripogon bromoides* are the common grasses. *Anaphalis bournei, A. meeboldii, A. subdecurrens, Arisaema wightii, Blumea hieracifolia, B. mollis, Burmannia pusilla, Campanula alphonsii, Cirsium wallichii* var. *wightii, Curculigo orchioides, Drosera peltata, Fimbristylis kingii, Lactuca hastata, Micromeria biflora, Osbeckia parvifolia, Parnassia mysorensis, Pedicularis zeylanica, Scirpus fluitans, Spiranthes sinensis, Swertia corymbosa, Utricularia graminifolia, U. uliginosa, Valeriana beddomei, Vernonia peninsularis* and *Viola betonicifolia* ssp. *nepalensis* are some of the plants found in association with grasses. Fire resistant fern *Pteridium aquilinum* is one of the aggressive ferns found in grasslands. In many places, high level grasslands lie in close juxstaposition with sholas.

RIPARIAN VEGETATION

This type of vegetation is found along courses of rivers and streams in plains, where alluvial soil is deposited. It forms a very narrow belt along the banks; sometimes it may extend to higher elevations. The trees may be evergreen or deciduous depending upon the region. *Arundo donax, Barringtonia acutangula, Combretum albidum, Derris scandens, Homonoia riparia. Phragmites karka, Polygonum* spp., *Pongamia pinnata,*

Saccharum spontaneum, Syzygium cumini, Terminalia arjuna, Typha angustata and *Vitex leucoxylon* are some of the plants found in this region.

AQUATIC AND SEMIAQUATIC VEGETATION

Aquatic and semiaquatic vegetation is met with in lakes, ponds, puddles, marshy places, etc. *Aponogeton natans, Ceratophyllum demersum, Eichhornia crassipes, Hydrilla verticillata, Lemna perpusilla, Monochoria vaginalis, Najas graminea, Nymphaea* spp., *Nelumbo nucifera* and *Vallisneria spiralis* are commonly found. *Hydrobryum olivaceum, Polypleurum* spp. and *Willisia selaginoides* are found on rocks in rivers. *Aeschynomene aspera, Bacopa monnieri, Eclipta prostrata, Hygrophila angustifolia, Rotula aquatica* and *Typha angustata* are found along the margins of lakes, ponds, etc. *Azolla pinnata, Ceratopteris thalictroides, Isoetes coromandeliana* and *Marsilea minuta* are some of the aquatic pteridophytes commonly seen.

FLORISTIC DIVERSITY

The forest of Tamil Nadu with a total area of about 21938 Sq. Km, show a wide variety in their floristic composition. Dense forest are found in southern Western Ghats (Nilgiri, Anamalais, Palnis and Tirunelveli-Travancore hill complex) and in Eastern Ghats expecially in Coimbatore, Dharmapuri, Salem, North Arcot and South Arcot districts. Southern Western Ghats have the best preserved and most extensive climax vegetation in peninsular India. Some of the tropical moist forest in Tamil Nadu are among the best representative areas with predominantly Indo-Malaysian elements. Out of about 17,500 species of flowering plants described from Indian subcontinent about 4000 are reported from W. Ghats (Nair and Daniel 1986) and about 5640 species and infraspecific taxa (including cultivated species) are available in Tamil Nadu (Nair and Henry 1983; Henry et al. 1987, 1989). This is significant as the area that supports such a great percentage of floristic elements occupies only 4.08% of the total area of India. Out of about 315 flowering plant families in India about 230 families are represented in Tamil Nadu. The State Flora Analysis of Tamil Nadu (Nair and Henry 1983; Henry *et al.* 1987, 1989) reveals high concentration of species in the hilly districts of Western Ghats. The unique mountainous Nilgiri district of Tamil Nadu alone has 2611 species of flowering plants belonging to 942 genera spread over 163 families (Sharma

et al. 1977). 2,105 species of flowering plants belonging to 872 genera spread over 137 families are reported from Tirunelveli (Mudaliar and Sundararaj 1954). Chandrabose and Nair (1968) report 849 species/ infraspecific taxa from Coimbatore town, Fyson (1915-21) records 500 species belonging to 264 genera on South Indian hill tops.

The Nilgiri Biosphere Reserve situated on the southern Western Ghats harbours 3,379 species of flowering plants alone (Balakrishnan and Ansari 1990). Another potential area- Agastyamalai, situated on the Tirunelveli Travancore hills at southern end is estimated to have about 2000 species of flowering plants in an area of about 2000 Sq km (Henry et al. 1984). The Nilgiris, Agastyamalai and its environs are some of the more potential centres of speciation and many plants new to science have been described from these places. Most of them happen to be narrow endemics. The high percentage of endemic elements shows that the southern Western Ghats have a typical flora of their own. The Nilgiris form a prominent type locality in peninsular India. About 25 new taxa have been described in recent years from Agastyamalai region (Henry *et al.* 1984). Many areas in this region still remain underexplored, so discovery of novelties is likely to be an unending process.

Floristic and taxonomic works carried out so far clearly indicate that Tamil Nadu is one of the richest areas in the country harbouring a large number of taxa which are highly evolved. The ten dominant families in W. Ghats are Poaceae, Leguminosae, Acanthaceae, Orchidaceae, Asteraceae, Euphorbiaceae, Rubiaceae, Asclepiadaceae, Geraniaceae and Lamiaceae (Nair 1991). The order of dominance of families in Tamil Nadu is Leguminosae, (117 genera, 507 species); Poaceae (145 genera, 436 species); Asteraceae (103 genera, 240 species); Rubiaceae (60 genera, 209 species); Euphorbiaceae (55 genera, 198 species); Orchidaceae (66 genera, 192 species); Cyperaceae (13 genera, 191 species); Acanthaceae (52 genera, 189 species); Lamiaceae (30 genera, 139 species) and Convolvulaceae (16 genera, 87 species). Families like Malvaceae, Melastomataceae, Balsaminaceae, Rosaceae, Rutaceae, Asclepiadaceae, Solanaceae, Scrophulariaceae, Verbenaceae, Lauraceae and Commelinaceae are well represented with more than 50 species each.

Following table shows the number of species (approximate) occurring in India and Tamil Nadu with respect to some dominant families of flowering plants. Analysis of these families may indicate the floristic diversity of Tamil Nadu.

Family	Tamil Nadu	W. Ghats	India
Leguminosae	507	320	1141
Poaceae	436	400	1291
Asteraceae	240	130	803
Rubiaceae	209	100	616
Euphorbiaceae	198	140	523
Orchidaceae	192	250	1229
Cyperaceae	191	160	545
Acanthaceae	189	165	500
Lamiaceae	139	115	435
Convolvulaceae	87	15	184

Leguminosae is one of the largest families of flowering plants with wide variety of habits such as herbs, climbers, lianas, shrubs to lofty trees. There are many species of economic importance including a number of edible legumes, medicinal plants, timber trees and wild relatives of cultivated plants in this family. Baker (1876) recognised 132 genera, 833 species and 109 varieties. Of these, 120 genera, 648 species and 76 varieties were then known to occur within the present political boundaries of Indian republic. With the addition of new species and new records made from different parts of India, at present, there are about 179 genera, 1152 species, 35 subspecies, 103 varieties and 7 forms in India including the cultivated species (Sanjappa 1992). About 85 genera and 320 species are reported from Western Ghats (Nair and Daniel 1986). There are 117 genera, 507 species, 6 subspecies and 21 varieties in Tamil Nadu (including cultivated species). The genera *Crotalaria, Dalbergia, Desmodium, Indigofera, Cassia* and *Acacia* are well represented. The Indo-Sri-Lankan genus *Humboldtia* with 6 species in the southern Western Ghats is represented by 5 species in Tamil Nadu.

Poaceae is one of the most dominant families from an ecological view point, occupying a wide and varied range of habitats. In India there are about 264 genera and 1291 species. Recent studies on certain tribes and genera clearly indicate that in peninsular India they are concentrated mostly on the Western Ghats. About 120 genera and 400 species are reported from Western Ghats (Nair and Daniel 1986). In Tamil Nadu there are about 145 genera, 436 species, 2 subspecies, 27 varieties and 1 forma. The tribe *Isachnae* has 4 genera and 34 species in India. Its

constituent genera *Coelachne* (2 species, 1 variety,) and *Isachne* (10 species) are well established in Tamil Nadu. Of the 12 species of *Garnotia* in India 9 species are reported from Western Ghats (Prakash and Jain 1979), 8 species occur in Tamil Nadu. A monotypic genus *Indopoa* is also found in Tamil Nadu. The occurrence of palaeoendemic genera *Manisuris* (1 species) and *Glyphochloa* (2 species, 1 variety) is phytogeographically interesting. Out of 19 principal genera of Bamboos occurring in India (Bahadur and Jain 1983) 5 genera, 9 species and 3 varieties occur in Tamil Nadu.

The family Asteraceae is represented by about 167 genera and 900 species in India (Hajra *et al.* 1995). 57 genera and 130 species are found to occur in Western Ghats (Nair and Daniel 1986). It reveals that about 50 species of the tribe *Vernonieae* recorded from South India about 45 occur in Western Ghats. Of this 50% of the species are found in Tirunelveli hills. The family includes predominantly herbaceous forms. They are adapted to varied ecological conditions. Arborescent forms viz. *Vernonia monosis* and *V. travancorica* are found in Tamil Nadu. The members of peninsular India are closely allied to the African species. The genera with the highest representation of species are *Anaphalis* (15 species) *Blumea* (17 species) *Senecio* (22) *Vernonia* (28 species and 1 variety). Majority of these species are of recent introduction and some are found as weeds in agricultural fields. Several ornamental taxa like *Chrysanthemum, Dahlia, Cosmos, Tagetes* and *Zinnia* are cultivated in gardens.

Rubiaceae is well developed family with trees, shrubs, climbers and herbs. There are about 113 genera and 616 species in India. 40 genera and 100 species are found in Western Ghats and 60 genera, 209 species, 1 subspecies, 32 varieties and 1 forma are found in Tamil Nadu. The tropical Asian genus *Hedyotis* (34 species 1 subspecies and 3 varieties) Indomalaysian genus *Lasianthus* (14 species) and other genera such as *Ixora, Ophiorrhiza* and *Psychotria* are well represented.

Euphorbiaceae, a cosmopolitan family is one of the largest and diversified families in Angiosperms. In India the family is represented by about 61 genera and 450 species (Binoj Kumar and Balakrishnan 1991). In Tamil Nadu there are 55 genera, 198 species, 1 subspecies and 11 varieties. The genera *Acalypha, Croton, Drypetes, Euphorbia, Glochidion, Jatropha, Mallotus* and *Phyllanthus* are well represented. In the genus *Glochidion* 5 species are endemic to Tamil Nadu.

Orchidaceae is known for its attractive and long lasting flowers. A variety of epiphytic, saprophytic and terrestrial orchids are found especially in the rain forests. Some of the orchids like *Aerides, Coelogyne, Dendrobium, Pecteilis gigantea* and *Rhynchostylis retusa* have large and attractive blooms. Genera such as *Bulbophyllum* (11 species), *Coelogyne* (8 species), *Dendrobium* (12 species), *Eria* (9 species), *Eulophia* (6 species), *Habenaria* (28 species), *Liparis* (13 species) and *Oberonia* (13 species) are well represented. According to Jain and Mehrotra (1984) there are 144 genera and 925 species; Karthikeyan *et al.* (1989) 1075 species, 2 subspecies, 107 varieties and 6 forma and Sathish Kumar and Manilal (1994) 166 genera and 1141 species in India. The Western Ghats harbour 267 species, 3 subspecies and 2 varieties of orchids representing 72 genera, including the rare *Paphiopedilum druryi* of Tirunelveli Travancore hills. Fischer (1928) reports 60 genera having 190 species from erstwhile Madras Presidency. About 150 species have been reported from parts of Kerala and Tamil Nadu by Abraham and Vatsala (1981). In Tamil Nadu there are about 66 genera, 192 species and 8 varieties. The Nilgiris alone harbour about 120 species in 49 genera. It contains 33 species that are reported from Himalayas. 35 species have a common distribution in Malaya or Thailand or Java (Joseph 1982). More than 50% of the orchid species dealt within the Flora of erstwhile Madras Presidency occur in Nilgiri itself.

Cyperaceae includes sedges which are cosmopolitan in distribution, but they have a narrow ecological range. *Carex* spp. are said to have a considerable ecological range. The family is represented in India by about 38 genera and 545 species. 13 genera, 191 species, 4 subspecies and 12 varieties occur in Tamil Nadu. The genera *Carex, Cyperus, Fimbristylis* and *Scirpus* are well represented in the State.

The family Acanthaceae is represented by about 92 genera and 500 species in India. 50 genera, 181 species and 15 varieties occur in Tamil Nadu. The genera *Andrographis* (18 species, 3 varieties), *Barleria* (18 species, 2 varieties), *Justicia* (11 species) and *Nilgirianthus* (15 species) are well represented.

The family Lamiaceae is represented in India by about 72 genera and 435 species. Tamil Nadu harbours about 30 genera, 139 species and 19 varieties. The genera *Anisochilus* (10 species, 1 variety), *Leucas* (29 species, 8 varieties) and *Plectranthus* (21 species, 1 variety) are well represented.

Convolvulaceae is represented by about 28 genera and 184 species in India. In Tamil Nadu there are 16 genera, 87 species, 1 subspecies and 2 varieties. The genera *Argyreia* (18 species 2 varieties), stem parasite *Cuscuta* (4 species), *Ipomoea* (33 species), *Merremia* (10 species, 1 subspecies) are well represented.

Impatiens of Balsaminaceae is a non-endemic genus that has a considerable number of endemic species on the Western Ghats. There are about 86 species on the Western Ghats and in Tamil Nadu there are about 62 species. Nilgiris and neighbourhood harbour 17 endemic species, Anamalai and Pulney hills have 6 endemic species and mountains of Tirunelveli and neighbourhood are with 6 endemic species. The narrow endemism exhibited by the species of *Impatiens* in the Western Ghats may indicate that they are neoendemics (Nair 1991).

Commelinaceae has attained full development here in that out of the 90 species in India 59 are reported from Tamil Nadu. The Indomalaysian genus *Belosynapsis* is represented by two species in Tamil Nadu which are rare.

Palms which include economically important plants are well represented. The rare plants viz. *Bentinckia condapanna* and *Pinanga dicksonii* also occur. *Calamus* is represented by 8 species and 1 variety which are much exploited for making furniture.

The aquatic families are represented by Alismataceae (3 genera, 3 species), Aponogetonaceae (1 genus, 5 species), Callitrichaceae (1 genus, 1 species), Ceratophyllaceae (1 genus, 1 species), Hydrocharitaceae (8 genera, 14 species), Lemnaceae (3 genera, 4 species), Najadaceae (2 genera, 6 species), Nelumbonaceae (1 genus, 1 species), Nymphaeaceae (1 genus, 2 species), Pontederiaceae (2 genera, 3 species), Potamogetonaceae (4 genera, 9 species), Trapaceae (1 genus, 1 variety) and Typhaceae (1 genus, 1 species).

The families having characteristic insectivorous plants are Droseraceae (3 species) and Lentibulariaceae (18 species). The parasitic plants belonging to diverse families viz. Loranthaceae (30 species), Santalaceae (4 species), Balanophoraceae (2 varieties), Cuscutaceae (4 species) and Orobanchaceae (8 species) are well represented. The families Lauraceae, Opiliaceae and Scrophulariaceae also have some parasitic

species. Saprophytes that are commonly found are *Burmannia championii, Aphyllorchis montana, Didymoplexis pallens, Epipogium roseum, Hyalisma jantha*, etc.

Gymnosperms are poorly represented in Tamil Nadu. Eventhough the following families viz. Cycadaceae (2 species) Ginkgoaceae (1 species), Podocarpaceae (4 species), Araucariaceae (4 species), Pinaceae (13 species), Taxodiaceae (5 species), Cupressaceae (23 species), Gnetaceae (2 species) are represented, most of the species are found only under cultivation in hill stations. *Cycas circinalis, Nageia wallichiana* (a coniferous tree indigenous to South India) *Gnetum ula* and *G. contractum* are commonly found.

Published works on Pteridophytes and Bryophytes of Tamil Nadu are meagre. Some systematic work has been done on the Ferns of Palni hills. Subramanyam et al. (1961) have recorded 50 species of Pteridophytes from the Cumbum Valley and Pachakumatchi hills of the Madurai district. Bir and Vasudeva (1971) have reported 118 species of ferns and 14 fern-allies from Kodaikanal. Manickam and Ninan (1976) mention the occurrence of 148 taxa of ferns including 14 novelties on Palni hills. *Cyathea* spp. - the tree ferns, many ferns and fern-allies which are epiphytic viz. *Asplenium* spp., *Hymenophyllum* spp., *Lycopodium* spp., *Microsorum* spp., etc., robust ferns like *Angiopteris evecta, Osmunda regalis, Blechnum orientale*, etc. occur along streams and rivulets. Climbing species of *Lygodium* are also commonly found.

The montane forest are rich in Bryophytes. About 728 taxa of liverworts are known from the country. Udar and Srivastava (1975) have made attempts to study the liverworts of Western Ghats. From South India about 225 species are reported, most of which are confined to Western Ghats (including hilly regions of Tamil Nadu). *Anthoceros* spp., *Dumortiera* spp., *Marchantia* spp., etc. occur here. Bryophytes are supposed to indicate the environmental changes and are of phytogeographical significance. About 17 species of South Indian liverworts are reported to occur in East Africa also (Schuster 1976). The moss flora of South India is also poorly known. The information available is mainly based on collections from hilly regions like Kodaikanal, Ooty and Mercara. 368 species of mosses are enumerated from the Palni hills alone by Foreau (1961), of which 110 were described as novelties by various earlier authors from these parts.

As far as the Algal, Fungal and Lichen floras are concerned the forest of Tamil Nadu remain unexplored. The hills of southern Western Ghats are supposed to be rich in all these elements as optimum conditions for profuse growth of them exist there. Intensive studies on them need to be done in future.

PHYTOGEOGRAPHY

Origin of the flora of peninsular India, its complexity and diversity have been discussed by various authors. India appears to have remained connected to Madagascar and Africa until at least 100 m.y. B.P. It commenced its northward motion about 100 m.y. B.P. and appears to have collided with Asia by mid-Eocene. The extensive crustal shortening and fracturing of the region as well as the upthrust of the Himalayas belongs to the second phase of the development of the region, commencing in the Miocene and reaching its strongest phase in the Plio-Pleistocene time. The presumed lower Eocene Deccan Intertrappean floras reviewed by Lakhanpal (1970) may represent mixtures of groups that have come from the north (such as Datiscaceae) with these that were derived from the south, and the flora of peninsular India was progressively enriched from mid-tertiary time onwards with northern, predominantly tropical groups of Angiosperms, such as Dipterocarpaceae (Axelrod 1974). India had a rich tropical and subtropical flora during the Cretaceous. As the Indian subcontinent was rafted north through different climatic belts many tropical taxa unique to it appear to have been eliminated, as were temperate austral alliances, including leptodactylid frogs and austral gymnosperms (Raven and Axelrod 1974). Nayar (1977) stressed that the Glossopteridean flora has clearly established the Gondwana origin of the landmass comprising South America, India, Malesian Islands, Madagascar, Australia and Antarctica. The past connection of peninsular India with the now sundered but still vagile continents has been underscored by Nayar (1982) with examples such as *Hernandia, Laurembergia, Pittosporum, Acrotrema, Apodytes dimidiata, Gomphandra, Nothopodytes foetida* and *Sarcostigma kleinii, Hydnocarpus*, etc. Abraham and Vatsala (1981) observe that the occurrence of 10 genera of Orchidaceae viz. *Acampe, Bulbophyllum, Disperis, Eulophia, Habenaria, Liparis, Nervilia, Oberonia, Satyrium* and *Vanilla* in the Western Ghats (Tamil Nadu and Kerala) and Africa and the very close resemblance between certain species of East Africa and the Western Ghats viz. *Calanthe masuca, C. volkensis, Eulophia epidendraea, E. schimperiana*, etc. may be explained in terms of the continental drift. The occurrence of 52 species out of 139 of the

tribe Andropogoneae of Poaceae in India as well as Africa may indicate the phytogeographical affinities of the two regions (Mehrotra and Jain 1982). The flora of the Western Ghats has much affinity with that of the Malesian region (Hooker, 1904; Subramanyam and Nayar 1974).

Hooker and Thomson (1855), Fyson (1915-21), Champion (1936), Biswas (1949) and Gupta (1962) have indicated similarities in the flora of South Indian hill stations with that of the Himalayas. Temperate species in the Nilgiris viz. *Ternstroemia japonica, Hypericum hookerianum, Thalictrum javanicum, Cotoneaster buxifolia, Parnassia wightiana, Lonicera ligustrina, Gaultheria fragrantissima, Symplocos lauriana*, etc. show relationship with the temperate flora of Assam Himalayas. Arora (1964) after making comparative studies of the flora at the familial level estimates that out of 110 and 103 families of woody dicotyledons in Assam and in the Western Ghats respectively, 98 are common to both the areas. All these should amply justify that the floristic diversity of the Western Ghats is of an ancient lineage (Nair and Daniel 1986). On the basis of its similarity, it is considered that the temperate flora of Nilgiris is part of Pleistocene relicts. The present disjunction in their distribution occurring in the Nilgiris in South India and Assam Himalayas is due to favourable ecological nitches afforded by these mountain tops (Nayar 1977).

The phytogeographical affinities of the two different types of flora of the Himalayas and the hills of South India have been carefully studied by Burkill (1924). The Malayan element in the hills of South India is considered to be much older. This is supposed to have been migrated through Bay of Bengal or Sri Lanka- Deccan route. The Himalayan element is glacial in age and its spread to South Indian hills is brought about by glaciation.

Plants like *Canna orientalis, Capparis zeylanica, Commelina paludosa, Costus speciosus, Ficus retusa, Ixora nigricans, Schleichera oleosa, Smilax zeylanica, Tiliacora acuminata* and *Trichopus zeylanicus* are some of the Indo-Malaysian elements present in Tamil Nadu.

Some of the species characteristic of tropical Africa viz. *Evolvulus alsinoides, Gymnema sylvestris, Pedalium murex, Peristrophe bicalyculata, Strychnos potatorum* and *Thunbergia erecta* are also found in Tamil Nadu. Plants like *Aristida funiculata, Brachiaria eruciformis, Canavalia virosa, Ecbolium viride* and *Hibiscus micranthus* extend up to the northern parts of Africa. *Cocculus hirsutus* distributed in Arabia,

Baluchistan, Pakistan, Myanmar, S. China and Africa extends to Tamil Nadu and Sri Lanka.

Some of the species like *Centratherum anthelminticum*, *Euphorbia rosea* and *Prosopis cineraria* found in Tamil Nadu occur in West Asian countries like Arabia, Afghanistan and Persia.

The vegetation of Nilgiris shows interesting similarities with the high altitude vegetation of Sri Lanka particularly in the presence of peat bogs where characteristic species of *Eriocaulon*, *Exacum* and *Utricularia* occur.

The strand flora found in the Islands of Rameswaram, Krusadai, Shingle, Hare and Church is almost similar to that of the coast of Sri Lanka (Nair and Vivekananthan 1983).

The coastal flora of Tamil Nadu shows similarities with that of coastal flora of adjacent States. Such a relationship is obvious with differences in the presence of a few taxa like *Halopyrum mucronatum* (Kanyakumari), *Myriostachya wightiana*, *Polycarpaea spicata* (Mandapam, Tuticorin), *Scaevola plumieri* (Point Calimere), *Sesamum prostratum* (Adaiyar beach).

ENDEMISM

In Tamil Nadu, the complex hill system (Southern Western Ghats) with several peaks comprising Nilgiris, Anamalais, Cardamom hills, Pulneys, Agastyamalai and Kalakkad hills provide various habitats and nitches suitable for endemic taxa. The distribution and concentration of endemic plants in a particular region is an index to the overall biogeography of the area. Many authors have discussed about endemism of Indian species. Chatterjee (1940) listed 133 endemic genera in the dicotyledonous flora of the erstwhile British India. Rao and Sastry (1972) estimated 164 endemic genera for the floristic region of India and adjoining countries. There are about 58 genera (incl. 47 monotypic genera) distributed over 25 families endemic to peninsular India (Nayar 1980, Ahmedulla and Nayar 1987). Most of the species of flowering plants endemic to peninsular India are confined to the Western Ghats (Nayar 1980). According to Nair (1991) there are 51 genera endemic to the Western Ghats. The genera *Ascopholis*, *Baeolepis*, *Diplocentrum*, *Indobanalia*, *Jerdonia*, *Nilgirianthus*, *Phlebophyllum*, *Pleocaulus*, *Poeciloneuron*, *Taeniandra* and

Xenacanthus are endemic to Western Ghats including Nilgiris. The genus *Baeolepis* is strictly endemic to Nilgiris.

As many as 1932 taxa (incl. 1788 species and 144 infraspecific taxa) belonging to 108 families of flowering plants are endemic to peninsular India. The abundance of endemic taxa on the South Indian hill tops in Western Ghats has been clearly pointed out by Blasco (1971) and according to him 223 species are known only in the 'montane stage' of South India. In the Western Ghats, there are about 89 species (71 dicots, 18 monocots) exclusively confined to Nilgiris (Kunthikrishnan 1991) of which 28 taxa are endemic to Kundah range alone (Shetty and Vivekananthan 1983), 18 species to the montane vegetation of the Palni and 23 species to Anamalais (Kunthikrishnan 1991) and 150 species to Agastyamalai and environs (Henry et al. 1984). Hence in the southern Western Ghats 'Nilgiris' is the second important centre for endemic plants next to Agastyamalai and environs. Most of these endemic plants have a narrow endemic range in distribution.

The statistics of endemism is prone to drastic changes when more and more botanical explorations are undertaken and additional knowledge on the distribution of species at global level are available. Frequent updating of taxonomic status may also increase or decrease the number (Ramesh and Pascal 1991).

As, many of the endemic species are restricted in distribution in small populations, they are constantly facing threat from various biotic influences and many of them are likely to become endangered.

ENDEMIC SPECIES

Ranunculaceae

Clematis theobromina

Berberidaceae

Berberis nilghiriensis
B. wightiana
Mahonia leschenaultii

Flacourtiaceae

Homalium jainii
Hydnocarpus pentandra
Scolopia crenata
var. *brevifolia*

Pittosporaceae

Pittosporum anamallayense
P. viridulum

Polygalaceae

Polygala jacobii

Capparaceae
Capparis nilgirensis
C. shevaroyensis

Caryophyllaceae
Polycarpaea diffusa

Malvaceae
Abutilon neilgherrense
var. *fischeri*

Tiliaceae
Grewia pandaica

Elaeocarpaceae
Elaeocarpus blascoi

Zygophyllaceae
Tribulus cistoides
T. lanuginosus
var. *orientalis*

Oxalidaceae
Biophytum insignis
B. intermedium
var. *pulneyensis*
B.longibracteatum
B. polyphyllum

Balsaminaceae
Impatiens campanulata
I. chandrasekharanii
I. clavicornu
I. crenata
I. cuspidata
I. debilis
I. denisonii
I. laticornis
I. lawsonii
I. lenuta
I. levingei
I. macrotheca
I. modesta
I. munronii
I. neo-barnesii
I. nilgirica
I. omissa
I. orchioides
I. parviflora
I. phoenicea
I. rufescens
I. trichocarpa
I. umbellata
I. uncinata
I. viridiflora
I. viscida
I. wightiana

Rutaceae
Euodia lunu-ankenda
var. *tirunelvelica*
Melicope indica
Paramignya beddomei

Icacinaceae
Miquelia dentata

Aquifoliaceae
Ilex gardneriana

Celastraceae
Glyptopetalum lawsonii
Microtropis densiflora
M. ovalifolia

Hippocrateaceae
Salacia beddomei

Rhamnaceae
Sageretia coimbatorensis

Vitaceae
Cayratia pedata var. *glabra*

Sapindaceae
Allophylus concanicus var. *lanceolatus*
A. serrulatus

Anacardiaceae
Nothopegia aureo-fulva

Papilionaceae
Crotalaria barbata
C. formosa
C. fysonii var. *fysonii*
C. fysonii var. *glabra*
C. kodaiensis
C. leschenaultii
C. longipes
C. madurensis var. *madurensis*
C. ovalifolia
C. scabra
C. shevaroyensis
C. willdenowiana ssp. *glabrifoliolata*
Dalbergia congesta
D. coromandeliana
D. gardneriana
D. tinnevelliensis
Derris benthamii var. *wightii*
Desmodium barbatum ssp. *saulierei*
D. dolabriforme
Indigofera pedicellata
I. tirunelvelica
I. trita var. *marginulata*
Leptodesmia congesta
Millettia splendens
Rynchosia filipes
R. fischeri
R. jacobii
R. velutina
Smithia gracilis
Tephrosia barberi

Caesalpiniaceae
Cassia floribunda var. *pubescens*

Mimosaceae
Acacia bolei
A. hohenackeri
Albizia lathamii
Dichrostachys santapauii

Rosaceae
Alchemilla indica var. *madurensis*
Photinia serratifolia var. *tomentosa*
Rubus racemosus

Myrtaceae
Eugenia floccosa
E. singampattiana
Syzygium beddomei
S. benthamianum
S. chandrasekharanii
S. tamilnadensis
S. zeylanicum var. *ellipticum*

Melastomataceae
Medinilla malabarica
Memecylon flavescens
M. molestum
M. sisparense

Memecylon subramanii
Osbeckia courtallensis
O. reticulata
O. leschenaultiana
Sonerila clarkei
S. elegans
S. grandiflora
S. pulneyensis
S. versicolor var. versicolor

Cucurbitaceae
Trichosanthe anaimalaiensis
Zehneria maysorensis var. *umbellata*

Begoniaceae
Begonia anamalayana

Umbelliferae
Bupleurum distichophyllum
B. plantaginifolium
Heracleum courtallense
H. hookerianum
H. rigens var. *elongatum*
H. rigens var. *multiradiatum*
Hydrocotyle conferta
Peucedanum anamallayense
Pimpinella pulneyensis

Araliaceae
Schefflera rostrata var. *rostrata*
S. rostrata var. *micrantha*

Caprifoliaceae
Viburnum hebanthum

Rubiaceae
Acranthera anamallica
Anotis longiflora
Canthium dicoccum var. *lanceolata*
C. ficiforme
C. neilgherrense var. *chartacea*
Galium rotundifolium
Hedyotis anamalayana
H. articularis subsp. *santapaui*
H. barberi
H. buxifolia
H. eualata var. *eualata*
H. eualata var. *agastyamalayana*
H. gamblei
H. hirsutissima
H. lessertiana
H. purpurascens var. *pallida*
H. sisparensis
H. viscida
Ixora viscida
I. saulieret
Knoxia sumatrensis var. *linearis*
Lasianthus blumeanus
L. ciliatus
L. cinereus
L. dichotomous
L. oblongifolius
L. strigillosus
Mussaenda tomentosa
Neanotis longiflora
N. monosperma var. *tirunelvelica*
Ophiorrhiza grandiflora
O. incarnata
O. pykarensis

Ophiorrhiza roxburghiana
O. tirunelvelica
Pavetta brunonis
P. globicephala
P. hohenackeri
P. laeta
P. wightii

Valerianaceae
Valeriana beddomei

Dipsacaceae
Dipsacus leschenaultii

Asteraceae
Anaphalis aristata
A. beddomei
A. elliptica
A. neelgerryana
A. wightiana
Carpesium cernuum var. *nilagiricum*
Emilia zeylanica var. *paludosa*
Helichrysum perlanigerum
H. wightii
Notonia shevaroyensis
Senecio ansteadi
S. calcadensis
S. hohenackeri var. *hohenackeri*
S. kundaicus
S. lavandulaefolius
S. lessingianus
S. neelgherryanus
S. polycephalus
Sonchus jainii
Vernonia anamallica
V. conyzoides
V. fysonii
V. gossypina
V. pulneyensis
V. recurva
Youngia nilgiriensis

Campanulaceae
Campanula wightii
Lobelia courtallensis

Primulaceae
Lysimachia leschenaultii

Myrsinaceae
Antistrophe serratifolia
A. sonchifolia
Embelia adnata
E. gardneriana
Rapanea thwaitesii

Sapotaceae
Isonandra perrottetiana

Symplocaceae
Symplocos anamallayana
S. macrophylla subsp. *microphylla*
S. macrophylla subsp. *rosea*
S. monantha
S. nairii
S. pulchra

Oleaceae
Jasminum calophyllum
J. cordifolium
J. wightii
Ligustrum decaisnei var. *decaisnei*
L. decaisnei var. *microphylla*

Apocynaceae
Tabernaemontana gamblei
Wrightia indica

Asclepiadaceae
Brachystelma bourneae
B. rangacharii
Caralluma diffusa
C. nilgiriana
Ceropegia metziana
C. amissa
Gymnema montanum var. *beddomei*
G. montanum var. *pubiflora*
Hoya kanyakumariana
Marsdenia tirunelvelica
Tylophora subramanii

Periplocaceae
Bacolepis nervosa

Loganiaceae
Strychnos minor

Gentianaceae
Exacum anamallayanam
E. courtallense
E. pumilum
E. wightianum var. *uniflorum*
Halenia perrottetii
Swertia corymbosa var. *grisebachiana*
S. trichotoma

Boraginaceae
Cordia diffusa
C. domestica
Ehretia wightiana
Heliotropium rottleri
Tournefortia argentea
T. heyneana
T. wightii

Convolvulaceae
Argyreia coonoorensis
A. nellygherya
Convolvulus flavus

Solanaceae
Solanum grandiflorum
S. vagum

Scrophulariaceae
Lindernia minima
Pedicularis perrottetti

Orobanchaceae
Christisonia neilgherrica
C. saulierei

Gesneriaceae
Didymocarpus fischeri
D. gambleanus
D. lyrata
D. ovalifolia
D. wightii
Jerdonia indica

Acanthaceae
Andrographis affinis
A. lawsonii
A. lobelioides
A. neesiana var. *neesiana*
A. neesiana var. *rotundifolia*
A. rothii
A. serpyllifolia
A. stellulata
A. stenophylla

Barleria pilosa
Diplosandra andersonii
D. bolampattiana
Ecbolium viride
var. *rotundifolia*
Lepidagathis spinosa
Leptacanthus amabilis
Mackenziea homotropa
M. violacea
Neuracanthus neesianus
Nilgirianthus papillosus
N. wightianus
Phlebophyllum humile
Phlebophyllum spicatum
var. *spicatum*
Pleocaulus sessilis
Rhinacanthus nasutus
var. *montana*
Santapaua madurensis
Stenosiphonium wightii
Taeniandra micrantha
Thunbergia bicolor
Xenacanthus heteromallus
X. zenkerianus

Verbenaceae
Lippia unica
Premna glaberrima
P. paucinervis

Lamiaceae
Acrocephalus palniensis
Anisochilus argenteus
A. dysophylloides
var. *dysopylloides*
A. dysophylloides
var. *purpureus*
A. robustus
A. sericeus
A. wightii
Dysophylla rugosa
Geniosporum tenuiflorum
var. *longiracemosum*
Leucas helianthemifolia
L. lamifolia
L. lanceaefolia
L. prostrata
L. pubescens
L. rosmarinifolia
L. vestita var. *angustifolia*
L. vestita var. *oblongifolia*
Orthosiphon. rubicundus
var. *hohenackeri*
Plectranthus bishopianus
P. bourneae
P. deccanicus
P. urticifolius
P. vettiveroides
Pogostemon atropurpureus
P. mollis
P. nilagiricus
P. paludosus
P. speciosus
P. wightii
Scutellaria colebrookiana
Teucrium plectranthoides
T. wightii

Amaranthaceae
Aerva wightii
Achyranthes aspera
var. *rubro-fusca*

Podostemaceae
Indotristicha tirunelveliana
Willisia selaginoides

Aristolochiaceae
Thottea barberi

Piperaceae
Piper barberi

Piper glabrirhache
P. obtusistigmum
P. ootacamundense
P. opacilimbum
P. ovatostemon
P. pykarahense
P. schmidtii
P. wightii

Lauraceae
Actinodaphne bourneae
A. campanulata var. *campanulata*
A. lanata
A. salicina
Cinnamomum walaiwarense
Cryptocarya anamalayana
C. neilgherrensis
Litsea ligustrina
L. stocksii var. *glabrescens*
L. venulosa
L. wightiana var. *tomentosa*
Neolitsea scrobiculata

Loranthaceae
Dendrophthoe memecylifolia
D. neelgherrensis
D. sarcophylla
Elytranthe lepidophylla
Helixanthera obtusata
Taxillus recurvus

Euphorbiaceae
Dalechampia velutina
Drypetes porteri
Euphorbia mayuranathanii
Glochidion ellipticum var. *ralphii*
G. neilgherrense
G. pauciflorum
G. sisparense
Jatropha maheshwarii
J. tanjorensis
J. villosa var. *ramnadensis*
Koilodepas calycinum
Mallotus subramanyamii
Phyllanthus fimbriatus
P. macraei var. *macraei*
P. macraei var. *hispidus*
P. missionis
P. singampattiana
P. stipulacea
Pseudoglochidion anamalayanum
Tragia bicolor

Urticaceae
Elatostema lineolatum var. *setosum*
E. wightii
Pouzolzia cymosa
P. wightii var. *nilghirensis*

Moraceae
Ficus angladei

Orchidaceae
Anoectochilus elatus
A. rotundifolius
Brachycorythis splendida
Bulbophyllum kaitiense
B. nodosum
Chrysoglossum hallbergii
Coelogyne glandulosa var. *bournei*
C. glandulosa var. *sathyanarayanae*
C. odoratissima
Dendrobium anamalayanum
D. nutans var. *rubrilabris*
Diplocentrum recurvum

Eria polystachya
E. pseudoclavicaulis
Habenaria cephalotes
H. decipiens
H. denticulata
H. digitata var. *travancorica*
H. elliptica
H. multicaudata
H. polyodon
H. richardiana
Hetaeria ovalifolia
Liparis beddomei
L. biloba
L. platyphylla
Luisia pulniana
Malaxis crenulata
Oberonia anamalayana
O. platycaulon
O. proudlockii
O. sebastiana
O. seidenfadeniana
O. wightiana var. arnottiana
O. wightiana var. nilgirensis
Proteroceras holtumii
Robiquetia josephiana
Spiranthes sinensis
var. *wightiana*
Thrixspermum
muscaeflorum
var. *nilagiricum*
Vanda wightii

Zingiberaceae
Kaempferia evansii

Dioscoreaceae
Dioscorea kalkapershadii

Liliaceae
Asparagus fysonii
Disporum leschenaultianum
var. *angustifolium*

Smilacaceae
Smilax wightii

Arecaceae
Calamus gamblei
var. *sphaerocarpa*

Araceae
Arisaema translucens
A. tuberculatum
A. tylophorum
Theriophonum
sivangaganum

Eriocaulaceae
Eriocaulon ensiforme
E. gamblei
E. mariae
E. nairii
E. pectinatum
E. robustum

Cyperaceae
Carex christii
C. flavidus var. *nilagiricus*
C. pseudoaperta
C. raphidocarpa
C. vicinalis
Cyperus curvibracteatus
C. latovaginata
C. lurida
C. plumbeonuceus
C. polyanthelus
C. rubriglumosus
C. stricticulmis
Fimbristylis aggregata
F. amplocarpa
F. contorta

Fimbristylis crystallina
F. eligulata
F. latiglumifera
F. latinucifera
F. longistigmata
F. paupercula
F. pustulosa
F. rectifolia
F. rigidiuscula
F. rugosa
F. scabrisquama
F. strigosa
F. subtrabeculata
F. tortifolia
F. uliginosa
Fuirena pubescens var. *pergamentacea*
F. pubescens var. *pergamentacea*
F. trilobites
Lipocarpha raynaleana
Scleria lithosperma var. *multispiculata*

Poaceae

Agrostis peninsularis
A. pilosula var. *pilosula*
A. pilosula var. *filifolia*
A. schmidii
Andropogon longipes
A. polyptychus
A. pumilus
Anthoxanthum borii
Apocopis vaginata
Arundinaria wightiana var. *hispida*
Arundinella nervosa
A. purpurea var. *purpurea*
A. purpurea var. *laxa*
A. setosa var. *nilagiriana*
Bothriochloa foulkesii
B. longifolia
Brachiaria munae
B. nilagirica
Cenchrus glaucus
Chloris wightiana
Coelachne perpusilla var. *nilagirica*
Cymbopogon flexuosus var. *coimbatorensis*
C. polyneuros
C. travancorensis
Cynodon barberi forma *longifolius*
Dichanthium foulkesii
D. oliganthum
D. pallidum
Dimeria acutipes
D. kollimalayana
Enteropogon coimbatorensis
Eriochrysis rangacharii
Eulalia wightii
Helictrotrichon polyneurum
H. schmidii
Heteropogon fischerianus
Isachne angladei
I. deccanensis
I. koenigii
I. oreades
Normanboria henrardiana
Ochlandra scriptoria var. *sivagiriana*
O. setigera
Panicum fischeri
Poa gamblei
Tripogon lisboae
Zenkeria elegans
Z. sebastinei

THREATENED AND RARE PLANTS

In the Plant Kingdom, a hypothetical rare species is the one with narrow habitat, low climatic tolerance, specialised adaptations requiring an outside agency for flower pollination, poor dispersal strategies, few seeds per fruit and poor viability of seeds. According to Lucas and Synge (1978) Rare/Endangered/Threatened plant species are those encountered only in traces at specific sites in their natural habitats for the past 50 years. Physical basis of rarity are endemism, disjunct distribution, and poor density populations. Causes of rarity are evolutionary status, reproductive inefficiency, shrinkage of nitches, anthropogenic causes and paucity of studies.

Recent studies on rare and threatened plants reveal that more than 700 species of flowering plants in Western Ghats are rare and threatened. Several papers presented during the symposium on rare and endangered and endemic plants of the Western Ghats (1991) clearly indicate that southern Western Ghats form the original locality from where a number of endangered and rare plants have been recorded. The three volumes of Red Data Book on Indian plants (1987, 1988, 1990) present information on 814 rare taxa of vascular plants for whole of India. Out of these 184 taxa of flowering plants are from southern Western Ghats alone. Many species reported by Gamble in the Flora of Presidency of Madras have not been relocated even from the type locality, showing that they have probably become extinct. Many species reported by Fischer (1921) from Anamalais could not be relocated by subsequent collectors from that area or elsewhere. Sharma (1977) could not collect several species reported earlier from Nilgiris. The possibly or probably extinct taxa of southern Western ghats (the portion lying within Tamil Nadu State is 12,760 Sq Km) are mostly narrow endemics or extremely rare species with nitch specificity. Correct field observation of the populations over a period of time is essential for measuring the threat value of species. IUCN (1978) has suggested a series of terms to denote different degrees of rarity. They are extinct, endangered, vulnerable and rare. The term 'Endemic' also conveys some sense of rarity.

RARE AND ENDANGERED PLANTS

Name of the species	Family	Status
Abutilon ramosum	Malvaceae	Rare
Acacia campbellii	Mimosaceae	Rare

Name of the species	Family	Status
Acacia hohenackeri	Mimosaceae	Rareand threatened
A. wightii	Mimosaceae	Rare and threatened
Acranthera grandiflora	Rubiaceae	Endangered
Acrocephalus palniensis	Lamiaceae	Indeterminate
Actinodaphne bourneae	Lauraceae	Endangered
A. lanata	Lauraceae	Endangered
A. lawsonii	Lauraceae	Rare
Aerva wightii	Amaranthaceae	Indeterminate
Albizia thomsonii	Mimosaceae	Rare
Alloteropsis semialata var. *viatica*	Poaceae	Endangered
Alphonsea zeylanica	Annonaceae	Endangered
Alysicarpus beddomei	Papilionaceae	Rare
Amomum microstephanum	Zingiberacee	Rare
Anisochilus argenteus	Lamiaceae	Vulnerable
A. wightii	Lamiaceae	Rare
Anoectochilus rotundifolius	Orchidaceae	Endangered or possibly extinct
Antistrophe serratifolia	Myrsinaceae	Rare
Aponogeton appendiculatus	Aponogetonaceae	Indeterminate
Atuna travancorica	Chrysobalanaceae	Indeterminate
Begonia aliciae	Begoniaceae	Endangered
B. anamalayana	Begoniaceae	Endangered
B. cordifolia	Begoniaceae	Rare
B. subpeltata	Begoniaceae	Rare
Belosynapsis kewensis	Commelinaceae	Endangered
Bentinckia condapanna	Arecaceae	Rare
Bombax insigne	Bombacaceae	Rare
Bulbophyllum acutiflorum	Orchidaceae	Rare
B. albidum	Orchidaceae	Rare
B. aureum	Orchidaceae	Rare
B. elegantulum	Orchidaceae	Vulnerable
B. kaitiense	Orchidaceae	Vulnerable

Name of the species	Family	Status
Bunium nothum	Apiaceae	
Calophyllum austroindicum	Clusiaceae	Rare
Campanula alphonsii	Campanulaceae	Rare
Capparis diversifolia	Capparaceae	Vulnerable
C. fusifera	Capparaceae	Rare
C. rheedii	Capparaceae	Rare
C. shevaroyensis	Capparaceae	Vulnerable
Carex christii	Cyperaceae	Indeterminate
C. pseudoaperta	Cyperaceae	Indeterminate
C. vicinalis	Cyperaceae	Indeterminate
Cayratia pedata var. *glabra*	Vitaceae	Rare
C. roxburghii	Vitaceae	Vulnerable
Ceropegia barnesii	Asclepiadaceae	Endangered
C. decaisneana	Asclepiadaceae	Rare
C. fimbrilfera	Asclepiadaceae	Vulnerable
C. maculata	Asclepiadaceae	Endangered
C. metziana	Asclepiadaceae	Rare
C. omissa	Asclepiadaceae	Endangered
C. pusilla	Asclepiadaceae	Rare
C. spiralis	Asclepiadaceae	Vulnerable
C. thwaitesii	Asclepiadaceae	Vulnerable
Chrysoglossum hallbergii	Orchidaceae	Indeterminate
Clematis theobromina	Ranunculaceae	Rare
Cleome burmanni	Capparaceae	Indeterminate
Coelogyne mossiae	Orchidaceae	Vulnerable
Commelina hirsuta	Commelinaceae	Rare and threatened
C. indehiscens	Commelinaceae	Rare
C. tricolor	Commelinaceae	Vulnerable
C.wightii	Commelinaceae	Vulnerable
Corymborkis veratrifolia	Orchidaceae	Rare
Cotoneaster buxifolius	Rosaceae	Vulnerable
Crotalaria bidiei	Papilionaceae	Rare

Name of the species	Family	Status
Crotalaria bourneae	Papilionaceae	Rare
C. clarkei	Papilionaceae	Rare
C. clavata	Papilionaceae	Endangered
C. conferta	Papilionaceae	Rare
C. digitata	Papilionaceae	Rare
C. formosa	Papilionaceae	Rare
C. fysonii var. *fysonii*	Papilionaceae	Rare
C. fysonii var. *glabra*	Papilionaceae	Endangered
C. globosa	Papilionaceae	Rare
C. grahamiana	Papilionaceae	Rare
C. kodaiensis	Papilionaceae	Endangered
C. longipes	Papilionaceae	Endangered
C. obtecta	Papilionaceae	Rare
C. pedunculatis	Papilionaceae	Rare
C. priestleyoides	Papilionaceae	Rare and Threatened
C. rigida	Papilionaceae	Rare
C. scabra	Papilionaceae	Rare
Cyanotis cerifolia	Commelinaceae	Indeterminate
Cynometra travancorica	Papilionaceae	Rare
Dalbergia congesta	Papilionaceae	Rare
D. gardneriana	Papilionaceae	Rare
D. tinnevelliensis	Papilionaceae	Rare
Decaschistia rufa	Malvaceae	Endangered
Derris benthamii var. *wightii*	Papilionaceae	Rare
D. thotharii	Papilionaceae	Rare
Desmodium barbatum subsp. *saulieret*	Papilionaceae	Rare
D. dolabriforme	Papilionaceae	Rare
D. ferrugineum subsp. *wynaadense*	Papilionaceae	Rare
D. ritchie	Papilionaceae	Rare
Desmos viridiflorus	Annonaceae	Rare
Dictyospermum ovalifolium	Commelinaceae	Rare
Didymocarpus missionis	Gesneriaceae	Rare

Name of the species	Family	Status
Dillenia retusa	Dilleniaceae	Endangered
Elaeocarpus blascoi	Elaeocarpaceae	Rare
E. munronii	Elaeocarpaceae	Rare
E. recurvatus	Elaeocarpaceae	Rare
E. venustus	Elaeocarpaceae	Vulnerbale
Eria albiflora	Orchidaceae	Rare
Eriochrysis rangacharii	Poaceae	Presumed extinct
Eriolaena lushingtonii	Sterculiaceae	Vulnerable
Eugenia discifera	Myrtaceae	Endangered
E. singampattiana	Myrtaceae	Endangered
Euonymus angulatus	Celastraceae	Endangered
E. serratifolius	Celastraceae	Endangered or possibly extinct
Garcinia talbotii	Clusiaceae	Rare
Glycosmis macrocarpa	Rutaceae	Rare
Goniothalamus rhynchantherus	Annonaceae	Rare
G. thwaitesii	Annonaceae	Rare
G. wynaadensis	Annonaceae	Endangered
Habenaria barnesii	Orchidaceae	Rare
Hedyotis albonervia	Rubiaceae	Endangered
H. barberi	Rubiaceae	Vulnerable
H. buxifolia	Rubiaceae	Rare
H. cyanantha	Rubiaceae	Rare
H. eualata var. *agastyamalayana*	Rubiaceae	Rare
H. gamblei	Rubiaceae	Rare
H. hirsutissima	Rubiaceae	Possibly extinct
H. swertioides	Rubiaceae	Rare
Helichrysum perlanigerum	Asteraceae	Rare
Hildegardia populifolia	Sterculiaceae	Endangered
Hopea erosa	Dipterocarpaceae	Endangered
Humboldtia bourdillonii	Caesalpiniaceae	Endangered
H. decurrense	Caesalpiniaceae	Rare
H. unijuga var. *unijuga*	Papilionaceae	Rare and endangered

Name of the species	Family	Status
Hybanthus travancoricus	Violaceae	Rare
Hydnocarpus macrocarpa	Flacourtiaceae	Rare
Hydrocotyle conferta	Apiaceae	Rare
Hypericum humifusum	Hypericaceae	Rare
H. japonicum var. *major*	Hypericaceae	Endangered
Ilex gardneriana	Aquifoliaceae	Possibly extinct
Impatiens neo-barnesii	Balsaminaceae	Endangered
I. nilagirica	Balsaminaceae	Endangered
Indigofera barberi	Papilionaceae	Rare
I. tirunelvelica	Papilionaceae	Rare
Indotristicha tirunelveliana	Podostemaceae	Rare and Vulnerable
Isonandra stocksii	Sapotaceae	Vulnerable
I. villosa	Sapotaceae	Indeterminate
Kalanchoe olivacea	Crassulaceae	Rare and Endemic
Kendrickia walkeri	Melastomataceae	Endangered
Kingiodendron pinnatum	Caesalpiniaceae	Rare
Lepidagathis barberi	Acanthaceae	Rare
L. diffusa	Acanthaceae	Indeterminate
Leptodesmia congesta	Papilionaceae	Rare
Liparis biloba	Orchidaceae	Vulnerable
L. platyphylla	Orchidaceae	Endangered
Melicope indica	Rutaceae	Vulnerable
Memecylon flavescens	Melastomataceae	Endangered
M. sisparense	Melastomataceae	Indeterminate
Meteromyrtus wynaadensis	Myrtaceae	Endangered
Miliusa nilagirica	Annonaceae	Endangered
Milletia splendens	Papilionaceae	Rare
Murdannia juncoides	Commelinaceae	Vulnerable
Neuracanthus neesianus	Acanthaceae	Endangered or possibly extinct
Nothopegia aureo-fulva	Anacardiaceae	Endangered
Oberonia bicornis	Orchidaceae	Rare
Ochreinauclea missionis	Rubiaceae	Vulnerable

Name of the species	Family	Status
Ophiorrhiza brunonis	Rubiaceae	Presumed extinct
O. pykarensis	Rubiaceae	Possibly extinct
Orophea thomsonii	Annonaceae	Endangered
O. uniflora	Annonaceae	Very rare
Palaquium bourdillonii	Sapotaceae	Indeterminate
Paphiopedilum druryi	Orchidaceae	Endangered
Pavetta hohenackeri	Rubiaceae	Vulnerable
P. wightii	Rubiaceae	Possibly extinct
Peucedanum anamallayense	Apiaceae	Indeterminate
Pimpinella pulneyensis	Apiaceae	Possibly extinct
Piper barberi	Piperaceae	Rare
Plectranthus bishopianus	Lamiaceae	Possibly extinct
P. bourneae	Lamiaceae	Indeterminate
Poeciloneuron pauciflorum	Clusiaceae	Endangered
Pogostemon atropurpureus	Lamiaceae	Rare
P. nilagiricus	Lamiaceae	Endangered
P. paludosus	Lamiaceae	Endangered
Polyalthia rufescens	Annonaceae	Rare
Polycarpaea diffusa	Caryophyllaceae	Vulnerable
Popowia beddomeana	Annonaceae	Rare
Pseudoglochidion anamalayanum	Euphorbiaceae	Indeterminate
Psychotria globicephala	Rubiaceae	Endangered
Pterospermum reticulatum	Sterculiaceae	Rare
Rhynchosia jacobii	Papilionaceae	Rare
R. velutina	Papilionaceae	Vulnerable
Salacia beddomei	Celastraceae	Rare
Santapaua madurensis	Acanthaceae	Endangered
Senecio kundaicus	Asteraceae	Endangered
Smilax wightii	Smilacaceae	Rare
Strobilanthes dupenii	Acanthaceae	Indeterminate
Syzygium courtallense	Myrtaceae	Endangered
S. gambleanum	Myrtaceae	Endangered
Tephrosia barberi	Papilionaceae	Rare
T. calophylla	Papilionaceae	Rare

Name of the species	Family	Status
Teucrium plectranthoides	Lamiaceae	Vulnerable
Thottea barberi	Aristolochiaceae	Vulnerable
Toxocarpus beddomei	Asclepiadaceae	Rare
Tylophora rotundifolia	Asclepiadaceae	Rare
Utleria salicifolia	Periplocaceae	Endangered
Vanasushava pedata	Apiaceae	Rare
Vanda wightii	Orchidaceae	Possibly extinct
Vanilla wightiana	Orchidaceae	Rare
Vernonia pulneyensis	Asteraceae	Endangered
V. recurva	Asteraceae	Endangered or possibly extinct
Wendlandia angustifolia	Rubiaceae	Presumed extinct
Willisia selaginoides	Podostemaceae	Rare
Youngia nilgiriensis	Asteraceae	Endangered
Pteriodophytes		
Cyathea nilgirensis	Cyatheaceae	Endangered
Dicranopteris linearis var. *sebastiana*	Dicranopteridaceae	Vulnerable
Elaphoglossum beddomei	Elaphoglossaceae	Rare
E. nilgiricum	Elaphoglossaceae	Endangered
E. stigmatolepis	Elaphoglossaceae	Vulnerable
Pronephrium thwaitesii	Thelypteridaceae	Vulnerable
Pseudocyclosorous gamblei	Thelypteridaceae	Endangered
P. griseus	Thelypteridaceae	Endangered
Sphaeropteris crinita	Cyatheaceae	Endangered

ECONOMIC USES

A large number of plants are used in our daily life for food, fodder, fibre, medicine, timber, firewood, fish-poisoning and in religious ceremonies. Tamil Nadu is rich in economically important plants. There are many edible and medicinal plants and timber trees apart from well known much-used ones. Some of the timber plants are *Acacia* spp. *Adenanthera pavonina, Aegiceras corniculatus, Alangium salvifolium, Albizia* spp., *Anogeissus acuminata, Artocarpus hirsutus, Avicennia officinalis, Bridelia retusa, Barringtonia acutangula, Bruguiera gymnorrhiza, Buchanania*

axillaris, Butea monosperma, Calophyllum inophyllum, Canarium strictum, Careya arborea, Dalbergia spp., *Diospyros* spp., *Dolichandrone atrovirens, Elaeocarpus* spp., *Ficus* spp., *Filicium decipiens, Garcinia* spp., *Holigarna arnottiana, Hopea* spp., *Lophopetalum wightianum, Michelia nilagirica, Myristica dactyloides, Oroxylum indicum, Palaquium ellipticum, Pterocarpus marsupium, Sterculia* spp., *Syzygium gardneri, Tetrameles nudiflora, Turpinia nepalensis, Trewia nudiflora, Vateria indica, Vitex altissima, Wrightia arborea, Xylocarpus granatum, Zanthoxylum rhetsa, Ziziphus mauritiana* var. *mauritiana,* etc.

In some wild plants the parts namely leaves, fruits and seeds are edible. Some of them are eaten during times of scarcity *viz. Abelmoschus manihot, Achyranthes aspera* var. *aspera, Alangium salvifolium, Aponogeton natans, Ardisia solanacea, Artocarpus* spp., *Asparagus racemosus, Baccaurea courtallensis, Buchanania axillaris, Calamus rotang, Capparis brevispina, Chenopodium murale, Chlorophytum tuberosum, Cleome gynandra, Coccinia grandis, Decalepis hamiltonii, Dioscorea* spp., *Phyllanthus emblica, Ficus* spp., *Flacourtia indica, Fragaria nilgerrensis, Garcinia* spp., *Limnophila aromatica, Leucas aspera, Mesua ferrea, Monochoria vaginalis, Momordica* spp., *Operculina turpethum, Passiflora edulis, Phoenix pusilla, Physalis* spp., *Sarcostemma secamone, Solanum* spp., *Sterculia* spp., *Syzygium cumini, Trema orientalis, Vallaris solanacea, Withania somnifera, Wrightia arborea, Xanthium indicum, Ziziphus* spp., etc.

Some of the medicinal plants found in this region are *Abelmoschus manihot, A. moschatus, Acacia* spp., *Acalypha fruticosa, Acorus calamus, Adhatoda vasica, Ageratum conyzoides, Alangium salvifolium, Aloe vera, Alpinia galanga, Anamirta cocculus, Aristolochia bracteolata, Asclepias curassavica, Bacopa monnieri, Bixa orellana, Buddleja asiatica, Calophyllum inophyllum, Calotropis gigantea, Canarium strictum, Cardiospermum halicacabum, Cassia* spp., *Cayratia* spp., *Centella asiatica, Cissus adnata, Cleome* spp., *Clerodendrum indicum, Cochlospermum religiosum, Commelina benghalensis, Corallocarpus epigaeus, Coscinium fenestratum, Cressa cretica, Crotalaria laburnifolia, Cuscuta chinensis, Cynodon dactylon, Datura stramonium, Dentella repens, Dioscorea* spp., *Drosera burmannii, Echinops echinatus, Eclipta prostrata, Erythrina suberosa, Euphorbia thymifolia, Evolvulus alsinoides, Fagopyrum esculentum, Galinsoga parviflora, Garcinia cowa, Glochidion zeylanicum, Grangea maderaspatana, Gymnema sylvestre, Hemidesmus indicus* var. *indicus, Hibiscus* spp., *Hybanthus enneaspermus, Hydrocotyle*

javanica, Ipomoea aquatica, Jatropha curcas, Kandelia candel, Launaea sarmentosa, Lepidagathis cristata, Mastixia arborea subsp *arborea, Memecylon umbellatum, Minusops elengi, Naregamia alata, Leptadenia reticulata, Lindernia anagallis, Litsea glutinosa, Macaranga peltata, Malva verticillata, Ocimum* spp., *Pavonia odorata, Pedalium murex, Pergularia daemia, Piper longum, Polygala* spp., *Polygonum orientale, Premna corymbosa, Radermachera xylocarpa, Rauvolfia densiflora, R. serpentina, Ruellia tuberosa, Sauropus quadrangularis, Sida cordifolia, Solanum hispidum, Sorghum halepense, Striga gesnerioides, Taraxacum officinale, Terminalia arjuna, Tribulus terrestris, Tridax procumbens, Tylophora indica, Utricularia bifida, Verbascum chinense, Vernonia cinerea, Vitex leucoxylon, Waltheria indica, Withania somnifera, Xanthium indicum, Xylocarpus granatum, Ziziphus oenoplia*, etc.

Fibres are extracted from *Abelmoschus manihot, Abutilon indicum* ssp. *indicum, Anodendron manubriatum, Antiaris toxicaria, Bauhinia vahlii, Calotropis gigantea, Cannabis sativa, Caryota urens, Cochlospermum religiosum, Corchorus capsularis, C. olitorius, Crotalaria retusa, Firmiana colorata, Holostemma adakodien, Sansevieria roxburghiana, Sida* spp. *Streblus asper, Trema orientalis, Urena lobata, Waltheria indica,* etc. Plants like *Ailanthes excelsa, Arundo donax, Careya arborea, Excoecaria agallocha, Ficus* spp. *Gmelina arborea, Kydia calycina, Lannea coromandelica, Macaranga peltata, Pterocarpus marsupium, Tetrameles nudiflora, Vateria indica,* etc. are used for the manufacture of paper.

Eichhornia crassipes and *Excoecaria agallocha* can be used for the production of power alcohol. *Abelmoschus ficulneus, Acacia leucophloea, Pterospermum canescens* and *Lannea coromandelica* are used as clarifier for sugarcane juice. A large number of wild relatives of cultivated plants such as species of *Alpinia, Amomum, Andropogon, Cinnamomum, Cissus, Coffea, Curcuma, Dioscorea, Garcinia, Lansium, Musa, Nephelium, Phaseolus, Rauvolfia, Saccharum,* etc. may be useful for breeding purpose.

Oil and fats can be obtained from *Bischofia javanica, Buchanania lanzan, Eruca sativa, Garcinia gummi-gutta, Madhuca longifolia, Manilkara hexandra, Semecarpus anacardium, Sterculia foetida* etc. *Acacia chundra, Adenanthera pavonina, Ailanthus triphysa, Bischofia javanica, Cassia tora, Lannea coromandelica, Pterocarpus marsupium, Wedelia chinensis,* etc. are some of the dye yielding plants of the State. Essential

oils extracted from *Abelmoschus moschatus, Acorus calamus, Aleurites moluccana, Anisomeles malabarica, Curcuma amada, Cymbopogon caesius, Michelia nilagirica, Vetiveria zizanioides,* etc. are useful in perfumery and preparation of cosmetics.

The plants commonly used for tanning are *Acacia* spp., *Bauhinia* spp., *Bischofia javanica, Bruguiera* spp., *Buchanania lanzan, Cassia auriculata, Ceriops tagal, Dalbergia sissoo, Kandelia candel, Rhizophora mucronata, Spondias pinnata, Terminalia* spp., *Xylocarpus granatum,* etc.

Parts of some plants or extracts from them are useful as insecticides. Some of such species are *Acorus calamus, Anamirta cocculus, Azadirachta indica, Echinops echinatus, Euphorbia thymifolia, Jatropha curcas, Sarcococca saligna, Sphaeranthus africanus, Vitex negundo,* etc. Plants like *Acalypha fruticosa, Cassia* spp., *Centrosema pubescens, Crotalaria semperflorens, Hydnocarpus laurifolia, Indigofera tinctoria, Peristrophe paniculata, Schleichera oleosa, Xanthium indicum,* etc. can be used as green manure.

A large number of species of plants are utilised as fodder for cattle and as fuel.

VULNERABILITY AND THREATS

The IUCN Committee for threatened plants has identified 23 factors as possible threats to natural population of plants viz. grazing, changes in arable farming, ploughing of old grasslands, forestry operations, traditional destructive practices, flooding, drainage, water pollution, air pollution, industrialization and urbanization, road laying, tourism development, dam construction, mining and quarrying, pressure from introduced plants, collections for horticulture, collections for botanical studies, critically low population status, natural causes, lack of pollinators and such other threats. The resultant effect of either one or several of these factors cause destruction of endangered and native species in the southen Western Ghats.

In South Indian hill stations the main factors affecting the loss of biodiversity are deforestation and destruction or modification of habitats. The vast area in the Nilgiris, Palnis and Anamalais have been converted into plantation and cultivated land. Potatoes and vegetables are cultivated in higher elevations and coffee plantations are found around Conoor, Kotagiri and Gudalur. Conversion of natural grasslands into

Eucalyptus and wattle plantations (forest plantation) is found around Doddabetta and Kundah range, Avalanche, Upper Bhavani, Mukurthi and Pykara. Major portions of the Kodaikanal Berijam grasslands are under Pine, Eucalyptus and wattle plantations. In Nilgiris small plantations of other exotics such as *Cupressus macrocarpa, Swietenia macrophylla, Callitris rhomboidea,* etc. also occur. In the lower reaches plantations of teak and Bamboo have been raised.

Pressure from introduced plants : Several exotic trees and shrubs introduced by European settlers, farmers, gardeners and foresters as ornamental and economically useful plants from other parts of the world in Nilgiris encroach the natural montane flora. Spread of certain exotics like *Eupatorium, Scoparia* and *Ulex europeus* has given great pressure on the native plants. The exotics with large, beautiful flowers have been found to be highly attractive to insects, thus providing a stiff competition to the native plants in their bid for pollinators.

Urbanization, Building townships, Roads, Dams and Industrialization : These are man-made threats to biodiversity. The availability of good land, water, power, congenial climate and forest resources have made Nilgiris more attractive and drawn a large population The increase in human population and settlements have led to an unplanned growth of urban centres and plantations putting a severe strain on the natural resources of the area. Many hydroelectric projects like Upper Bhavani, Kundah, Pykara, Avalanche, Mukurthi etc. and other developmental activities were at the expense of the sholas and grasslands of western Nilgiris.

Tourism development also affects the flora and vegetation of an area. Nilgiris, "Queen of hill stations", and Kodaikanal are summer resorts and important tourist centres. Many lodging houses, clubs, picnic spots, garden roads etc. have been constructed resulting in clearance of the natural vegetation.

The major threat for Agastyamalai hills and Palni hills are human interference. The tallest peak called Agasthyarkudam in Agasthyamalai hills is associated with the mythological sage Agastya and it is, like Palni, an important pilgrimage spot. Every year thousands of devotees from Kerala and Tamil Nadu visit this place. The devotees cut and burn many rare plants of Agastyarkudum to keep themselves warm during the cold winter nights. *Pinanga dicksonii* is a rare palm, it is cut by almost

every pilgrim for using as walking sticks for climbing hills. Large scale collection of medicinal plants and beautiful rare orchids are going on without any restriction whatsoever

Overexploitation of plants for commercial, scientific and educational purposes (material for research and for making herbaria) also bring about adverse effects on the vegetation.

Pastoralism and livestock rearing are the main occupation of hill tribes. Overgrazing leads to degradation of grasslands that harbour a good number of endemic plants.

The annual fire during summer months is often a man-made threat to the plants.

Changes in arable farming : The Badagas who have colonized the Nilgiri hills form an agricultural community. Their intensive agriculture, shifting cultivation on the slopes, swamps and along perennial streams have a great impact on the natural vegetation.

CONSERVATION STRATEGIES

First of all status evaluation of species has to be undertaken. Intensive and extensive field surveys to the type localities and places of previous collections of rare plants and adjoining hill ranges for rediscovery of these plants and collection of seeds and to find out the present status. In the case of species of *Strobilanthes* careful and thorough exploration of the area is essential as these bloom after long intervals.

If the status surveys are successful in locating some populations, the area of its occurrence must be immediately fenced off from biotic interference. Elimination of biotic factors especially fire to safegaurd the habitats is an immediate necessity. Measures are to be undertaken for *in situ* conservation with the help of State and Central Government and declaration of the habitat as protected reserves, and to take steps to increase its population in the wild.

Attempts must be made to study the ecology and reproduction biology of the species and to understand means of their propagation. *In-situ* and *ex-situ* conservation measures to save it from possible extinction must be undertaken.

Living plants or rhizomes are to be collected and cultivated in botanic gardens and conservatories and other areas having similar natural habitats and ecological environment.

Propagation of rare, endangered and endemic taxa through biotechnological methods has to be attempted.

Collection of seeds and resowing in similar edaphic and climatic conditions, and maintainance of the germ-plasm by keeping the seeds in modern seed banks and replacing them by fresh collection every year as seeds of some species have poor viability have to be done.

After obtaining sufficient number of reproductive materials they can be supplied to plant lovers and general public.

Commercial farms for medicinal plants are to be established to prevent uninterrupted plant collection from the forests. Possible uprooting of the plants for other than conservation purposes should be prohibited whenever rare plants are located in the wild. Collection of less known economic plant species and wild relatives of cultivated plants and their *in situ* and *ex situ* conservation have to be attempted.

Rare and endangered species are to be excluded from the list of Minor Forest Produce.

Unscientific methods of collection of plant parts to be replaced by modern techniques.

Autecological studies to be undertaken for the identified species in the Red data book.

Ecologically fragile eco-systems such as "High mountain tops" are to be protected.

Identification of tree species needing conservation must be done on top priority basis.

Awareness of the public, tribals and staff concerned regarding the importance of rare, threatened and endemic plants is to be created by publicity materials like pamphlets, signboards and similar other methods.

Biosphere Reserves

The concept of Biosphere reserves was originated as a mean to protect the valuable genetic resources *in-situ* for posterity. They provide less expensive protection for the wild relatives of crops. The Biosphere Reserves have been formed as per the guidelines of UNESCO. In Tamil Nadu there are two Biosphere Reserves viz. Gulf of Mannar Biosphere Reserve and Nilgiri Biosphere Reserve.

The Nilgiri Biosphere Reserve: The Nilgiri tract was the first choice for the constitution of a Biosphere Reserve in India. It embraces the sanctuary complex of Wynad, Nagarhole, Bandipur and Mudumalai, the entire forested hillslopes of Nilambur and Nilgiris, the Upper Nilgiri Plateau, the Silent Valley and the Siruvani hills. It covers parts of the forests of Western Ghats in Tamil Nadu, Karnataka and Kerala and forms a regional Conservation Centre of plant wealth. The total area of this Biosphere Reserve is around 5670 Km^2 of which 2020 Km^2 is the core zone, 2290 Km^2 the manipulation zone (forestry) and it has around 1330 Km^2 as manipulation zone (Agriculture) and 30 Km^2 as restoration zone. It includes substantial unspoilt areas of natural vegetation types ranging from dry scrub, dry and moist deciduous, semievergreen and wet evergreen forests, evergreen sholas, grassy downs and swamps. The region includes many less known groups of plants including endemic and endangered species of plants. About 80% of the flowering plants reported from the Western Ghats appear to occur in the Nilgiri Biosphere Reserve.

Gulf of Mannar Biosphere Reserve: The Gulf of Mannar marine province is situated between the mainland of India and Sri Lanka. There are about 20 odd isles which extend from Pamban area to Tuticorin. They provide a variegated, very interesting heterogenous and at once unique habitats for its donizens. Nalla Thani Tivu (101.20 Ha), Musal Tivu (129.04 Ha) and Krusadai Islands (65.80 Ha) have been notified for the formation of a Marine National Park under the Wildlife Protection Act of 1972 by the Forest and Fisheries Department in Tamil Nadu Government.

Tamil Nadu has a few Wild Life Sanctuaries and Nature Reserves dedicated to the preservation of wild life.

Wildlife Sanctuaries

		Area
Indira Gandhi Wildlife Sanctuary (Anamalai Wildlife Sanctuary)	Coimbatore	96003 Ha
Guindy National Park	Chennai	300 Ha
Kalakkad Wildlife Sanctuary	Nellai Kattabomman	25064 Ha
Mudumalai Wildlife Sanctuary	Nilgiri	39946 Ha
Mundanthurai Tiger Sanctuary	Nellai Kattabomman	56700 Ha
Mukurthi Nilgiri Tahr	Nilgiri	7846 Ha
Point Calimere Sanctuary	Thanjavur	1726 Ha
Pulicat lake bird Sanctuary	Pulicat	15367 Ha
Vedanthangal Water bird Sanctuary	Chengalpattu	30 Ha
Vettangudi bird Sanctuary	Ramanathapuram	38 Ha
Srivilliputur Grizzled Squirrel Wildlife Sanctuary	Kamarajar	48520 Ha
Arignar Anna Zoological Park	Chennai	510 Ha

Nature Reserves

There are some areas specially reserved for conservation of plant communities, as against Wildlife Sanctuaries.

Kalakkad	Nellaikattabomman	Semi-evergreen	5485.52 Ha
Papanasam	Nellaikattabomman	Dry deciduous	4338 Ha
Kuthanachiar	Madurai	Mixed deciduous	2017 Ha
Tiruchidambar valley	Madurai	Mixed deciduous	673.39 Ha
Mathikettan Shola	Madurai	Montane wet temperate	400 Ha
Karian shola	Coimbatore	Moist deciduous Post climax	400 Ha
Veerapuli	Kanyakumari	Moist deciduous	357.72 Ha

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Tropical evergreen forest at Meghamalai, high wavy mountains, Madurai dist.

Riparian vegetation along river Tamaraparni, Tirunelveli dist.

Eastern slopes of western ghats showing the merger of scrubs with plains

Habenaria longicorniculata : a common ground orchid
in high altitude grassland of Nilgiris

Dendrobium anamalayanum : a rare epipnytic endemic orchid in Anamalai hills

Peperomia dindigulensis : large herb on wet rocks and branches of trees

Aeschynanthus perrottetii : an evergreen element

Polygonum nepalense : a common herb in
the ground layer of evergreen forest

Aristolochia tagala : a common medicinal plant

Plectranthus barbatus : a plant with edible roots

Madhuca longifolia : an evergreen element along riverbanks

Gouania microcarpa : a common climber in moist deciduous forest

TRIPURA

D.B. Deb

The state of Tripura lies between 22°56' - 24°32' N latitude and 91°10' 92°21' E longitude covering an area of 10477 sq km, bounded by the international border of Bangladesh to the west, the south and the north, and by the Barak valley of Assam to the north-east and by Mizoram to the east.

Originally it was the Hill Tippera, a Princely State for nearly 500 years with Bengali as the state language. Three distinct zones, namely i) Hill ranges, ii) Undulating high lands of narrow and broken plateau and iii) Low lands and river flats are distinguishable.

Five major ranges of hills running from north-west to south-east and alternating with marshy valleys are spread over the state. These ranges lie at an average distance of about 20 km. They are the (a) Jampui (b) the Sakhantlang (c) the Longtarai (d) the Atharamura and (e) the Baramura-Debtamura ranges. In between Sakhantlang and Longtarai lies the Unakoti. The highest peak lies at Betling Sib, 975.36 m above the sea level, (ii) Undulating high lands of narrow and broken plateau cover extensive areas. (iii) Low lands and river flats are generally level lands where rivers deposit their alluvium.

Geologically, the rock formations range in age from the lower tertiary to the recent. All the recent deposits in the form of sands, gravels and silt consitute alluvium. Laterite is relegated to the pleistocene.

Soils of high land are developed from sandstone and shales and are podsolic and lateritic. Soils of the low land are developed from the alluvium deposited by the rivers. (Deb 1975).

The climate of the state is characterised by moderate temperature and a highly humid atmosphere. The average annual rainfall is about 2100 mm. About 63% of the rainfall is received in the south-west monsoon season. The maximum temperature recorded at Agartala was 40° C and the minimum was 3.9° C.

VEGETATION

The quantum of botanical exploration of India was assessed and evaluvated state wise on the basis of the study of aquatic vascular plants of India. (Deb 1977)

Vegetation of a region is mostly the resultant effect of climatic, edaphic, physiographic and biotic factors. Shifting cultivation or jhumming is a biotic factor that to a very large extent contributed to the ecological changes of the original vegetation. Land cleared of the forest and repeatedly jhummed and abandoned is favorable for bamboo growth.

Vegetation of the state is classified under climatic types, seral types and subsidiary edaphic types. The climatic types are represented by Evergreen forest (including the so called semi-evergreen type) and Moist deciduous forest comprising, (a) Sal forest and (b) Moist deciduous mixed forest. The seral types are represented by swamp vegetation. Subsidiary edaphic types comprise Bamboo forest, Cane brakes, Garjan forest, Savannah and Grassland vegetation. (Deb 1975, 1981, 1983).

1. The Evergreen Forest

The evergreen forest cover the major part of the state in Dharamnagar subdivision , Kailashahar subdivision , Jampui Sakhan ranges , parts of Belonia, Sabroom , Kanchanpur and Sadar subdivision. It occupied wider areas in the past. Having been repeatedly subjected to biotic influences, the forest are depleted to a very large extent, now existing only in patches in the steep slopes, rocky and steady river banks and localities which are not suitable for shifting and plough cultivation. Evergreen forest of this state are intermediate between Cachar evergreen forest and Chittagong evergreen forest (Champion 1936, Champion and Seth 1968). Semi-evergreen forest are generally known as primary type of forest basically distint from the evergreen ones. Evergreen forest existing in more exposed aspects and disturbed areas appear like semi-evergreens.

Lofty dense evergreen forest are characterised by a large number of species. Most of the species of the top canopy are evergreen with tall clear boles. Some are semideciduous or deciduous which do not interfere with the evergreen nature of the forest as a whole.

Dipterocarpus turbinatus, Artocarpus chaplasha, Amoora wallichii, Aphanamixis polystachya, Syzygium polypetalum, Eugenia praecox, Schima wallichii, Elaeocarpus spp., *Tetrameles nudiflora* (scarce and overheading all others) and many others dominate the top canopy. The middle and lower canopies are dense and varied. *Knema angustifolia, K. linifolia,K. malayana, Horsfieldia amygdalina, Dysoxylum binectariferum, Acrocarpus fraxinifolius, Michelia champaca, Cinnamomum glanduliferum, C. iners, Cinnamomum bejolghota, Holigarna longifolia, Turpinia pomifera, Ardisia* spp., *Litsea* spp., *Neolitsea zeylanica , Persea* spp. and rest of others form the second storey. Bamboos are frequent. Small palms are common. Epiphytes are not numerous. Ferns, orchids, mosses, etc. are principal epiphytes. Climbers are plenty.

Araceae, Zingiberaceae, Taccaceae, Liliaceae, Haemodoraceae Commelinaceae are very common.

2. Moist deciduous forest

This type of forest are very common all over the state. They are dominated by deciduous trees, and are of two types, characterised by the presence or absence of Sal (*Shorea robusta*).

Sal forest lies in Belonia, Udaipur, Sonamura and Sadar sub-divisions. In such forest, Sal is the ecologically characteristic and economically important species that dominates over more than 60% of the top canopy.

Moist deciduous forest devoid of Sal, cover the largest area of the forest. Dominants are mostly deciduous but subdominants and lower storey are composed largely of evergreen species. Top canopy is not dense. Differentiation in canopy layers, strictly speaking, does not exist.

3. Garjan forest

It cover a small area at present. These occur in Khowai, Muhuri, Tulatalikona, Chailengta, Deo, Dharmanagar, Jalaya, and other places. The forest is dominated by Garjan (*Dipterocarpus turbinatus*) occurring in groups. It is also associated with Sal. It forms a closed canopy.

4. Swamps

It is locally called 'Lunga' cover a large area of the state. Mostly herbaceous species, some shrubs and a few scattered trees are found in such a situation. *Barringtonia acutangula, Lagerstroemia parviflora, Albizia procera, Mallotus philippensis, Macaranga denticulata* are important trees. *Phragmites karka, Saccharum arundinaceum, Clinogyne dichotoma,* etc., are common.

5. Bamboo forest

This type of forest cover large areas as in Mizoram, Chittagong and Myanmar. Scattered trees interrupt the continuity of the Bamboo forest.

6. Cane brakes

It occur in wet hollows extending outwards to various directions. These are impenetrable thorny thickets situated in patches in the evergreen, semi-evergreen, and moist deciduous forests in contact with tall trees near water. *Calamus guruba, C. floribundus, C. erectus, C. leptospadix, C. viminalis,* etc. are common canes. Cane brakes of this state have been too much deteriorated because of large scale supply during the second World War.

7. Grasslands

The grasslands owe their origin to human activities like shifting cultivation, felling, lopping, forest fire, etc. These biotic factors have operated in varying combinations and intensities to produce relatively stable types of grasslands which are, however, only stages in regression to the original forest types under the influence of repeated fire and grazing. Grassland community is a biotic sub-climax or a biotic plagioclimax. Locally grassland may be formed as an edaphic climax on wet soils. Development of grasslands in Tripura follows the general pattern in large parts of the country within the climatic and altitudinal limits.

Jheels and low marshy localities are gradually silted by hill wash and organic debris carried with the flow of flood water. Gradually marshy and aquatic grasses in course of time take possession of the land. The flow of water is gradually slowed down with the accumulation of large quantities of silt followed by rise in surface level of the land making it

suitable for other plants to grow thereon and in course of time higher life forms may form a fairly stable forest.

8. Aquatic vascular plants

A survey of aquatic vascular plants of India shows that there are 35 taxa cosmopolitan or widely distributed over the earth. All of these occur in West Bengal, Assam, Tripura and Manipur, while most of them (33) are in Maharastra, U.P., Bihar and Tamilnadu (32). Of the 144 aquatic vascular plants occurring in India, 94 taxa are represented in West Bengal, 87 in Tamilnadu, 81 in Maharastra, while 45 in Tripura, 29 in Arunachal Pradesh. None of the 24 species restricted to temperate climate or saline or brakish water is found in Tripura.

There are 38 taxa which are not so widely distributed over the earth or so common in India, all of which occur in West Bengal, 27 in Bihar, 25 in Orissa but only 8 in Tripura, 9 in Manipur and 4 in Arunachal Pradesh.

DIVERSITY

It is estimated that about 86% of the flora is widely distributed in India and adjoining countries. The flora of Tripura state (Deb 1981, 1983) is represented by 1546 species in 862 genera and 192 families of vascular plants as folllows

Plant group	Famlies	Genera	Species
ANGIOSPERMS	168	816	1463
Dicot	139	637	1160
Monocot	29	179	303
GYMNOSPERMS	6	8	13
PTERIDOPHYTA	18	38	70
Total	192	862	1546

The ratio of genera and species, dicot and monocot species also gives an idea of the diversity pattern The proportion of monocot and dicot species in the world is 1:4.35. These data for Tripura and adjoining states are as follows

Proportion of taxa	India	Tripura	Mizoram	Manipur
Monocot:Dicot spp.	1:2.3	1:3.82	1:2.91	1:3.64
Monocot:Dicot genera	1:1.81	1:1.95	1:2.11	1:3.40
Genera:Species in Angiosperms	1:7	1:1.79	1:2.00	1:208

The number of genera and species in Tripura are tabulated and compared below with those of Manipur and Mizoram.

Name of the Group	Tripura		Manipur		Mizoram	
	Genera	Species	Genera	Species	Genera	Species
ANGIOSPERMS	816	1463	948	1977	601	1199
Dicot	637	1160	730	1542	457	892
Monocot	179	303	218	435	144	307
GYMNOSPERMS	8	13	12	15	6	6
PTERIDOPHYTA	38	70	60	200	47	134
Total	862	1546	1020	2192	654	1339

It is evident from the foregoing table that the Flora of Tripura has a larger number of genera and species than those of Mizoram and Manipur having much varied climatic conditions and about the double in area is obviouly having a larger number of genera and species.

Families with more than 20 species each are tabulated below in order of the abundance of species. The numbers of genera in the family are given in parenthesis.

Sl.No.	Family	No of species (Genera)
1.	**Fabaceae** (Leguninosae)	144 (64)
2.	**Poaceae** (Gramineae)	79 (49)
3.	**Rubiaceae**	76 (39)
4.	**Euphorbiaceae**	67 (31)
5.	**Asteraceae** (Compositae)	54 (39)

Sl.No.	Family	No of species (Genera)
6.	Lamiaceae	34 (23)
7.	Cyperaceae	33 (11)
8.	Orchidaceae	33 (23)
9.	Verbenaceae	30 (13)
10.	Moraceae	29 (5)
11.	Acanthaceae	28 (19)
12.	Scrophulariaceae	28 (11)
13.	Solanaceae	26 (11)
14.	Cucurbitaceae	26 (16)
15.	Malvaceae	25 (11)
16.	Araceae	26 (15)
17.	Zingiberaceae	24 (9)
18.	Apocynaceae	22 (20)
19.	Convolvulaceae	22 (9)
20.	Lauraceae	21 (8)
	Total	827(426)

15 of these families are represented by Dicotyledons and the remaining 5 are monocots. Fabaceae is with largest number of genera and species. Poaceae is the second family in this respect.

PHYTOGEOGRAPHY

J.D. Hooker (1909) placed Tripura in his subzone Northern Burma that includes Mizoram, Chittagong (Bangladesh), Arakan (Myanmar) and Andaman Islands. Vegetation throughout this subregion approximates to that of the Eastern Himalayas differing conspicuously in the absence of the alpine zone and species of *Picea, Abies, Tsuga, Larix* or *Juniperus* and in the presence of Nepal and Sikkim palm *Trachycarpus maritianus* In the valleys and in lower elevations, the vegetation of the tropical zone of the Himalayas prevails. The absence of temperate climate or altitude restricts the flora of Tripura to that extent.

The flora of North Tripura is similar to or in continuation of that of the adjoining Barak valley of Assam (Karimganj, Hailakandi and Cachar)

and of Bangladesh (South Sylhet). In the north eastern region Jampui and Sakhantlang forest are in continuation of the forest of Mizoram. In the Sabroom district the flora is akin to or in continuation with that of Chittagong district of Bangladesh where Dipterocarpaceae, Lauraceae, Ternstroemiaceae, Euphorbiaceae and Fabaceae are well represented. The Garjee Sal forest is in continuation of the Sal forest of Chittagong. The Garjan forest (*Dipterocarpus turbinatus*) is likewise similar to that of Chittagong. The Sal forest in Belonia evidently gives an impression of the former existence of the Sal forest extended over the whole area.

ENDEMISM

Tripura, a Princely State for centuries before independence of the country, having no high altitude or climatic extremes and being surrounded by botanically richer localities did not attract any explorer in early days. On the other hand, a fairly large number of new taxa were described from the surrounding regions. As a consequence, no new species could be discovered from this State. About 86% of the species occurring in Tripura are widely distributed in India and adjoining countries, the remaining 14% of the species are of comparatively restricted distribution. Several species described from the nearby localities are worthy of report.

THREATENED AND RARE TAXA

Name of the species	Family	Distribution
Begonia surculigera	Begoniaceae	Tripura (Unokoti); Myanmar
Colona flagrocarpa	Tiliaceae	Tripura (Sakhan Tlangsang); Bangladesh (Chittagong)
Ophiorrhiza villosa	Rubiaceae	Tripura (Kumarghat and Sipaijala), South Andaman; Bangladesh (Chittagong), Myanmar
Torenia mucronulata	Scrophulariaceae	Tripura (Ghorakappa); Myanmar

Name of the species	Family	Distribution
Tournefortia roxburghii	Scrophulariaceae	Tripura (Sabroom), Mizoram; Bangladesh (Chittagong)
Jasminum listeri	Oleaceae	Tripura (Jampui ranges), Mizoram; Bangladesh (Chittagong)
Wallichia caryotoides	Arecaceae	Tripura (Baramura and Atharamura ranges), Mizoram; Bangladesh (Chittagong)
Cycas pectinata	Cycadaceae	Tripura (Baramura range), Manipur; Assam
Podocarpus neriifolius	Podocarpaceae	Tripura (Laljuri), Assam, Manipur, West Bengal; Bangladesh.
Gnetum montanum	(Gnetaceae	Tripura (Teliamura), Eastern India
G. oblongum	Gnetaceae	Tripura (Silachari), Eastern India
Mangifera sylvatica	Anacardiaceae	Tripura (Teliamura and Ambasha)
Dischidia benghalensis	Asclepiadaceae	Tripura, Assam, Arunachal Pradesh, Nagaland, Manipur; Thailand and Indonesia
D. nummularia	Asclepiadaceae	Tripura, Assam, Arunachal Pradesh, Nagaland, Manipur; Thailand and Indonesia
D. major (= *D. rafflesiana*)	Asclepiadaceae	Tripura, Assam, Arunachal Pradesh, Nagaland, Manipur; Thailand and Indonesia

Taxa restricted to Assam and Tripura : *Dalbergia thomsonii, Desmodium griffithianum, Fissistigma verucosum,* extending to Meghalaya and Mizoram also, *Ixora subsessilis, Lasianthus tubiflorus, Litsea meissneri, Ophiorhiza subcapitata, Nycticalos thomsonae, Phlogacanthus guttatus, P. tubiflorus, Pogostemon hispidus, Rhaphidophora lancifolia, Steudnera assamica, Tetrastigma obovata* and *Xantolis assamica.*

Taxa restricted to Bangladesh, Assam and Tripura : *Desmos longiflorus, Michelia baillonii, Elaeocarpus prunifolius, Antidesma roxburghii, Garcinia acuminata, Diospyros stricta, Protium serratum, Syzygium polypetalum, Sabia lanceolata, Tarena disperma, Premna esculenta, P. coriacea* var. *cuneata, Pycnarrhena planiflora, Argyreia argentia, A. splendens, Staurogyne argentea, Phlogacanthus curviflorus, Rhinacanthus calcaratus, Paspalum longifolium* var. *lorhirachis, Milletia caudata, Cotula haemispherica, Homalonema aromatica* and *Stichoneuron membranaceum.*

Taxa restricted to Myanmar, Bangladesh, Assam and Tripura : *Calliandra umbrosa, Staurogyne thyrsioides, Acrocephalus verbaenifolius, Castanopsis armata, Begonia barbata, Byttnera pilosa, Sterculia versicolor, Combretum dasystachyum, C. flagrocarpum, Acanthus leucostachyus, Microtaena cymosa, Palaquium polyanthum, Chisocheton paniculatus, Willughbeia edulis, Aglaionema hookerianum, Alocasia fornicata* and *Coelogyne graminifolius.*

Taxa restricted to Myanmar, Assam and Tripura : *Beilschmiedia assamica, Acacia prunescens, Aporusa oblonga, Memecylon celastrinus, Paramignya scandens, Dysoxylum procerum, Jasminum coarctatum, Melodinus khasianus, Premna pinguis* and *Gomphostemma wallichii.*

Taxa restricted to Eastern Himalaya, Assam and Tripura : *Cryptocoryn amygdalina, Phoebe attenuata, Rubus hamiltonii, Dalbergia lanceolaria, Dalbrgia rimosa, Lonicera glabrata, Elatostema papillosum, Pilea scripta, Sloania dasycarpa, Actephila excelsa, Phyllanthus fraternus, Leea bracteata, L. trifoliata, Ardisia neriifolia, Jaminum caudatum, J. subtriplinum, Ophiorrhiza lucida, Wendlandia wallichii, Clerodendrum bracteatum, Holmskioldia sanguinea, Stephania glandulifera, Dichrocephala hamiltonii, Lycianthus macrodon, Eranthemum palatiferum, Strobilanthes capitatus, Aeschynanthus grandiflorus, Melissa axillaria, Globba clarkei, G. multiflora, Rhaphidophora decursiva, Calamus leptospadix, Oberonia pachyrachis* and *Scleria terestris.*

Taxa distributed in Eastern Himalaya, Arunachal Pradesh Assam, Tripura and Bangladesh: *Magnolia pterocarpa, Litsea laeta, Persia villosa, Dalhousia bracteata, Derris robusta, Brassaiopsis griffithii, Bridelia assamica, Glochidion lanceolatum, Eugenia praecox, Ilex umbellata, Olax acuminata, Tolypanthus involucratus, Tetrastigma bracteatum, Sabia limonacea, Pegia nitida, Strychnos wallichiana, Hoya globulosum, Ixora acuminata, Premna latifolia* var.*mucronata, Eranthemum strictum, Tournefortia candollei, Amischotolype hookeri, Amomum linguiforme* and *Calamus floribundus.*

Taxa distributed in Eastern Himalaya, Arunachal Pradesh, Assam, Tripura and Myanmar : *Fissistigma bicolor, Goniothalamus sesquipedalis, Litsea lancifolia, L. panamouja, Tephrosia candida, Brassaiosis griffithii, Maesa chisia, M. montana, Aesculus assamica, Psychotria denticulata, Cordia grandis, Wedelia wallichii, Solanum barbisetum, Solanum kurzii, Ipomoea kingii, Achyrospermum wallichianum, Rhaphidophora peepla, Dendrobium cathcartii, Hetaeria rubens, Ornithochilus fuscus* and *Sarcanthus filiformis.*

Taxa distributed in Eastern Himalaya, Arunachal Pradesh, Assam, Tripura, Bangladesh and Myanmar : *Knema angustifolia, K. linifolia, Millettia pachycarpa, Mucuna bracteata, Gynocardia odorata, Hydnocarpus kurzii, Stixis suaveolens, Begonia roxburghii, Grewia sapida, Pterospermum lancaefolium, Croton joufra, Glochidion sphaerogynum, Garcinia paniculata, Osbeckia rostrata, Sonerila maculata, Jasminum scandens, Hedyotis lineata, Ixora villosa, Morinda angustifolia, Mussaenda roxburghii, Psychotria calocarpa, P. fulva, Uncaria pilosa, U. sessilifructus, Wendlandia grandis, Cordia fragrantissima. Blumea lanceolaria, Acrocephalus verbaenifolius, Peliosanthes teeta, Calamus tenuis, Pinanga gracilis, Acampe papillosa* and *Podochilus cultratus.*

Taxa distributed in Eastern Himalaya, Assam, Tripura, Myanmar, and China : *Indigofera atropurpurea, Kydia calycina, Schima wallichii, Maytenus hookeri, Maesa ramentacea, Jasminum anastomozans, Stelmatoctrypton khasianus, Callicarpa rubella* and *Lysionotus serratus.*

Taxa restricted to Assam, Manipur, Tripura, Andaman Islands and Myanmar : *Horsfieldia amygdalina, Adenia trilobata, Jasminum subglandulosum* and *Psychotria adenophylla.*

Taxa restricted to Tripura, Assam, Arunachal Pradesh, Nagaland, Manipur, Indonesia, Andaman Is., Myanmar, Bangladesh and Thailand : *Erycibe peguensis* and *Dischidia nummularia*

Taxa discontinuously distributed in Western ghats, Assam, Tripura, Bangladesh, Myanmar : *Artocarpus heterophyllus., Gardenia resinifera, Caesalpinia mimosoides, Caesalpinia digyna and Vitex altissima.*

ECONOMIC PLANTS

In an attempt to assess the economic potential of the vegetable resources of the State useful plants were grouped from a utilitarian point of view and a series of papers were published in this regard (Deb 1975-1981). Some of the most useful timber yielding plants are *Shorea robusta, Tectona grandis, Albizia procera, A. lucida, Artocarpus chaplasha, Chukrasia velutina, Dipterocarpus turbinatus, Duabanga grandiflora, Lagerstroemia parviflora, L. speciosa, Mesua ferrea, Terminalia alata* var. *tomentosa, T. bellirica, T. myriocarpa, Toona ciliata, Careya arborea, Gmelina arborea, Stereospermum personatum, Magnolia pterocarpa, Vitex peduncularis, Syzygium cumini, Cinnamomum bejolghota, Dillenia indica, D. pentagyna, Michelia champaca, Palaquium polyanthum* and many others.

Medicinal plants

129 species are recognized as officinal drugs in Indian Pharmacopoea. 61 of these grow in this State, 26 as wild and 35 under cultivation as garden plants. In addition to those recognized as officinal, 350 vegetable products are used in Ayurvedic and Unani medicine, of which 131 species grow in the State, 79 as wild and 52 under cultivation as garden plants. Again, of 2535 taxa named in Chopra's Glossary of Medicinal Plants, 628 are found here, 403 in wild state and 225 as garden plants. Of the wild ones, 143 are rare. It is worthwhile to mention here that 349 of those 628 species are known more for economic importance other than medicinal. 158 most important medicinal plants in Tripura were enumerated with local names, parts used, occurrence, flowering and fruiting time etc. (Deb 1968, 1978). Some of the most important ones are *justicia adhatoda* (Acanthaceae),*Andrographis paniculata* (Acanthaceae) *Aquillaria malaccensis* (Thymelaeaceae), *Asparagus reticulatus* (Liliaceae), *Bacopa monniari* (Scrophulariaceae). *Centella asiatica*

(Umbelliferae). *Phyllanthus emblica* (Euphorbiaceae), *Hemidesmus indicus, Holarrhena pubescens,* (Apocynaceae) *Hydnocarpus kurzii, Ocimum tenuiflorum* (Labiatae) *Marsilea minuta, Phlogacanthus thyrsiflorus* (Acanthaceae), *Rauvolfia serpentina* (Apocynaceae), *Saraca asoca* (Fabaceae), *Terminalia bellirica* and *T. chebula* (Combretaceae), *Vitex negundo* and *V. peduncularis* (Verbenaceae).

VULNERABILITY AND MAJOR THREATS

Biodiversity is a natural phenomenon primarily based on geographical situation, geological formation, altitude, temperature, annual rainfall, etc. This natural phenomenon is influenced by anthropogenic factors i.e., the activity of man in different ways, which are detrimental to the environmental conditions by way of deforestation, construction of roads, urbanization, agricultural extensions and in many other ways, which influence biodiversity to a very large extent more in a tropical country than in others. Change in environmental condition is detrimental to biodiversity. Increasing pressure of population on land and vegetaion, encroachment of forest land, clear felling of forest, land slides, soil erosion, shifting cultivation or jhumming, forest fire, construction of roads, water channels, floods, silting of river beds, etc. lead to change in the original vegetation and change of forest types to the detriment of biodiversity. Destruction of the habitat, over harvesting, inappropriate introduction of foreign plants, uncontrolled use of pesticides, antibiotics, overuse of artificial manure, etc. are also harmful to biodiversity.

Delicate plants are vulnerable to change in atmospheric condition from humid to dry. Again, a plant is associated with other life forms of different species, genera and families in a facultative way of mutual benefit and co-existence. Dessication or destruction of a plant brings about a change in adaptabilty of associated ones.

The type specimen of *Keenania modesta* (Rubiaceae) originally collected from Duarband Pass, Cachar in 1874 by R.L. Keenan before the establishment of Tea gardens could not be traced out. The original habitat and environmental condition of the locality have undergone such a change leading to extinction of the plant from the locality. In humid tropical climate epiphytes commonly grow on forest trees. Three species of *Dischidia* viz., *Dischidia benghalensis, D. nummularia* and *D. major* were very common in Barak valley of Assam, and in several localities in Tripura until recently, but they could not be located in those places where

they were growing Likewise *Rauvolfia serpentina* which was scattered over many localities in West Tripura is now very rare.

Shifting cultivation influences the ecological changes of the original vegetation. Land cleared of forest and jhummed and abandoned is detrimental to biodiversity. Swamp vegetation, bamboo forest, cane brakes, garjan forest and grassland vegetation have undergone rapid changes and affected the biodiversity.

Vast areas of natural forest brought under tea or rubber plantations or plough cultivation must have led to the destruction of many plants and habitats of many animals.

Very large scale cultivation of an American *Dioscorea* for extraction of diosgenin leaving aside important Indian ones and large scale cultivation of rubber plants for rubber industry have been taken up by the Govt. of Tripura. It will take some years to find out the influnce of these plants in the country.

CONSERVATION MEASURES

Belonia Nature reserve has been proposed by the Govt. of Tripura. No tangible action seems to have been taken so far.

Population explosion demanding human habitations, agricultural extensions, industrial development and the like is to be accommodated at the cost of natural vegetation or in otherwords floristic diversity.

It is not possible to maintain original biodiversity in natural course in view of topmost necessity of human society. Utmost efforts may be taken to minimise the interference with the natural vegetation and ecological conditions of a locality. That too is possible if the use of additional land is kept to the minimum by substitution of alternative means.

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Saraca asoka
(Courtesy : M. Sanjappa)

Curcuma aromatica
(Courtesy : H.J. Chowdhery)

UTTAR PRADESH

B.P. Uniyal
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Uttar Pradesh, constituting 73 districts, is one of the largest states of India spread over an area of 2,94,411 sq km i.e. about 9% of the total area of the country. It lies between 23°90' - 31°18' N latitude and 76°95' - 84°67' E longitude. Politically, the state is bounded by Bihar in the east, Nepal and Tibet in the north, Delhi, Haryana, Himachal Pradesh and Rajasthan in south west, and Madhya Pradesh in the south. The state has a wide altitudinal range and accordingly a varied climate that accounts for a rich and diversified flora. Uttar Pradesh has the unique distinction of having two biogeographical zones, the "Western Himalaya" and the "Upper Gangetic Plains" which extend to the neighbouring states also. The state can be divided into three distinct physiographic regions as follows

1. The Himalayan Region

This region is well known for its lofty peaks like Nanda Devi (7817 m), Kamet (7756 m), Nilkanth (7596 m), Trishul (7140 m), Kedarnath (7138 m), Dunagiri (7066 m) and many others. The great rivers like the Ganga, Yamuna, Tons, Ramganga, etc. all originate from the glaciers/lakes situated in this part of Himalaya that is better known as "Western Himalaya". The only Biosphere Reserve of the state "The Nanda Devi Biosphere Reserve" is in this part of Uttar Pradesh. The entire region accounts for one-sixth of the total area of the state.

2. The upper Gangetic Plain

This region falls between the Himalaya in the north and hill plateu in the south and covers the major portion of the Uttar Pradesh plains. The altitude does not exceed 300 m except at the foot of Siwalik ranges. Geologically the region is composed of Pleistocene and recent rocks which are unconsolidated sediment deposits in the river valleys. The slope of the plain in the eastern parts is from north-west to South east and from north to south in the western part. The area is well known for the fertile land and is therefore densely populated.

3. The Southern Hill Plateau

This zone is, in fact, an extension of the central Vindhyan plateau and is composed of flubomarine deposits of an arid region of ancient geological period, perhaps precambrian. The altitude in this region also is within 300 m barring some parts of the district Mirzapur. The general slope of the area is towards north east.

VEGETATION

The vegetation of Uttar Pradesh has been dealt with by different workers based on collections from hills of the N.W. Himalaya and the plains included under the upper Gangetic plains. Wallich (1829-31) provided descriptions of some plant species gathered from Kumaon. Royle (1833-39) gave a good account of vegetation of U.P. particularly the hilly region. Sir Richard strachey and J.E. Winterbottom travelled extensively through the hills of Kumaon and collected over 2000 spp. which were finally transferred to Hooker's Herbarium. A list of these plants (1852-1853) was published in 1882 and later supplemented by Duthie in 1918. based on his own collections and that of Anderson. A.E. Osmaston (1927) also travelled widely and succeeded in bringing out *"Forest flora of Kumaon"* Kanjilal (1928) also published *"Forest flora of Chakrata, Dehra Dun and Sahranpur forest division"* which included some plants from the plains as well. Raizada (1962) also worked on the plants of Kumaon and brought out publications. Among the recent workers, of Himalayan region of Uttar Pradesh are Sahni and Raizada (1955), Jain (1956), Rao (1959), Rau (1968, 1975), Gupta (1956-1957), Naithani (1984), Pangtey and Joshi (1987), B.P. Uniyal, Surender Singh and D.K. Singh (1995), Hajra (1988) Hajra and Bipin Balodi (1995), Wadhwa, Rao and Hajra (1987) Balodi (1996), Negi (1988) and many others. U.C. Bhattacharya, N.C. Nair, B.V. Shetty and C.L. Malhotra also collected extensively from the hills and plains of Uttar Pradesh and published their findings in different journals.

The floristics of Plains was studied by M.P. Edgeworth (1852) Duthie (1903-29) Kanjilal (1933), Rau (1969) Srivastava (1976), Babu (1977), Pant (1986), Bhattacharyya (1964) Dixit *et al.* (1984-1985), Kapoor (1962) Maheshwari and Tomar (1983) Malhotra (1966), Misra *et al* (1983, 1981, 1979), Panigrahi and Saran (1967). Patil (1963), Paliwal and Singh (1982), Shukla and Verma (1988), Singh (1969), Singh and

Tomar (1983), Singh and Singh (1985) Uniyal, Balodi and Baijnath (1994), Verma and Mishra (1979-1982) Uniyal, Swami and Uniyal (1997) and many others.

In the plains and lower hights upto 800 m moist tropical and dry deciduous forest of sal, teak or mixed/pure forest of *Syzygium, Aegle, Haldina, Acacia* and *Terminalia* are found. At places, scrub forest having evergreen species are also found. Since the plain are surrounded on three sides by different states, viz., Rajasthan, Madhya Pradesh, Delhi and Bihar, obviously it has certain elements which are common to these states too.

The dominant trees in the region are *Syzygium cumini* (Jamun), *Shorea robusta* (Sal, Shakhu), *Anogeissus latifolia,* (Bakli, Dhaura), *Aegle marmelos,* (Bel), *Haldina cordifolia* (Haldu), *Mitragyna parvifolia* (Kaim or Tekui), *Mallotus philippensis* (Rohini), *Madhuca longifolia* var. *latifolia* (Mahua), *Dalbergia sissoo* (Sheesham), *Ficus religiosa* (Peepal), *F. auriculata* (Timla), *F. semicordata* (Khainu), *F. virens* (Pakad), *F. benghalensis* (Bargad), *Acacia catechu* (Khair), *Albizia lebbeck* (Siris), *Terminalia alata* (Asna, Asain), *T. bellirica* (Bahera), *Oroxylum indicum, Holoptelea integrifolia* (Dhamina), *Streblus asper* (Sehore), *Diospyros melanoxylon, Butea monosperma* (Dhak, Palas), *Buchanania lanzan* (Chirongi), *Cassia fistula* (Amaltas), *Lannea coromandelica* (Jigma, Jhingan), *Pongamia pinnata* (Karanj), *Sterculia* spp., etc. At places, successful plantation of *Tectona grandis* (Teak) has been done.

The dominant shrubs in the area are *Murraya koenigii* (Gandela, Kathneem), *Holarrhena pubescens* (Kachri), *Lantana camara* (Kuri), *Ziziphus mauritiana* (Ber), *Z. oenoplia* (Makoi), *Colebrookea oppositifolia* (Chavova, Binda), *Carissa opaca, Glycosmis arborea* (Gutahru), *Ardisia solanacea* (Jalkaima), *Grewia hirsuta* (Seetachabeni), *G. subinaequalis* (Pharsa), *Crotalaria juncea* (Bansai), *Adhatoda vasica* (Bansa, Adusa), *Jatropha gossypifolia* (Lal arand), *Zanthoxylum armatum* (Timur), *Rubus ellipticus* (Hisalu), *Berberis lycium* (Kingor), etc.

Climbers, twiners and stragglers are also found in the forests and open fields. Some of these are *Tiliacora acuminata* (Karot, Rangoya), *Aspidopterys wallichii, Ipomoea* spp. *Pueraria tuberosa,* (Gindaru), *Abrus precatorius* (Ratti), *Mucuna* spp. (Konch), *Bauhinia vahlii* (Maljhan), *Hiptage benghalensis* (Gulabbas, Madhavilata), *Tinospora cordifolia* (Giloy, Guruch), *Ichnocarpus frutescens* (Dudhibel), *Ampelocissus*

latifolia (Pata Bel), *Piper longum* (Peepar-mul), *Gloriosa superba* (Karihari), *Celastrus paniculata* (Malkangani), *Smilax* spp. (Ram datun), *Cryptolepis buchanani* (Lakhun) and *Asparagus adscendens* (Satawar), etc.

The most common herbs including grasses and sedges form the ground flora of the forest as well as the grassland amidst forest. Some of them are *Ocimum basilicum* (Bantulsi), *Cassia tora* (Chakwar), *Clerodendrum viscosum* (Bhant), *Boerhavia diffusa* (Punarnava), *Curculigo orchioides* (Kali musli), *Chlorophytum tuberosum* (Safed musli), *Echinops echinatus, Malvastrum coromandelianum* (Bariari), *Vernonia cinerea* (Sahdevi), *Achyranthes aspera, Argemone mexicana* (Bharbhanda), *Solanum surattense* (Bhatkataiya), *Tribulus terrestris* (Gokhuru), *Arundo donax* (Kiliknal), *Saccharum spontaneum* (Kans), *Desmostachya bipinnata* (Kush), *Vetiveria zizanioides* (Garra or Khuskhus), *Phragmites karka* (Narkul), *Eulaliopsis binata* (Bhabhar, Bankas), *Imperata cylindrica* (Bhalai or Charni), *Dactylocte aegyptium* (Makra), *Cymbopogon martinii* (Jarakush), *Chrysopogon fulvus* (Senra), *Bothriochloa intermedia* (Sindhur), *Heteropogon contortus* (Sura padura), *Eclipta alba* (Bhringraj), *Acalypha indica, Oxalis corniculata, Launea procumbens, Centipeda minimia, Adiantum incisum,* etc.

Hydrophytic vegetation occupies considerable areas of Terai belt. Some of the common aquatic and semi-aquatic plants are *Nelumbo nucifera* (Kamal), *Ludwigia octovalvis* (Laungra), *Ipomoea aquatica* (Kalmi sag), *Vallisneria spiralis, Trapa natans, Utricularia aurea, Marsilea minuta, Cyperus platystylis, Potamogeton nodosus, Sagittaria guayanensis, Aeschynomene aspera, Hygrophila auriculata, Polygonum barbatum, P. glabrum, Typha angustata, Ammannia baccifera, Ceratophyllum demersum, Bacopa monnieri, Centella asiatica* (both called "Brahmi"), *Fimbristylis bisumbellata, Scirpus articulatus, S. lateriflorus, Coix aquatica, Eichhornia crassipes, Hydrilla verticillata, Nymphaea pubescens, Pistia stratioites, Eleocharis* spp., *Eriocaulon sieboldianumm, Acorus calamus,* etc.

With the increase in the altitude a change in the vegetation is clearly visible. Higher up between 1000-3000 m mixed forest of *Rhododendron arboreum, Quercus leucotrichophora* (Banj), *Lyonia ovalifolia* (Anyar) and *Myrica esculenta* (Kaphal) are first to appear. In between *Viburnum cotinifolium, Symplocos paniculata, Lonicera quinquelocularis, Neolitsea umbrosa, Cornus macrophylla,* etc. are also

seen mixed up. The undergrowth constitutes *Sarcococca saligna, Daphne cannabina, Coriaria nepalensis, Deutzia staminea, Myrsine africana, Elaeagnus* sp. together with herbaceous elements. *Pinus roxburghii*, is the first to make appearance among the gymnosperms. These mixed forest are followed by *Quercus dilatata* (Tilonj), *Q. semecarpifolia* (Kharsu), *Acer* sp (Thunder), *Prunus puddum* forest with species of *Euonymus, Ilex excelsa* and *Aesculus indica* (Pangar) and *Carpinus viminea*. Some tree *Cotoneasters* and *Juglans regia* (Akhrot) also make scattered appearance. At certain places pure strands of *Pinus roxburghii, Cedrus deodara, Taxus wallichiana* or *Abies pindrow* (Ransula) make a sight to watch. On dry slopes *Pyrus pashia, Prinsepia utilis, Berberis lycium* and *B. chitria* are dominant.

The herbaceous growth at this altitude mainly consists of *Morina longifolia, Anemone obtusiloba, A. vitifolia, Podophyllum hexandrum, Corydalis* spp. *Paeonia emodi, Paris polyphylla,* and species of *Geranium, Viola, Valeriana, Bergenia,* etc. Species of *Cypripedium, Pleione, Calanthe* and *Cardiocrinum giganteum* are occasionally noticed. Another orchid *Gastrochilus distichus* makes frequent appearance on *Quercus* sp. *Kingidium taenialis* is also seen perching on *Albizia* sp. and *Lyonia ovalifolia* at some places. *Rubus paniculatus, Hedera nepalensis, Cayratia trifolia, Smilax glaucophylla, Clematis* spp. *Dioscorea* sp, etc. are the common climbers while *Holboellia latifolia, Schisandra grandiflora* and *Sabia campanulata* are seen occasionally. *Jasminum dispermum* and *Aristolochia dilatata* are also seen hanging from rocks.

Still higher up is *Betula utilis* (Bhojpatra) that forms the tree limit in this part of Himalaya. Above this altitude shrubby or herbaceous plants like species of *Hippophae, Juniperus, Saussurea, Primula, Corydalis, Pleurospermum, Rheum, Rhododendron anthopogon, Meconopsis aculeata,* etc. make the vegetational cover.

Besides, a number of species have been reported from U.P. as new to the country or the state following explorations and critical studies. Some of them are *Pseudelephantopus spicatus, Solanum rostratum, S. trilobatum, Phippsia algida, Cyperus meeboldii, C. cyperoides, Achyranthes aquatica, Ageratum houstonianum, Ambrosia artemisifolia, Argyreia sericea, Crotalaria pusilla, Eleocharis fistulosa, Eupatorium riparium, Aristolochia indica, Cleome monophylla, Fimbristylis aestivalis, F. albo-viridis, Mikania cordata, Rynchospora hookeri, Myagrum perfoliatum, Ranunculus trilobus, Fimbristylis narayanii, Rhododendron*

nivale, Hydrobryum griffithii, Trisetum scitulum, Oberonia wightiana, Diplomeris hirsuta, Vernonia albicans, Urtica urens, Sebaea khasiana, Lalldhwojia cooperi, Fimbristylis merguensis, Soliva anthemifolia, Modiola caroliniana, etc.

Besides the above mentioned vegetational account there are certain associations that need special mention. These include grasslands, pure strands and cold arid regions.

The grasslands

In some areas like the Corbett National Park and the Dudhwa National Park pure grasslands are often seen. The main components of these grasslands are *Arundo donax, Phragmites karka, Apluda mutica* (Bassi), *Themeda arundinacea* (Ulla), *Cymbopogon* sp. (Jarakush), *Bothriochloa bladhii* (Sindhur), *Imperata cylindrica, Saccharum narenga, Sclerostachya fusca, Oryza rufipogon* (Tinna), etc. Such is the density of these grasslands that it is difficult to pierce through. Besides providing fodder these also act as a protection cover for the animals.

The alpine grasslands are called 'bugyals'. These bugyals present an eye pleasing look with species of *Anemone, Ranunculus, Gentiana, Pedicularis, Cyananthus, Polygonum*, and many important medicinal plants like *Nardostachys grandiflora, Dactylorhiza hatagirea, Rheum moorcroftianum*, etc. *Pinguicula alpina* is the interesting insectivorous plant species in the Martoli bugyals in Kumaon.

The Dafia - Dhoora, Baram-shandev area in the Kumaon is rich in orchid wealth. Out of the 223 species of orchids reported from the North west Himalaya, about two third are found in this area. Many of the East Himalayan orchid species like *Diplomeris hirsuta, Cryptochilus lutea, Cymbidium eburneum, Cirrhopetalum guttulatum* etc. have been collected from this area.

Another feature of special interest are the pure strands of pine forest in Uttarkashi that extend to miles together. Here stands the tallest pine tree of Asia measuring 60.65 m with a girth of 2.50 m as measured in 1989. Diva Danda and listiyakhet are other localities where pure strands of Pine forest can be seen. Bhujgarh and Suraithata in Chamoli district are also worth mentioning for pure strands of *Betula utilis* and *cupressus torulosa* respectively.

Quercus - Rhododendron Lyonia association is the general feature of temperate region but in the "Govind Pashu Vihar" in Uttarkashi district, *Aesculus - Juglans - Carpinus - Corylus* association is dominant between Taluka and osla and , is therefore, worth mentioning.

Though cold arid regions of Western Himalaya are mostly confined to Jammu and Kashmir and Himachal Pradesh yet some parts of Kumaon and Garhwal Himalaya like Niti, Malari and Milam fall under the same category. Like other cold deserts, here also *Lamium rhomboideum, Hyoscyamus niger, Thylacospermum caespitosum, Cicer microphyllum, Hyssopus officinalis, Lagotis glauca, Dracocephalum heterophyllum, Corydalis flabellata* and species of *Astragalus* are common. *Oxytropis duthieana*, a rare species was described on the basis of collections from this area.

DIVERSITY

As is understandable from the vegetational account, the vegetation changes following a change in altitude and climate resulting in diversity of the flora.

Out of the 377 families of flowering plants recognised by Cronquist (1983), Uttar Pradesh has 203 families out of which 156 belong to dicotyledonous, 29 to monocotyledonous and 18 to gymnospermous plants. A total of *ca* 4250 species are estimated to occur in Uttar Pradesh under *ca* 1500 genera. The following families are monogeneric.

Family	Genera	Species in in India (approx)	Species in U.P.
Biebersteiniaceae	*Biebersteinia*	1	1
Callitrichaceae	*Callitriche*	5	2
Ceratophyllaceae	*Ceratophyllum*	3	1
Coriariaceae	*Coriaria*	2	1
Cuscutaceae	*Cuscuta*	21	4
Daphniphyllaceae	*Daphniphyllum*	1	1
Hippuridaceae	*Hippuris*	1	1
Leeaceae	*Leea*	11	5

Family	Genera	Species in India (approx)	Species in U.P.
Moringaceae	*Moringa*	2	1
Nelumbonaceae	*Nelumbo*	1	1
Paeoniaceae	*Paeonia*	1	1
Platanaceae	*Platanus*	2	2 (Int.)
Sparganiaceae	*Sparganium*	1	1
Sphenocleaceae	*Sphenoclea*	1	1
Trapaceae	*Trapa*	2	2
Typhaceae	*Typha*	2	2

Besides, the following monotypics are also found in Uttar Pradesh

Asperugo procumbens
Boenninghausenia albiflora
Caesulia axillaris
Catamixis baccharoides
Chamaesciadium garhwalicum
Circaeaster agrestis
Colebrookea oppositifolia
Craniotome versicolor
Desmostachya bipinnata
Didiciea cunninghamii
Euryale ferox
Goniocaulon glabrum
Hemidesmus indicus
Hemiphragma heterophyllum
Herpetospermum pedunculosum
Hygroryza aristata
Indopiptadenia oudhensis
Ivanjohnstonia jaunsariensis
Kashmiria himalaica
Kedarnatha sanctuarii
Lawsonia inermis
Meeboldia selinoides
Martynia annua
Microcarpaea muscosa
Microschoenus duthiei
Mnesithea laevis
Modiola caroliniana
Myagrum perfoliatum
Nelsonia campestris
Neodistemon indicum
Nicandra physaloides
Nothosaerva brachiata
Notochaete hamosa
Ochthochloa compressa
Oxyria digyna
Parrotiopsis jacquemontiana
Pentapetes phoenicea
Peracarpa carnosa
Platystemma violoides
Plesmonium margaritiferum

Pongamia pinnata
Pseudodanthonia himalaica
Pycnoplinthus uniflorus
Roylea cinerea
Schleichera trijuga
Sinomenium acutum
Streptolirion volubile
Tamarindus indica
Tenagocharis latifolia
Theropogon pallidus
Thylacospermum caespitosum
Thysanolaena maxima
Tussilago farfara
Woodfordia fruticosa

Ten dominant families

Sl.No.	Family	(Genera) Species	
		U.P.	India
1.	Poaceae	(139) 453	(264) 1194
2.	Asteraceae	(123) 325	(166) 803
3.	Fabaceae (Papilionaceae)	(70) 261	(133) 973
4.	Cyperaceae	(26) 225	(38) 545
5.	Orchidaceae	(69) 223	(184) 1229
6.	Rosaceae	(18) 134	(40) 432
7.	Lamiaceae	(43) 121	(72) 435
8.	Scrophulariaceae	(34) 108	(63) 368
9.	Euphorbiaceae	(35) 100	(84) 523
10.	Ranunculaceae	(19) 87	(28) 191

(The figure in parenthesis indicates no of genera)

It is clear from the above table that six families have more than 200 species. The largest family Poaceae leads in the number of genera and species. Forty five genera are represented by a single species each including six monotypic genera, viz., *Hygroryza, Mnesithea, Pseudodanthonia, Ochthochloa, Desmostachya,* and *Thysanolaena. Poa* (21 spp.) is the largest genus followed by *Eragrostis* (19 spp.,) and *Cymbopogon* (11 spp.). The endemic species include *Microstegium falconeri, Poa pseudamoena, P. rhadina, Pseudodanthonia himalaica, Themeda dacruzii, Pogonatherum santapaui, Festuca nandadevica, Eulaliopsis duthiei,* etc.

Asteraceae, represented by about 325 species is the second largest family in the flora of Uttar Pradesh. 68 genera, have single species out of

which *Caesulia, Catamixis, Goniocaulon* and *Tussilago* are monotypics. *Saussurea* (27 spp.) is the largest genus followed by *Artemisia* (20 spp.) and *Aster* and *Blumea*, both with 11 species each. Among the endemics are *Cicerbita filicina, Artemisia filiformilobulata, A. tenuifolia*, etc. *Leucomeris spectabilis* is the only species that reaches the height of a small tree.

Fabaceae (Papilionaceae) occupies third position with about 261 species under 70 genera. Out of these, 31 genera are represented by a single species each. The genera *Parochetus, Pongamia*, etc. are monotypic. *Astragalus* (25 spp.) is the largest genus followed by *Indigofera* (22 spp.), *Crotalaria* (19 spp.) and *Desmodium* (17 spp.). The endemics include *Astragalus agacanthoides, Derris kanjilalii, D. scandens* var. *saharanpurensis, Hedysarum microcalyx, Pueraria stracheyi*, etc.

Cyperaceae with 26 genera and 225 species occupies fourth position in the flora of Uttar Pradesh. Nine genera have been represented by single species with *Microschoenus* being the only monotypic. *Carex* (63 spp.) is the largest genus followed by *Cyperus* (35 spp.), *Fimbristylis* (33 spp.), *Kobresia* (14 spp.) and *Schoenoplectus* (13 spp.). *Microshoenus duthiei, Carex nandadeviensis, C. myosurus* var. *praestans, Kobresia trinervis* var. *foliosa* are endemic to Uttar Pradesh.

The fifth largest family is Orchidaceae represented by 69 genera and 223 species. Among these 31 genera are represented by a single species, Of these *Arundina, Didiciea* and *Smitinandia* are monotypic. The genus *Habenaria* with 16 species is the largest one followed by *Dendrobium* (15 spp.) *Liparis* (10 spp.), *Cymbidium* (9 spp.). and both *Calanthe* and *Oberonia*, with 8 species each. *Archineottia microglottis, Aphyllorchis gollanii, Eria occidentalis, Flickingeria hesperis, Listera nandadeviensis*, etc. are some of the endemic species of Uttar Pradesh.

The families occupying position sixth to ninth have more than 100 species each. Families Euphorbiaceae and Rosaceae have many tree species while there is none in Scrophulariaceae and only one, *Leucosceptrum canum* in Lamiaceae that sometimes attains the height of a small tree. Among these families, *Cotoneaster* with 31 species is the largest genus followed by *Euphorbia* (28 spp.), *Potentilla* (20 sp.), *Prunus* (18 spp.), *Spiraea* (1 spp.), *Rosa* (15 spp.) and *Rubus* (14 spp.). Three genera viz. *Contoneaster, Rubus* and *Spiraea* include a good number of endemic species.

Family Ranunculaceae at tenth positon is the only Family that include less than 100 species. All the species are herbaceous or scandent shrubs. The genera *Actaea, Cimicifuga, Naravelia* and *Oxygraphis* are represented by a single species each. *Clematis, Ranunculus,* and *Thalictrum,* are the larger genera of the family.

Carex with 63 species is the largest genus and the only one having more than 50 species. *Polygonum* (*s.l.*) and *Senecio* (*s.l.*) are the other larger genera but following segregation they have been reduced to a much smaller number of species. Some of the dominant genera. in the flora of Uttar Pradesh are tabled below

Genera	Family	No. of species (appr.)
Carex	Cyperaceae	63
Cyperus	Cyperaceae	35
Fimbristylis	Cyperaceae	33
Cotoneaster	Rosaceae	31
Euphorbia	Euphorbiaceae	28
Saussurea	Asteraceae	27
Astragalus	Fabaceae	25
Indigofera	Fabaceae	22
Poa	Poaceae	21
Ficus	Moraceae	21
Potentilla	Rosaceae	20
Artemisia	Asteraceae	20

Endemic, Rare and Interesting Taxa

With such a wide area and two distinct biogeographic regions, Uttar Pradesh is bound to have many endemic taxa. In the last about 25 years many novelties have been described from this large state which may well pass into the endemic category. Some of the novelties described from Uttar Pradesh are listed in the following table.

Novelties described from Uttar Pradesh in the last few years

Name	Family
Aconogonum kuttiense	Polygonaceae
Alchemilla palii	Rosaceae
Androsace garhwalicum	Primulaceae
Anemone raui	Ranunculaceae
Artemisia filiformilobulata	Asteraceae
A. tenuifolia	Asteraceae
Arenaria curvifolia	Caryophyllaceae
Carex nandadeviensis	Cyperaceae
Caragana beefensis	Fabaceae
C. brevispina var. *gamblei*	Fabaceae
Clematis connata	Ranunculaceae
Derris kanjilalii	Fabaceae
Eria occidentalis	Orchidaceae
Euphorbia sharmae	Euphorbiaceae
Eulophia ucbii	Orchidaceae
Eulaliopsis duthiei	Poaceae
Festuca nandadevica	Poaceae
Flickingeria hesperis	Orchidaceae
Geum aequilobatum	Rosaceae
Indigofera gangetica	Fabaceae
I. thothathrii	Fabaceae
Kedarnatha sanctuarii	Apiaceae
Listera nandadeviensis	Orchidaceae
Polygonum kumaonum	Polygonaceae
Pogonatherum santapaui	Poaceae
Pygaeophyton garhwalensis.	Brassicaceae
Rhodiola lobulata	Crassulaceae
Rosa hirsuta	Rosaceae
Sinocrassula indica var. *paniculata*	Crassulaceae
Spiraea panigrahiana	Rosaceae
S. parkeri	Rosaceae
S. raizadii	Rosaceae
Themeda dacruzii	Poaceae

ENDEMISM

Following table includes some of the plants that are endemic to the state of U.P. unless otherwise mentioned.

Name of the species	Family	Remarks
Acer oblongum var. *membranaceum*	Aceraccae	Type only
Alectra parasitica var. *chitrakutensis*	Scrophulariaceae	
Alysicarpus roxburghianus	Fabaceae	
Aphyllorchis gollani	Orchidaceae	
Archineottia microglottis	Orchidaceae	
Arenaria ferruginea	Caryophyllaceae	Type only
Astragalus agacanthoides	Fabaceae	
A. pindreensis	Fabaceae	In H.P. and Jammu and Kashmir also
A. kashmirensis	Fabaceae	In H.P. and Jammu and Kashmir also
Berberis lambertii	Berberidaceae	Rare
B. affinis	Berberidaceae	Rare
B. osmastonii	Berberidaceae	Rare
Chimonobambusa jaunsarenis	Poaceae	
Cicerbita filicina	Asteraceae	
Clarkella nana	Rubiaceae	
Cotoneaster garhwalensis	Rosaceae	
C. pangiensis	Rosaceae	Found in H.P. also
C. wattii	Rosaceae	Found in H.P. also
C. stracheyi	Rosaceae	Found in H.P. also

Name of the species	Family	Remarks
C. prostratus	Rosaceae	Found in H.P. also
Cotoneaster osmastonii	Rosaceae	Found in H.P. also
Crotalaria hirta	Fabaceae	To India
Cyananthus integra	Campanulaceae	
Desmodium benthamii	Fabaceae	To India
Didiciea cunninghami	Orchidaceae	In Sikkim also
Erythrina resupinata	Fabaceae	Bihar and Orissa also
Eulophia mackinnonii	Orchidaceae	M.P. also
Gentiana tetrasepala	Gentianaceae	Type only
G. saginoides	Gentianaceae	Type only
Hedysarum microcalyx	Fabaceae	H.P., Jammu and Kashmir and Punjab
Indigofera cedrorum	Fabaceae	In H.P. also
I. hamiltonii	Fabaceae	In other states also
Itea nutans	Iteaceae	
Ivanjohnstonia jaunsariensis	Boraginaceae	
Kashmiria himalaica	Scrophulariaceae	Rare
Mahonia jaunsarensis	Berberidaceae	
Meeboldia selinoides	Apiaceae	Type only
Microschoenus duthiei	Cyperaceae	Type only
M. falconeri	Poaceae	In H.P. also
Pittosporum eriocarpum	Pittosporaceae	
Poa rhadina	Poaceae	Rare
P. pseudamoena	Poaceae	
P. jaunsarensis	Poaceae	In Jammu and Kashmir

Name of the species	Family	Remarks
Pseudodanthonia himalaica	Poaceae	Restricted distribution
Pueraria stracheyi	Papilionaceae	
Trachycarpus takil	Arecaceae	Restricted distribution
Trisetum scitulum	Poaceae	In Sikkim also

Leaving aside the above mentioned neoendemics and endemics there are some other species which need attention. *Eremostachys superba* has a very restricted distribution and so has *Catamixis baccharoides*, but the latter species has been located at two new spots which is encouraging. Occurrence of tree fern (*Cyathea spinulosa*) in Chamoli is also interesting from distributional point of veiw. *Psilotum nudum* growing on *Shorea robusta* and *Wallichia densiflora* are two rare species collected from the Corbett National Park.

PHYTOGEOGRAPHICAL AFFINITIES

Uttar Pradesh encompasses major area of two distinct biogeographical regions with enormous floral and faunal wealth. Barring plants like *Ageratum conyzoides, Bidens pilosa, Eupatorium odoratum, commelina benghalensis, Embelia ribes, Elephantopus scaber, Monochoria hastata, Vernonia cinerea, Xanthium strumarium*, etc. which are distributed almost throughout the country, state has many plants common with the adjoining states, and the neighbouring countries.

Plants common with Bihar : *Neanotis calycina, Cotula anthemoides, C. hemisphaerica, Breea arvensis, Cyathocline purpurea, Cyperus amabilis, Disporum cantoniensis, Cephalostigma hirsutum, Gardenia turgida, Jasminum arborescens, Fimbristylis podocarpa, Knoxia roxburghii, Remusatia vivipara, Spermadictyon suaveolens, Urginea indica, Scleria pergracilis*, etc.

Plants common with Delhi : *Alysicarpus monilifer, A. vaginalis, Argemone mexicana, Desmodium gangeticum, D. triflorum, Fumaria indica, Grangea maderaspatana, Hydrolea zeylanica, Hydrilla verticillata,*

Indigofera astragalina, Juncus bufonius, Justicia quinquangularis, Laggera aurita, Malvastrum coromandelianum, Murraya koenigii, Oxalis martiana, Peristrophe bicalyculata, Phragmites karka, Polygonum plebejum, Rauvolfia serpentina, Tiliacora acuminata, Tinospora cordifolia, Urena lobata, Vaccaria pyramidata, Vetiveria zizanioides, etc. Tree species like *Butea monosperma, Moringa oleifera, Bombax ceiba, Pterospermum acerifolium, Dalbergia sissoo, Schleichera oleosa, Bauhinia variegata,* etc. are known in cultivation in Delhi.

Plants common with Haryana : *Apluda mutica, Arnebia hispidissima, Butea monosperma, Aristida mutabilis, Calotropis procera, Carissa spinarum, Catamixis baccharoides, Cenchrus setigerus, Dalbergia sissoo, Desmostachya bipinnata, Eragrostis tenella, Grewia tenax, Heliotropium strigosum, Indigofera linifolia, Leptadenia reticulata, Mollugo nudicaulis, Moringa oleifera, Melia azedarach, Saccharum bengalense, Tragus roxburghii, Tribulus terrestris, Trichodesma indicum, Verbascum thapsus, Ziziphus mauritiana,* etc.

Plants common with Madhya Pradesh : *Anagallis arvensis, Acacia catechu, A. nilotica* ssp. *indica, Berberis asiatica, Butea monosperma, Amberboa ramosa, Fuirena wallichiana, Eupatorium capillifolium, Helicteres isora, Diospyros cordifolia, Goniocaulon glabrum, Moringa oleifera, Grewia tenax, Pterospermum acerifolium, Tectona grandis, Tribulus terrestris, Vallaris solanacea,* etc.

Plants common with Rajasthan : *Arnebia hispidissima, Acacia catechu, A. nilotica* ssp. *indica, Berberis asiatica, Butea monosperma, Calotropis procera, Carissa spinarum, Dalbergia sissoo, Diospyros cordifolia, Dactyloctenium aegyptium, Desmostachya bipinnata, Echinochloa colona, Elytrophorus spicatus, Euryale ferox, Grewia tenax, Heliotropium strigosum, Indigofera linifolia, Ipomoea carnea* ssp. *fistulosa, I. eriocarpa, Kydia calycina, Leptadenia pyrotechnica, L. reticulata, Mollugo nudicaulis, M. pentaphylla, Moringa oleifera, Oryza rufipogon, Ranunculus muricatus, R. sceleratus, Salvadora oleoides, Tiliacora acuminata, Tribulus terrestris, Trichodesma indicum, Vallaris solanacea, Verbascum thapsus, Ziziphus mauritiana, Zeuxine strateumatica,* etc.

Plants common with cold desert of Himachal Pradesh and Jammu and Kashmir : *Aconitum heterophyllum, Podophyllum*

hexandrum, Hyssopus officinalis, Lamium rhomboideum, Dracocephalum speciosum, Hippuris vulgaris, Allium stracheyi, Thylacospermum caespitosum, Hippophae tibetana, Arnebia benthami, Asperugo procumbens, Poa bulbosa, Festuca valesiaca, Carex curta, Hordeum murinum, Lindelofia longiflora, Rheum tibeticum, Dactylorhiza hatagirea, Biebersteinia odora, Ephedra gerardiana, Limosella aquatica, etc.

Plants common with Eastern Himalaya : *Anemone geum, A. obtusiloba, Clematis connata, Oxygraphis endlicheri, Diplomeris hirsuta, Tropidia curculigoides, Didicea cunninghami, Rhododendron nivale, Swertia sikkimensis, Ainsliaea latifolia, Primula erosa, P. petiolaris, Hydrobryum griffithii, Cassiope fastigiata, Corydalis lathyroides, C. longipes, Prunus venosa, Lalldhwojia cooperi, Cotula anthemoides,Cyathea gigantea, Caltha palustris, Hemiphragma heterophyllum,* etc.

Plants common with Eastern Ghats and Deccan Peninsula : *Ochna obtusata, Aegle marmelos, Sterculia urens, Asparagus racemosus, Gloriosa superba, Cassytha filiformis, Abrus precatorius, Anogeissus latifolia, Terminalia bellirica, Semecarpus anacardium, Crotalaria medicaginea, Plumbago zeylanica, Ziziphus oenoplia, Oroxylum indicum, Emilia sonchifolia, Arundinella pumila, Bauhinia vahlii, Tectona grandis, Hiptage benghalensis,* etc.

Plants common with Western Ghats : *Commelina paludosa, Arisaema tortuosum, Remusatia vivipara, Hypoxis aurea, Fimbristylis narayanii, Carex phacota, Goodyera procera, Campanula colorata, Centunculus tenellus, Galium rotundifolium, Pycreus sulcinux, Curculigo orchioides, Vernonia albicans, Rauvolfia serpentina,* etc.

Plants common with Bangladesh : *Calamus tenuis, Cyathocline purpurea, Eriocaulon oryzetorum, Eriophorum comosum, Fimbristylis podocarpa, Ichnocarpus frutescens, Ficus hispida, Holarrhena pubescens, Mallotus philippensis, Smilax zeylanica, Spiranthes australis, Vallaris solanacea, Wallichia densiflora, Phoenix sylvestris, Sphenoclea zeylanica, Murdannia nudiflora, Ceratophyllum demersum, Buddleja asiatica, Biophytum sensitivum, Punica granatum, Monochoria vaginalis, Shorea robusta, Reinwardtia indica,* etc.

Plants common with China : *Abrus precatorius, Calanthe tricarinata, Actinidia callosa, Bauhinia racemosa, Biophytum sensitivum,*

Circaeaster agrestis, Colquhounia coccinea, cypripedium himalaicum, Euonymus echinatus, Euphrasia officinalis, Lonicera quinquelocularis, Juniperus recurva, Hydrolea zeylanica, Achyranthes aspera, Ehretia acuminata, Gagea lutea, Dopatrium junceum, Sanicula europaea, Myrsine africana, Ricinus communis, Rubia cordifolia, Saccharum narenga, Vallisneria spiralis, etc.

Plants common with Myanmar : *Anthocephalus chinensis, Buddleja asiatica, Butea monosperma, Calamus tenuis, Dendrocalamus strictus, Diospyros cordifolia, Ficus hispida, Gardenia turgida, Hymenopogon parasiticus, Maesa indica, Murraya koenigii, Naravelia zeylanica, Nyctanthes arbor-tristis, Rhododendron arboreum, Semecarpus anacardium, Solanum erianthum, Tectona grandis, Toddalia aculeata, Wallichia densiflora, Caesalpinia decapetala,* etc.

Plants common with Nepal : *Acanthospermum hispidum, Catamixis baccharoides, Disporum cantoniense, Cyathocline purpurea, Corydalis lathyroides, Caltha palustris, Delphinium vestitum, Cotoneaster meuseli, Erigeron kumaonensis, Geum roylei, Epilobium gouldii, Indopipatadenia oudhensis, Meizotropis pellita,Pedicularis hoffmiesteri, P. nodosa, Parnassia kumaonica, Rhodiola imbricata, Saxifraga kumaunensis, Sedum gagei, S. holei, Soroseris deasyi, Pyrus ursina,* etc.

Plants common with Pakistan : *Ranunculus muricatus, Capsella bursa-pastoris, Cleome viscosa, Silene conoidea, Tamarix dioica, Tribulus terrestris, Indigofera linifolia, Alysicarpus monilifer, Acacia catechu, Oenanthe stolonifera, Centella asiatica, Solanum surattense, Evolvulus alsinoides, Tragus roxburghii, Phalaris minor, Paspalidium punctatum, Vernonia cinerea, Withania somnifera, Ziziphus mauritiana, Erysimum altaicum,* etc.

Plants common with Sri Lanka : *Anaphalis margaritacea, Bidens biternata, Carex nubigena, Commelina paludosa, Dichrocephala integrifolia, Eleocharis atropurpurea, Dioscorea pentaphylla, Glossogyne bidens, Gloriosa superba, Jasminum humile, Laggera alata, Ophiopogon intermedius, Pentanema indicum, Smilax aspera, Vallaris solanacea,* etc.

Plants common with Tibet : *Adonis chrysocyathus, Anemone obtusiloba, Caltha scaposa, Ranunculus hirtellus, Saussurea gossypiphora,*

S. gnaphalodes, Waldheimia glabra, Tanacetum nubigenum, Ptilotrichum canescens, Viola biflora, Arenaria debilis, Bergenia ciliata, Saxifraga diversifolia, Corydalis flabellata, Pyracantha crenulata, Rhodiola sinuata, Nardostachys grandiflora. Hippophae tibetana, Euphorbia stracheyi. Cypripedium elegans, Primula denticulata, etc.

USEFUL PLANTS

Every plant on the earth is useful in a way or other. It may or may not be of direct use to man or the animal world, but it definitely contributes significantly towards ecosystem to which it belongs. Sometimes, however, even most unpopular adventive weeds may turn out to be of considerable potential application. As such *Lantana camara,* the growing menace as an obnoxious weed, has also been found a useful source of energy. Another unwanted plant *Agave cantula* has become the source of income in the village Kimsar of Pauri Garhwal. The plant grows on unirrigated coarse wasteland, and does not require any care. The fibre obtained from this plant is being used for making bags, file covers, mats, purses, etc. *Urtica parviflora,* generally avoided by the people, becomes life saving food plant during times of famine. The brooms made out of the leaves of *Phoenix* and *spikes* of *Thysanolaena maxima* are a common sight in the market.

On the other hand, plants like *Grewia optiva* and *Ficus auriculata* are used in many ways. The leaves of *Grewia optiva* are much valued for fodder. The bark is used as shampoo and the fibre obtained from the bark is made into ropes. The fruits are eaten and the wood, after removing the bark, provides an excellent fuel. Similarly the leaves of *Ficus auriculata* are used, besides fodder as plates. The young figs are cooked as vegetable while the mature ones are eaten raw. The other species of *Ficus* which are used as fodder and wild fruits are *F. palmata, F. racemosa* and *F. semicordata.* Apart from these *Rumex hastatus, Dodonaea viscosa, Agave cantula,* etc. are some of the species which help in soil binding and are sometimes used for checking the soil erosion resulting from the construction of new roads, etc.

Following of plants serve the mankind in various ways.

Useful Plants

Name of the species	Agricultural Implements	Dye	Fibre	Fodde	Fuel	Gum	Medicinal	Timber	Wild Edible	Other Uses	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
Abelmoschus manihot	-	-	-	-	-	-	-	-	+	-	
Abies pindrow	-	-	-	-	+	-	-	-	-	-	
Abrus precatorius	-	-	-	-	-	-	+	-	-	+	As weight by the jewellers
Acacia catechu	-	-	-	-	+	-	+	+	-	-	
Achyranthes aspera	-	-	-	-		-	+	-	-	-	
Aconitum ferox	-	-	-	-	-	-	+	-	-	-	
A. heterophyllum	-	-	-	-	-	-	+	-	-	-	
Acorus calamus	-	-	-	-	-	-	+		-	-	
Adhatoda zeylanica	-	-	-		-	-	+	-	+	-	
Adiantum incisum	-	-	-		-	-	+	-	-	-	
A. philippense	-	-	-			-	+	-	-	-	
A. capillus-veneris	-	-	-	-	-	-	+	-	-	-	
Aegle marmelos	-	-	-	-	+	-	+	+	+	+	Sacred
Aesculus indica	-	-	-	-	-	-	-	-	+	-	

1	2	3	4	5	6	7	8	9	10	11	12
Agave cantula			+							-	
Ageratum conyzoides							+				
Albizia lebbeck	+				+		+	+			
Allium stracheyi									+		
A. humile									+		
Ampelocissus latifolia									+		
Anagallis arvensis							+			+	Fish poison
Andrographis paniculata			-				+				
Angelica glauca							+				
Anisomeles indica							+				
Anogeissus latifolia				+							
Arachne cordifolia		-		-			+				
Arnebia benthamii							+				
Artemisia indica				+			+				
Asparagus filicinus							+				
Bacopa hamiltoniana		-	-				+				
Barleria prionitis							+				
Bauhinia vahlii			+	+					+	+	as plates
B. variegata		-	-	+	+		+	+	+		
B. retusa	-	-	-	+	+	+	+	+			

1	2	3	4	5	6	7	8	9	10	11	12	
	Berberis asiatica	-	-					+	-	-	-	
	B. lycium	-	+	-	-	-		+		+	-	
	Bergenia ciliata	-	-	-		-		+		+		
	Betula utilis	-	-	-				+		-		Substitute for tea
	Boehmeria rugulosa	-	-		+	+		+				
	B. platyphylla	-	-	-	+							
	Boerhavia diffusa	-						+				
	Bombax ceiba	+			+	+		+	+	+	+	
	Bridelia verrucosa	-			+							
	Bupleurum falcatum	-						+				
	Buxus wallichiana							+				Substitute for tea
	Callicarpa macrophylla							+		+		
	Calotropis procera			+				+				
	Cannabis sativa			+				+		+	+	
	Carpinus viminea				+							
	Cartsa opaca	-						+		+		
	Cassia fistula					+		+				
	Cedrus deodara	-							+			
	Celastrus paniculatus	-		-	-		+					
	Celtis caucasica	-	-	-	-	-	-		-	+		

1	2	3	4	5	6	7	8	9	10	11	12
Celtis australis	-		-	+	+			+	+		
Centella asiatica	-						+				
Cirsium wallichii		-				-	+		+		
Cissampelos pareira	-	-	+	-			+				
Clematis gouriana				-			+				
Cleome viscosa			-		-	-			+		
Cocculus laurifolius	-		-		+		+				
Colebrookea oppositifolia	-			-	-		+	-			
Convolvulus arvensis	-						+		-		
Cordia obliqua	-		-	-	-		-	-	+		
Corydalis govaniana	-	-	-	-	-		+				
Corylus jacquemontii	-	-	-	-			-	+			
Cotoneaster microphylla	-							+			
Crotalaria albida	-	-	-	+			+	-			
C. tetragona	-		+	+			-				
C. medicaginea	-	-	-	-	-	-	+	-			
Cryptolepis buchanani	-	-	-	-	-	-	+	-			
Cymbopogon martinii	-	-	-	+		-	+	-			
Cyperus esculentus	-	-	-	-	-		+	-			
C. rotundus							+	-			

1	2	3	4	5	6	7	8	9	10	11	12
Dactylorhiza hatagirea	-	-		-	-	-	+	-			
Dalbergia sericea	+			+	+	-	-	+			
D. sissoo	+	-	-	-	+	-	+	+		-	
Datisca cannabina	-	+		-	-		+				
Datura stramonium	-	-		-	-	-	+				
Debregeasia velutina	-			+	-	-			+		
D. hypoleuca	-	-		+	-	-			+		
Deeringia amaranthoides	-		+	-	+						
Dendrobenthamia capitata	-		-	-	-			+			
Dendrocalamus strictus	-		+		-	+	+	+		+	
Desmodium oojeinense	+	-		+	+			+			
D. triflorum	-				-		+				
D. gangeticum	-				-		+				
Dioscorea bulbifera				-	-		+		+		
D. deltoidea	-				-		+		+		
Diploknema butyracea	-			-	-				+		
Dodonaea viscosa	-			-	-	-	+			+	
Dryopteris nigropaleacea	-	-		-	-		+				
Drypetes roxburghii	-	-	-	+	-	-	-		-	-	
Duchesnea indica	-	-	-	-	-	-	+	-	+	-	

1	2	3	4	5	6	7	8	9	10	11	12
Eclipta prostrata			-	-	-		+	-	-	+	Hair oil
Ehretia laevis				-	+		-	-	-	-	
Engelhardtia spicata	-	-	-	-	+			-	-	-	Fish poison
Erythrina suberosa	+		+	-	+		+			-	
Eulaliopsis binata			+	+	-	-			-	-	
Euphorbia hypericifolia							+		-		
E. hirta				-	-		+	-			
E. helioscopia			-	-		-	+				
E. royleana			-				+				
Evolvulus alsinoides				-			+				
Ficus arnottiana					-		+	-			Substitute for tea
F. auriculata		-		+	+			+	+		
F. benghalensis			-	-		-			+	+	Sacred tree
F. carica			-	+					+		
F. cunia			+	+			+		+		
F. glomerata				-	-				+		
F. hederacea		-		-	-				+	-	
F. palmata		-	-	+	+				+		
F. semicordata	-	-	+	+	-	-		-	+	-	

1	2	3	4	5	6	7	8	9	10	11	12
Flacourtia indica	-	-	+	+	-	-	-	-	+		
Fragaria vesca	-	-	-	-	-	-	-	-	+		
Fumaria indica	-	-	-	-	-		+	-	-	+	Fish poison
Gallium aparine	-	-	-	-	-	-	+	-	-	-	
Gaultheria trichophylla	-	-	-	-	-			-	+		
Gentiana kurroo	-	-	-	-			+	-	-	-	
Geranium nepalense	-	-	-	-			+	-	-		
G. rotundifolium	-	-	-				+	-	-		
G. ocellatum	-	-		-			+	-	-		
Girardinia heterophylla	-						+	-	-		
Gloriosa superba	-						+	-	-		
Gonatanthus pumilus	-		-						+		
Grewia optiva	+		+	+	+		+	-	+	+	Locally used as shampoo
Hedychium spicatum	-		-	-			+	-	-	+	Perfuming tabacco
Heliotropium strigosum	-	-		-			+	-	-		
Hippophae salicifolia	-				-			-	+		
H. tibetana	-	-	-	-			-	-	+		
Hiptage benghalensis	-	-	-	-	+	-	-	-	-		

1	2	3	4	5	6	7	8	9	10	11	12
Holoptelea integrifolia			-	-	-	-	-	+	-	+	Wood pulp for paper
Hydrocotyle sibthorpoides			-	-	-	-	+	-	-		
Hypericum perforatum			-	-	-	-	+			-	Oil
Ichnocarpus frutescens			+	-	-	-	+				Stems are used for
Impatiens balsamina			-	-	-	-	+		+		
I. gigantea			-	-	-		-		+		making ropes
Indigofera heterantha				-	-				+		
Iphigenia indica				-		-			+		
Ipomoea hederifolia			-	-	-	-	+				
I. purpurea			-	-	-		+				
Jasminum officinale				-	-		+			+	Hair oil
J. multiflorum			-	-	-		+				
Jatropha curcas							+			+	
Kydia calycina			+	-	+		+	+		+	Paper and rayon grade pulp
Lactuca dissecta		-		-	-				+		
Lannea coromandelica	+		-	-	+	+		+		+	" " " " "
Leucas lanata				-	-		+				
Lygodium japonicum							+				

1	2	3	4	5	6	7	8	9	10	11	12
Mallotus philippensis	-	+		+	+	-	+			+	
Malus baccata	-		-		-	-	+		+	-	
Maoutia puya	-		+	-		-					
Marsdenia roylei	-	-	+	-		-					
Melia azedarach	-			-	+	-	+	-			
Microstylis wallichii	-	-		-	-	-	+				
Millettia extensa	-		+	+	+	-	+				Fish poison
Moringa oleifera	-		+	-	+	-	+		+	+	Paper pulp
Morus alba	-			+	+		+		+		
Mucuna nigricans							+				
Murraya koenigii	-	-				-	+		+		Used in curries
Myrica esculenta	-				-	-	+		+		
Myrsine africana	-						+				
Nardostachys grandiflora	-						+				
Neolitsea pallens	-								+	-	
Notholirion thomsonianum	-					-	+				
Nyctanthes arbor-tristis	-			-	+		+				
Olea glandulifera	-	-	-	-		-	+	+			
Oreocnide frutescens	-	-	+	-	-	-	-	-	-		
Oroxylum indicum	-	-	-	-	-	-	+	-	-	-	

1	2	3	4	5	6	7	8	9	10	11	12
Osyris wightiana				-							Substiture for tea
Oxalis corniculata							+		+		
Paeonia emodi							+				
Perilla ocimoides							+		+	+	Edible oil yielding
Phoenix humilis				+					+		
Phyllanthus emblica		+			+		+		+	+	Ink, pickle
Picrorhiza kurrooa							+				
Pinus roxburghii	+				+	+	+	+	+		
Pistacia khinjuk				+	+		+				
Plantago major						+	-				
Plumbago zeylanica							+				
Podophyllum hexandrum							+	-			
Polygonatum cirrhifolium									+		
P. verticillatum											
Portulaca oleracea									+		
Potentilla fulgens							+				
Prinsepia utilis				-			+				
Pterospermum acerifolium				+	+		+	+		+	Leaves are used as
Punica granatum	+			-	+		+	_	+		plates
Pyracantha crenulata			-		+				+		
Pyrus pashia	+			+							

1	2	3	4	5	6	7	8	9	10	11	12	
	Rauvolfia serpentina	-	-	-	-	-		-	-	-	-	
	Reinwardtia indica	-	-	-	-			+	-	+	-	
	Rheum moorcroftianum	-	-	-	-	-	-	+	-	-	-	
	R. webbianum	-	-	-	-	-		+	-	+	-	
	Rhododendron anthopogon	-	-	-	-	-		-	-	-		Lus. as substitute for tea
	R. arboreum	-	-	-	-	-		-	-	-	-	Drinks are made
	Rhus parviflora	-	-	-	-		-	+	-	-	+	Used as tobacco
	Ribes alpestre	-	-	-	-	-			-	+		
	Ricinus communis	-	-	-	-	-		+	-	-		
	Rosa sericea	-	-	-	-			)	-	+		
	R. brunonii	-	-	-	-				-	+	-	
	Roylea cinerea	-	-	-	-	-		+				
	Rubia manjith	-	+	-	-			+				
	Rubus ellipticus		-	-	-	-		-		+		
	R. niveus	-	-	-	-					+		
	R. paniculatus	-	-	-	-	-	-			+		
	Rumex hastatus	-	-	-	-	-	-	-	-	+	-	
	Salix tetrasperma	-	-	-	+	+	-	-	+	-	+	Making baskets

1	2	3	4	5	6	7	8	9	10	11	12
Salvia plebeia		-		-	-		+				
Sapindus mukorossi	-	-		-	-	-	-			+	Used as subsitute of soap
Saussurea obvallata	-	-		-	-	-	+				
Semecarpus anacardium	-	-		-	-	-			+	-	
Sida acuta	-	-		-		-	+		-	-	
Spondias pinnata			-		-	-	+	-	+		
Stephania glabra	-	-		-	-	-	+				
Sterculia villosa	-	-	+	+	-	+					
Swertia chirayita	-	-		-	-		+			-	
Syzygium cumini	+	-		+	+		+	+	+		
Taxus baccata	-				-		+				
Terminalia bellirica	-	-	-	-	+	-	+				
T. alata		-	-	+	+						
Toddalia asiatica	-	-	-	-	+				-	-	
Toona ciliata		-		-	+			+			
Trema politoria	-	-	+	+	-		-	-	-	-	
Tridax procumbens	-	-	-	-	-	-	+		-	-	
Triumfetta rhomboidea		-	-	-	-	-	+	-		-	
Tulipa clusiana f. *stellata*		-	-	-	-		+		-	-	

1	2	3	4	5	6	7	8	9	10	11	12
Tylophora asthmatica	-	-	-	-	-	-	+	-	-	-	
Ulmus wallichiana	-	-	-	+	-	-	-	-	-	-	
Urena lobata	-	-	+	-	-	-	+	-	-	-	
Urtica parviflora	-	-	-	-	-	-	+	-	-	-	
Viola canescens	-	-	-	-	-	-	+	-	-	-	
Vitex negnudo	-	-	-	-	+	-	+	-	-	+	Baskets
Withania somnifera	-	-	-	-	-	-	+	-	-	-	
Woodfordia fruticosa	-	-	-	-	-	-	+	-	+	-	
Xylosma longifolium	-	-	-	-	+	-	-	-	-	-	
Zanthoxylum armatum	-	-	-	-	-	-	+	-	-	+	Twigs as tooth brush,
Ziziphus mauritiana	-	-	-	-	-	-	-	-	+	+	Preparation of local drink

CONSERVATION

With such a large number of useful plants, the state, particularly the Himalayan region, has been a hunting ground to the poachers and illegal traders. The exploitation of pine forest by the Britishers in the erstwhile Tehri Garhwal is well known. The medicinal plants have been exploited to such an extent that certain plants needed protection through law. Plant species like *Dioscorea deltoidea, Aconitum heterophyllum, Picrorhiza kurrooa, Dactylorhiza hatagirea,* etc., once common in the Himalayan region, are now categorized as threatened or vulnerable. Even plants of fodder value like *Ulmus wallichiana* appear in the IUCN Red Data Book. Overexploitation will certainly result in the extinction of such species and therefore conservation measures have to be taken up seriously. The Biosphere Reserves and National parks are welcome step in this direction. A joint Scientific expedition in the Nanda Devi Biosphere Reserve in 1993 reported that the population of medicinal plants had considerably increased after being declared a Biosphere Reserve.

With the developmental activities gaining momentum, many plants have lost or are loosing their habitat. These include many endemics or plants with restricted distribution like *Eremostachys superba, Trachycarpus takil, Psilotum nudum, Arceuthobium minutissimum,* etc. The last named is a tiny parasite growing over *Pinus excelsa* in the Himalayan region and has been gathered on a few occasions only. Many species like *Microschoenus duthiei, Poa rhadina,* etc. have not been gathered since their type collection. Such plants *Gentigna saginoides* and *Meeboldia selinoides* have to be searched for and attempts to be made either for *ex-situ* or *in-situ* conservation. The Botanical Gardens, therefore, have an important role to play as conservatories.

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Swargarohini Peak

Sorbus ursina : a temperate element

Cassiope fastigiata in the Himalayas

Cyananthus lobatus : Wild ornamental

Arnebia benthamii : a plant of medicinal importance

Polygonum affine in glacial moraines

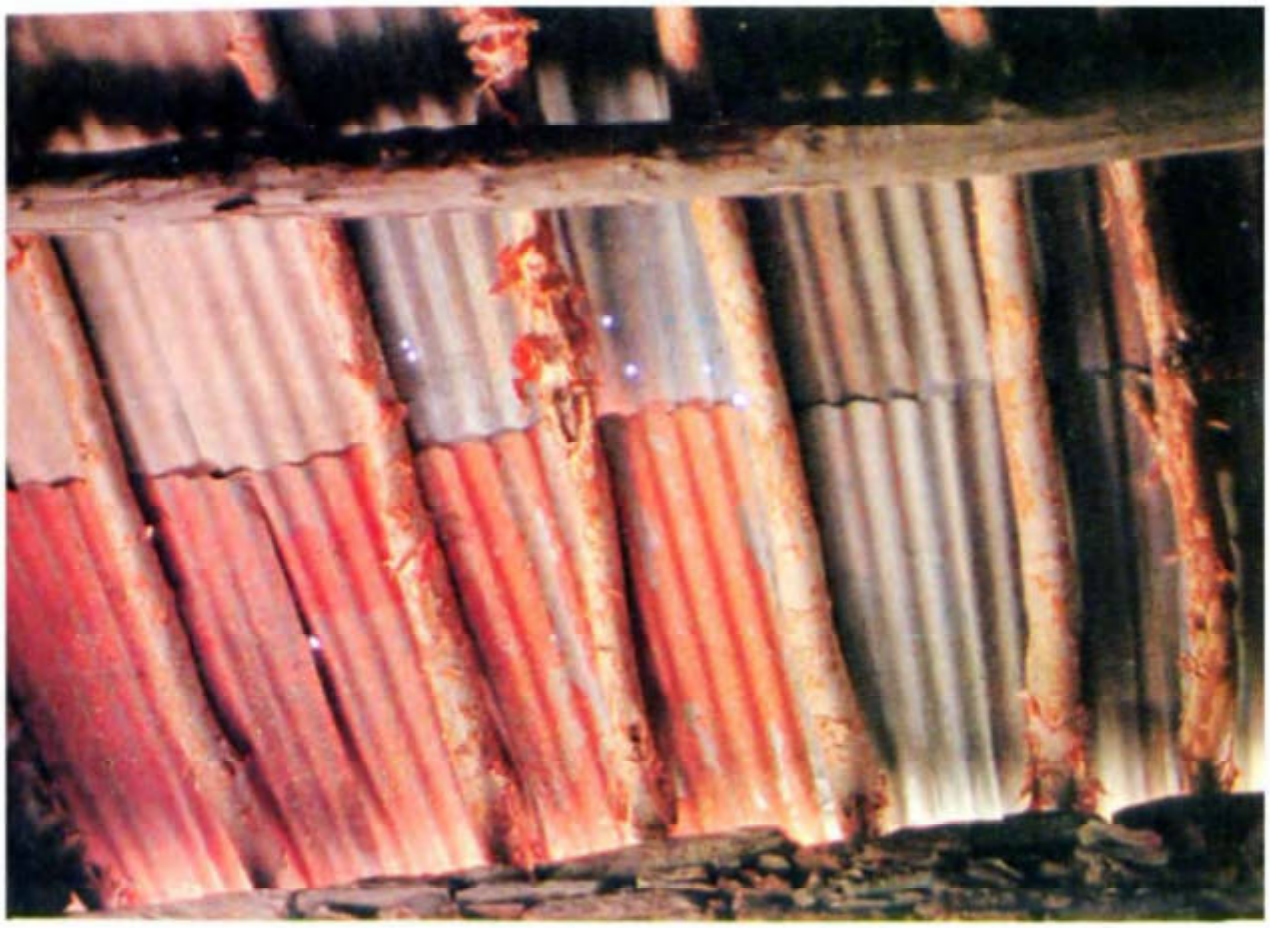
Juniperus recurva in the alpine Himalaya

Osmunda regalis : a plant of medicinal value

Rosa webbiana

Cotoneaster microphyllus : a common Himalayan species

Artemisia maritima



Betula logs : used in roof making

Schefflera venulosa

Fagopyrum esculentum : an edible plant species

Pure strand of *Abies* forest

Cephalanthera longifolia : a ground orchid

WEST BENGAL

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The State of West Bengal lies between 21° 45' 27° 16' N latitude and 85° 55' 89° 56' E longitude, covering a geographical area of about 88,752 sq km. It is bounded on the north by Sikkim and Bhutan, on the east by Assam and Bangladesh, on the south by the Bay of Bengal, on the west by Bihar and Orissa and on the north-west by Nepal.

West Bengal is divided into the following five broad geographical regions:

1. The Darjeeling Himalaya
2. Tarai-Duars region
3. Western undulating highland and plateau
4. North and South Bengal plains
5. Gangetic delta

The Darjeeling Himalaya region lies on the extreme northern boundary of West Bengal and includes Darjeeling, Kurseong and Kalimpong sub-divisions of Darjeeling district and a northern fringe of Jalpaiguri district. A number of mountain ranges and deep river valleys are unique features in this region. The Singalila range stands on the western border of Darjeeling district. Sandakphu (3630 m), the highest mountain peak of West Bengal lies in this range. Other major peaks are Falut (3596 m), Sabargam (3543 m) and Tonglu (3063 m). The Sinchula range forms the common boundary between Bhutan and Jalpaiguri district. The part of range lying on Jalpaiguri district has an average height of 1600 m. The temperature during summer varies usually between 15° - 20° C but the winter is very cold with the temperature falling even below 5° C. Snowfall also occurs in winter. Average annual rainfall is 300 cm. In Buxaduar, the average annual rainfall exceeds 500 cm and is the highest rainfall area in the state.

The southern part of Darjeeling district and the entire Jalpaiguri district except a few pockets on the northen fringe constitute the Tarai-Duars region. Reddish loamy soils mixed with sand, pebbles, gravels and stones are found here. Alluvial soils are present on river sides. The average temperatures in summer is 29°-C and in winter it is 17° C. Heavy rainfall occurs in monsoon.

The entire Purulia district and western part of Bardhaman, Bankura and Midnapur districts constitute the western undulating uplands and plateau. This area is the extension of Chotanagpur plateaue. Among the hills rising above the general level of plateau Ayodhya, Panchet, Baghmundi of Purulia district and Susunia and Biharinath of Bankura district are worthmentioning. Gargaburu of Ayodhya hills is the highest peak (677 m) of this region. Soils of this area is generally laterite. The average daily temperature during summer varies between 26°C - 39°C. Sometimes temperature rises up to 48°C and in winter average temperature remains 13°C which sometimes drops down to 5°C.

The river Ganges divides plains of Bengal into North and South Bengal plains. North Bengal plains include Coochbehar, Uttar and Dakshin Dinajpur and Malda districts. On the other hand, South Bengal plains include Murshidabad, Nadia, Birbhum, Hooghly, Howrah and some part of Bardhaman, Bankura, Midnapur, North and South 24- Parganas districts. Soil of this region is generally alluvial. Laterite soil also occurs in some places. The average summer temperature is between 36°C - 38°C and winter temperature is 15°C. The average rainfall is 250 cm in North Bengal plains and ranges from 150 - 200 cm in the plains of South Bengal.

The Gangetic delta includes Sundarban area in South 24- Parganas district. The area has many creeks and tracts of lowland, marshy places and wide river openings. Soil is usually saline. Sandy soil predominates on islands, river beds and on the Bay coast. The climate is hot and very humid. The average temperature is 20°C in winter and 28°C in summer. Annual rainfall varies between 180 - 200 cm.

VEGETATION

The vegetation of West Bengal has attracted the attention of many explorers and botanists since the beginning. Anderson (1862) collected plants from Calcutta for providing guidelines for preservation and examination of plant specimens. Gamble (1875) provided a detailed account

of vegetation of Darjeeling forest. Further, Gamble (1878) published a list of trees, shrubs and large climbers of Darjeeling district. A detailed study on vegetation of West Bengal and adjoining areas was made by Prain (1903, 1905), Cowan and Cowan (1929), Banerjee (1934), Sengupta (1937), Biswas (1966), Datta and Majumdar (1966), Guha (1968), Guha Bakshi (1984), Pal *et al.* (1991) Bennet (1979), Chakraverty and Jain (1984), Das and Ghosh (1982), Sikdar and Samanta (1983). and Sanyal (1994). A detailed survey of exotic weeds was done by Maity and Guha Bakshi (1981). Besides this, study made on Eastern Himalayas (Hara 1966, 1971; Ohashi 1975, etc.) and the vegetation of whole country throws light on plants of this state also. Mention may be made of Hooker (1872-1897), Sharma *et al.* (1993), Hajra *et al.* (1995), Banerjee *et al.* (1989), Troup (1921), Janarthanam and Henry (1992), etc.

West Bengal is unique in having a complete physiographic and ecological continuum between the tropical and the temperate forest zones. About 13 per cent of the total area (11,548 sq km) of the State is under forest cover, showing wide variations from place to place.

In general, the vegetation of the state can broadly be categorised into five vegetational zones following Champion and Seth (1968) with some modifications

I. MOIST TROPICAL FOREST

1. Tropical semi-evergreen forest

This type of forest extends from the foot hills to an elevation of 1000 m in the heavy rainfall tracts of North Bengal. The top canopy of this forest is closed and mainly made up of evergreen species except some deciduous or nearly deciduous species. Middle storey is dense with the varied undergrowth. Depending on the altitudinal variation species combination are also varied.

In the Tarai region of Darjeeling district, the first storey is made up of *Syzygium formosum, Phobe hainesiana, P. attenuata, Castanopsis indica, Michelia champaca. Litsea* spp., *Magnolia hodgsoni, Canarium strictum,* etc. The middle storey consists of *Meliosma simplicifolia, Aglaia hiernii, Gynocardia odorata, Turpinia pomifera,* etc.

In the lower hill slopes of Kalimpong division of Darjeeling district, up to an elevation of 760 m or more, association between *Schima wallichii*

and *Bauhinia purpurea* along with *Toona ciliata, Ailanthus integrifolia, Duabanga grandiflora, Stereospermum colais, Tetramelis nudiflora* etc. are noticeable in the first storey.

Actinodaphne obovata, Phobe lanceolata, Garcinia stipulata, etc. are the major components of the second storey.

In the Tarai region of Jalpaiguri district variations in the species components are well marked. The first storey here is made up of species like *Michelia champaca, M. montana, Syzygium wallichii, Persea villosa, Schima wallichii, Turpinia pomifera,* etc. The second storey is made up of *Aporusa octandra, Meliosma pinnata, Styrax serrulatum, Ilex umbellulata, Casearia vareca,* etc.

In the aforesaid regions the shrub and under shrub layers consists of the species like *Coffea bengalensis, Clerodendrum viscosum, Leea crispa,* etc. The common climbers are well represented by *Piper* spp., *Bauhinia scandens, B. vahlii, Dioscorea* spp., etc. The forest floor is covered with the dense growth of ferns of the genera like *Dicranopteris, Gleichenia, Lygodium, Hymenophyllum, Lindsaea, Adiantum, Pteris, Asplenium, Dryopteris, Polypodium,* etc.

2. Tropical moist deciduous forest

a. Moist sal forest

This type of forest is present from Tarai to an elevation of 650 m or more. The area of Jalpaiguri and Darjeeling districts having annual rainfall of more than 300 cm shows such type of forest. In the Teesta valley, the first storey of the forest consists mainly of *Shorea robusta* in association with the species of *Terminalia* and *Garuga* on the mountain slopes. The other species are *Schima wallichii, Lagerstroemia parviflora, Sterculia villosa,* etc. The second storey of the forest consists of *Mallotus philippensis, Litsea monopetala, Semecarpus anacardium, Callicarpa arborea,* etc. Among the climbers the species like *Bauhinia vahlii, Milletia extensa, Beaumontia grandiflora,* etc. are dominant. The forest floor is covered with *Microstegium ciliatum.*

This combination of the Sal forest is slightly changed in the Rangeet valley where the main components of the first storey are *Shorea robusta*

and *Pinus roxburghii*. In the second storey *Schima wallichii, Semecarpus anacardium, Casearia graveolens, Bridelia retusa,* etc. are common. The shrubby layer includes *Woodfordia fruiticosa, Wendlandia tinctoria, Indigofera* spp., etc.

High quality Sal forest are also found in Kurseong, Buxa and Jalpaiguri divisions which is known as "bharbar" Sal forest. The dominating species are *Schima wallichii, Lagerstroemia parviflora* and *Terminalia tomentosa* along with *Shorea robusta* in the first storey and species of Lauraceae and Meliaceae in the second storey. Grasses like *Microstegium ciliatum* and *Imperata cylindrica* are common in the forest floor. The Sal forest of Tarai region is characterised by the dense growth of Canes and Ferns in the forest floor and some evergreen tree species in the second storey.

b. Mixed moist deciduous forest

This type of forest mostly occurs in outer Himalayan ranges up to an elevation of 500-650 m. where rainfall is comparatively high (more than 250 cm). The forest is characterised by the absence of Sal trees totally or present sporadically. The principle trees of upper storey are *Terminalia bellirica, Lagerstroemia parviflora, Sterculia villosa, Schima wallichii, Duabanga grandiflora, Aphanamixis polystachya, Dillenia pentagyna, Gmelina arborea,* etc. The second storey consists of *Careya arborea, Bauhinia purpurea, Premna corymbosa, Mallotus phillippensis, Meliosma simplicifolia, Oroxylum indicum,* etc. The forest floor is damp and covered with the profuse growth of *Dendrocnide sinuata, Ardisia solanacea, Coffea bengalensis, Mussaenda glabrata, M. wallichii, Maesa macrophylla,* etc. *Bauhinia vahlii, B. scandens, Ichnocarpus frutescens, Dioscorea* spp., *Clematis* spp., *Mucuna macrocarpa, Cissus repanda, C. assamica, Cayratia carnosa,* etc. are found to climb over the trees. A number of epiphytic orchids and ferns are also common on the tree trunk in partially shaded localities.

3. Littoral and Swamp forest

a. Littoral forest

It is found in the adjoining areas of Sundarban. The principle arboreal form in this forest are *Hibiscus tiliaceus, Thespesia populnea,*

Vitex negundo, V. trifolia, Dolichandrone spathacea, etc. Among the herbs, the dominant species are *Acanthus ilicifolius, Lippia geminata, Phyla nodiflora, Porteresia coarctata, Saccharum spontaneum,* etc.

b. Tidal swamp forest

In West Bengal the tidal forest are located in the Gangetic delta, at the Sundarban area of the state. The area of mangrove forest is estimated to be 4170 sq km which is 62.31 percent of the mangrove forest of the country. This type is again classified into three subgroups

(i) Brakish water forest : This type of forest is restricted to the western side of Sundarban. Trees are rarely with stilt roots but the pneumatophores are usual in occurrence. Principal trees are *Heritiera fomes, Sonneratia apetala, S. caseolaris, Bruguiera gymnorhiza, B. sexangula, Xylocarpus moluccensis* and *Avicennia officinalis*. Some other common plants are *Excoecaria agallocha, Cynometra iripa, Amoora cucullata, Ceriops decandra, Phoenix paludosa, Acanthus ilicifolius, Pandanus tectorius, Nipa fruticans,* etc.

(ii) Moderately saline water forest : This type of forest is more dense than the brakish water forest. The principal trees include *Heritiera fomes, Excoecaria agallocha, Ceriops decandra, Bruguiera gymnorhiza, Aegialitis rotundifolia, Kandelia candel, Carapa obovata,* etc. *Nipa fruticans* is relatively uncommon.

(iii) Saline water forest: It is a closed evergreen forest with species of moderate height, composed of trees which are adapted for survival on the tidal mud. The soil permanently remains wet with saline water and become submerged during every tide. Development of stilt roots, thick leathery leaves and viviparous germination are the gerneral features of the forest components. The common species dominating in this forest are *Rhizophora mucronata, R. apiculata, Kandelia candel, Avicennia alba, A. marina, A. officinalis, Aegiceras corniculatus, Bruguiera cylindrica, B. gymnorhiza, B. parviflora, Ceriops tagal, Xylocarpus granatum, Sonneratia apetala,* etc.

The climbers, dominantly present in all these three type of forest of Sundarban are mainly represented by the members of Asclepiadaceae and Leguminosae. Some species are *Sarcolobus globosus, S. carinatus,*

Dischidia nummularia, Hoya parasitica, Finlaysonia obovata, Derris andamanica, D. trifoliata, Mucuna gigantia, Dalbergia candenatensis, Cynometra iripa, Acanthus volubilis, etc.

Some dominant epiphytic Orchidaceous members are *Bulbophyllum roxburghii, Oberonia gammiei, Acampe dentata, A. multiflora,* etc.

II. DRY TROPICAL FOREST

1. Dry deciduous forest

The dry decid[illegible] forest is found in laterite tract of Purulia, Bankura, Birbhum a[illegible] Midnapore districts. The species composition and de[illegible] The common composition of the tre[illegible] *Bridelia squamosa, Buchanania[illegible] anacardium, Tectona grandis, Terminalia arjuna, T. tomentosa, Pterocarpus marsupium, Butea monosperma, Cochlospermum religiosum, Sterculia urens, Haldina cordifolia, Diospyros exsculpta,* etc. In the hilly tracts of Ajodhya and Susunia, the common trees are *Bursera serrata, Dalbergia latifolia, Garuga pinnata, Helicteres isora, Mallotus philippensis, Acacia catechu, Desmodium oojeinense,* etc.

The shrub layer commonly comprises of *Holarrhena pubescence, Zizyphus mauritiana, Z. rugosa, Antidesma acidum, Woodfordia fruticosa, Flacourtia indica, Meyna spinosa,* etc. The common climbers are *Asparagus racemosus, Combretum roxburghii, Tinospora cordifolia, Derris scandens, Aristolochia indica,* etc.

2. Mixed deciduous forest

This type of forest is found at the Teesta river valley and Jaldapara area of North Bengal. The forest is generally called Khair (*Acacia catechu*) Sisso *(Dalbergia sisso)* forest. Other tree species which are grown along with Khair-Sisso association are *Albizia procera, A. lebbek, Bischofia javanica, Bombax ceiba, Trema orientalis,* etc. Grasses like *Saccharum procerum, Phragmitis karka, Themeda* spp. are common in the forest floor

III. SUB TROPICAL FOREST

The subtropical forest is mainly noticed from an elevation of 1000-2000 m in Darjeeling Himalayan region where the annual rainfall varies between 200 400 cm. The dominant species of this forest are mostly evergreen species and attain a fairly good height and density, though some large deciduous trees like *Betula* also occur. The forest floor is always covered with dense growth of different fern species. Presence of epiphytic orchids on the tree trunks are also a common feature. The forest vegetation is dominated by *Schima- Castanopsis - Phobe* association in the lower region and *Engelhardtia - Castanopsis - Schima - Betula* association in the upper elevation. The common species of first storey are: *Castanopsis tribuloides, C. indica, Schima wallichii, Phobe attenuata, Engelhardtia spicata, Betula cylindrostachys, Alnus nepalensis, Stereospermum personatum, Magnolia hodgsonii, Reevesia pubescence, Persea fructifera, Ostodes paniculata, Aglaia perviridis*, etc. The trees of the second storey are *Boehmeria rugulosa, Ficus semicordata, Meliosma simplicifolia, Trichilia connaroides, Macaranga* spp., *Turpinia pomifera, Eurya* spp. etc. Among the shrubs the common are *Maesa chisia, Aechmanthera tomentosa, Rubus ellipticus, R. diffusus, Osbeckia nepalensis, O. stellata, Melastoma nepalensis, Artemisia* sp. *Dendrocalamus sikkimensis, Drepanostachyum polystachyum, Chimonobambusa hookeriana* are the common bamboo species.

The palms are well represented in this forest by the species like *Calamus acanthospathus, C. erectus, Wallichia densiflora, Livistonia jenkinsiana*, etc.

IV. TEMPERATE FOREST

1. Lauraceous forest

This forest ranges from 1800-2400 m with conspicuous *Michelia-Machilus (Persia)* association. The common tree species of the upper storey are *Persia fructifera (Machilus edulis), Michelia cathcartii, Cinnamomum bejolghota, Engelhardtia spicata, Beilschmiedia* spp., *Litsea cubeba, L. kingii, Symplocos* sp., *Lithocarpus fenestrata, Prunus nepalensis*, etc.

2. Evergreen oak forest

The typical Oak forest lies from an elevation of 2150 2750 m. The principal trees of this forest include *Quercus lamellosa, Q. lineata, Lithocarpus pachyphylla, L. fenestrata, Castanopsis tribuloides, C. clarkeii, Acer cambelli, Michelia doltspora, M. cathcartii,* etc. The second storey is composed of *Symplocos lucida, Betula alnoides, Carpinus viminea* etc. Among the shrubs the common species are *Daphne papyracea, Viburnum erubescens, Strobilanthes oligocephalus, S. helictus, S. divaricatus, Rubus lineatus, R. reticulatus,* etc.

3. Rhododendron-conifer forest

Between the elevation of 2700 -3800 m, the Rhododendron- Conifer forest is noticeable. A gradual transition of tree forms from lower elevation to higher is very conspicuous here. In lower elevation the dense evergreen forest is predominated by *Rhododendron* and *Quercus*. Gradually the Oak gives way to conifers at the higher elevation. The conifers are dominated by *Abies* in the higher elevations whereas by *Tsuga dumosa* in the lower elevations. These species are accompanied with *Rhododendron* which forms the secondary layers in the forest.

At Ramam (2750 m) of Darjeeling district, the picture of the vegetation is as follows. The upper storey is made up of *Tsuga dumosa* with occasional presence of *Abies densa*. The representative trees of the second storey are *Lithocarpus pachyphylla, Quercus lineata, Rhododendron arboreum, R. grande, Acer campbelli, Betula utilis,* etc. Among the shrubs *Daphne cannabina, Rubus niveus, Berberis aristata, Gaultheria hookeri, Piptanthus nepalensis* are frequently present.

The forest also have a dense under growth of bamboo species like *Chimonobambusa griffithiana, Drepanostachyum falcatum,* etc.

Near Sandakphu (3500 m) *Abies densa* is the sole representative of the Coniferous members which forms the first storey of the forest. The second storey is mainly made up of *Rhododendron arboreum, R. cinnamomum, R. barbatum, R. hodgsoni, R. griffithianum,* etc. The bamboo *Thamnocalamus aristatus* is very abundant in the forest.

V. GRASS LAND

Grassy terrains or savannah are found to occur in the riverian areas which tend to be flooded during the rainy seasons but remain dry in rest of the year. Moist habitat of these areas support a luxuriant growth of tall grasses like *Saccharum procerum, S. spontaneum, Themeda gigantea, T. villosa, Erianthus arundinaceus, Phragmitis karka,* etc. Tree species like *Shorea robusta, Bombax ceiba, Albizia procera, Bischofia javanica, Dillenia pentagyna* etc. along with the dense patches of *Zizyphus mauritiana, Z. oenoplia, Z. rugosa* are found to be scattered in grassland.

FLORISTIC DIVERSITY

West Bengal has a spectacular plant diversity endowed with a flora ranging from littoral forest of Sundarban to the temperate vegetation of Darjeeling district, coupled with the dry deciduous scrub vegetation of the western stretch of the state.

The perusal of the relevant literature reveal that the flora comprises of 3580 species (21.33%) belonging to 1333 genera (44.64%) and 200 families (78.74%) of Angiosperms out of 16,779 species under 2986 genera and 254 families recorded from India (Kartikeyan *in lit.*). The number of families, genera and species of Angiosperms are given in Table I.

Table I
Number of angiospermic family, genera and species

Plant group	Family	Genera	Species
ANGIOSPERMS	200	1333	3580
Dicot	165	1014	2641
Monocot	35	319	939

The proportion of the Dicot and Monocot plants in the family level is 5:1 and in the genus and species level in 3:1.

A list of families indicating the comparative diversity of genera and species with that of India as a whole, along with their relative percentage is given in Table II.

Table II
List of families showing comparative diversity figure of genera and species

Name of the family	No. of genera in state	No. of genera in India	Percentage	No. of spp. in state	No. of spp. in India	Percentage
1	2.	3.	4.	5.	6.	7.
DICOTYLEDONS						
Acanthaceae	46	92	50.00	120	500	24.00
Aceraceae	1	1	100.00	12	25	48.00
Actinidiaceae	1	2	50.00	2	10	20.00
Aizoaceae	5	8	62.50	8	11	72.72
Alangiaceae	1	1	100.00	3	5	60.00
Amaranthaceae	14	20	70.00	29	60	48.33
Anacardiaceae	10	22	45.00	13	71	18.30
Annonaceae	10	24	41.66	20	120	16.66
Apocynaceae	23	47	48.9	36	119	30.25
Aquifoliaceae	1	1	100.00	6	25	24.00
Aristolochiaceae	1	5	20.00	1	25	4.00

1	2.	3.	4.	5.	6.	7.
Asclepiadaceae	29	57	50.87	51	260	19.61
Averrhoaceae	1	1	100.00	2	2	100.00
Balanitaceae	1	8	12.5	3	21	14.28
Balanophoraceae	1	3	33.33	3	8	37.5
Balsaminaceae	1	1	100.00	32	200	16.00
Basellaceae	1	2	50.00	1	3	33.33
Begoniaceae	1	1	100.00	17	55	30.90
Berberidaceae	2	4	50.00	11	70	15.71
Betulaceae	2	4	50.00	5	11	45.45
Bignoniaceae	7	20	35.00	11	35	31.42
Bixaceae	1	1	100.00	1	1	100.00
Bombacaceae	3	3	100.00	3	5	60.00
Boraginaceae	11	43	25.58	20	209	9.56
Burseraceae	4	8	50.00	5	22	22.72
Cactaceae	3	3	100.00	5	5	100.00
Callitrichaceae	1	1	100.00	1	6	16.66
Campanulaceae	4	11	36.36	10	45	20.22
Cannabinaceae	1	2	50.00	1	2	50.00

1	2.	3.	4.	5.	6.	7.
Capparaceae	5	7	71.42	18	55	32.72
Caprifoliaceae	5	6	83.3	16	71	22.53
Cardiopterygaceae	1	1	100.00	1	1	100.00
Caricaceae	1	1	100.00	1	2	50.00
Caryophyllaceae	12	28	42.85	24	126	19.04
Casuarinaceae	1	1	100.00	1	2	50.00
Celastraceae	5	13	38.46	15	67	22.38
Ceratophyllaceae	1	1	100.00	1	2	50.00
Chenopodiaceae	2	23	8.69	3	69	4.34
Clusiaceae	4	8	50.00	8	82	9.75
Cochlospermaceae	1	1	100.00	1	1	100.00
Combretaceae	6	8	75.00	12	48	25.00
Compositae (Asteraceae)	79	166	47.59	133	803	16.56
Convolvulaceae	15	28	53.57	57	184	30.97
Cornaceae	2	7	28.57	3	15	20.00
Crassulaceae	3	10	30.00	7	71	9.85
Cruciferae(Brassicaceae)	10	64	15.62	19	207	9.17
Cucurbitaceae	20	39	51.28	30	99	30.30

1	2.	3.	4.	5.	6.	7.
Cuscutaceae	1	1	100.00	3	15	20.00
Datiscaceae	1	2	50.00	1	2	50.00
Dilleniaceae	2	3	66.66	4	12	33.33
Dipsacaceae	3	7	42.85	6	18	33.33
Dipterocarpaceae	3	5	60.00	3	30	10.00
Droseraceae	2	2	100.00	3	4	75.00
Ebenaceae	1	1	100.00	6	51	11.76
Eleocarpaceae	2	2	100.00	5	33	15.15
Elatinaceae	1	2	50.00	2	8	25.00
Ericaceae	6	15	40.00	48	199	24.12
Euphorbiaceae	37	84	44.04	111	523	21.22
Fagaceae	3	6	50.00	16	57	28.00
Flacourtiaceae	3	11	27.27	8	39	20.51
Fumariaceae	3	4	75.00	6	65	9.23
Gentianaceae	7	22	31.82	12	188	6.38
Geraniaceae	1	6	16.66	3	45	6.66
Gesnariaceae	5	24	20.83	11	114	9.65
Haloragaceae	1	3	33.33	2	11	18.18

1	2.	3.	4.	5.	6.	7.
Hamamelidaceae	1	7	14.28	1	9	11.12
Hippocastanaceae	1	1	100.00	1	2	50.00
Hydrophyllaceae	1	2	50.00	1	2	50.00
Hypericaceae	1	3	33.33	11	29	37.90
Icacinaceae	3	12	25.00	3	22	13.63
Lebiatae	29	72	40.27	51	435	11.72
Lardizabalaceae	1	3	33.33	1	5	20.00
Lauraceae	10	17	58.82	46	212	21.70
Lecythidaceae	1	5	20.00	2	13	15.38
Leeaceae	1	1	100.00	6	15	40.00
Leguminosae (s.l.)	97	167	58.08	324	1141	28.40
Lentibulariaceae	1	2	50.00	11	36	30.55
Linaceae	2	4	50.00	3	9	33.33
Lobeliaceae	2	3	66.66	4	21	19.04
Loganiaceae	5	10	50.00	8	34	23.52
Loranthaceae	7	9 (including Viscaceae)	77.80	17	49(including Viscaceae)	34.70
Lythraceae	6	9	66.70	16	51	31.37

1	2.	3.	4.	5.	6.	7.
Magnoliaceae	2	3	66.70	9	24	37.50
Malpighiaceae	2	4	50.00	3	25	12.00
Malvaceae	17	22	77.27	52	93	55.90
Melastomataceae	6	21	28.50	17	150	11.33
Meliaceae	12	23	52.10	14	97	14.43
Menispermaceae	8	22	36.36	11	43	25.58
Menyanthaceae	1	3	33.33	2	6	33.33
Molluginaceae	1	1	100.00	2	6	33.33
Martyniaceae	1	1	100.00	1	6	16.70
Moraceae	7	13	53.85	47	122	38.52
Moringaceae	1	1	100.00	2	2	100.00
Myrsinaceae	6	12	50.00	19	109	17.40
Myrtaceae	3	14	21.42	12	146	8.21
Nelumbonaceae	1	1	100.00	1	1	100.00
Nyctaginaceae	4	4	100.00	4	15	26.70
Nymphaeaceae	1	2	50.00	4	7	57.14
Nyssaceae	1	1	100.00	1	1	100.00
Ochnaceae	1	4	25.00	2	6	33.33

1	2.	3.	4.	5.	6.	7.
Olacaceae	2	7	28.57	3	18	16.66
Oleaceae	9	10	90.00	23	99	23.23
Onagraceae	3	6	50.00	12	49	24.48
Opiliaceae	2	3	66.70	2	3	66.70
Orobanchaceae	2	7	28.57	3	32	9.37
Oxalidaceae	2	3	66.70	7	21	22.58
Papaveraceae	3	5	60.00	8	27	29.62
Passifloraceae	2	3	66.70	7	24	29.16
Pedaliaceae	2	2	100.00	1	4	25.00
Periplocaceae	2			2		
Petiveriaceae	1	included in Phytolaccaceae		1	included in Phytolaccaceae	
Phytolaccaceae	1	4	25.00	1	6	16.66
Piperaceae	2	3	66.66	15	100	15.00
Pittosporaceae	1	1	100.00	2	12	18.18
Plantaginaceae	1	1	100.00	2	12	16.66
Plumbaginaceae	1	6	16.66	2	10	20.00
Podophyllaceae	1	1	100.00	1	2	50.00

1	2.	3.	4.	5.	6.	7.
Polygalaceae	2	4	50.00	10	31	32.25
Polygonaceae	5	17	29.41	38	163	23.30
Portulacaceae	1	2	50.00	3	8	37.50
Primulaceae	5	10	50.00	34	183	18.57
Proteaceae	1	2	50.00	1	7	14.28
Punicaceae	1	1	100.00	1	1	100.00
Ranunculaceae	15	28	53.60	54	193	27.98
Rhamnaceae	7	15	46.66	16	68	23.52
Rhizophoraceae	5	8	62.50	10	18	55.55
Rosaceae	14	40	35.00	55	432	12.75
Rubiaceae	44	113	38.90	116	616	18.83
Rutaceae	15	29	51.70	28	114	24.56
Sabiaceae	2	2	100.00	8	15	53.33
Salicaceae	2	2	100.00	6	64	9.37
Salvadoraceae	1	3	33.33	1	4	25.00
Santalaceae	1	10	10.00	1	18	5.55
Sapindaceae	10	18	55.60	12	50	24.00
Sapotaceae	6	14	42.80	8	49	16.32

1	2.	3.	4.	5.	6.	7.
Saurauiaceae	1	1	100.00	4		
Saxifragaceae	12	1		34		
Schisandraceae	2	2	100.00	6	6	100.00
Scrophulariaceae	24	62	38.70	64	368	17.39
Simaroubaceae	3	8	37.50	3	15	20.00
Solanaceae	8	17	47.00	30	75	40.00
Sonneratiaceae	2	2	100.00	3	4	75.00
Sphenocleaceae	1	1	100.00	1	1	100.00
Stachyuraceae	1	1	100.00	1	1	100.00
Sterculiaceae	15	19	78.90	22	68	32.35
Staphyleaceae	1	2	50.00	2	4	50.00
Stylidiaceae	1	1	100.00	2	2	100.00
Styraceae	2	4	50.00	2	6	33.33
Symplocaceae	1	1	100.00	11	43	25.58
Tamaricaceae	1	3	33.33	3	16	18.75
Theaceae	4	9	44.44	6	23	26.00
Tiliaceae	4	8	50.00	17	53	32.00
Toricelliaceae	1	1	100.00	1	1	100.00

1	2	3.	4	5.	6	7
Trapaceae	1	1	100.00	1	3	33.00
Tropeolaceae	1	1	100.00	1	1	100.00
Turneraceae	1	1	100.00	2	2	100.00
Ulmaceae	5	6	83.33	8	22	36.00
Umbelliferae (Apiaceae)	21	72	29.16	31	288	10.76
Urticaceae	12	27	44.44	46	151	30.40
Valerinaceae	2	5	20.00	3	27	11.00
Verbenaceae	15	25	60.00	50	145	34.48
Violaceae	3	3	100.00	17	41	41.41
Viscaceae	1	4	25.00	4	21	19.00
Vitaceae	6	10	60.00	29	94	30.85
Zygophyllaceae	2	7	28.30	2	14	14.28
MONOCOTYLEDONS						
Agavaceae	2	2	100.00	2	18	11.11
Alismataceae	3	6	50.00	6	14	42.85
Amaryllidaceae	3	5	60.00	8	24	33.33
Aponogetonaceae	1	1	100.00	2	7	28.57

1	2	3.	4.	5.	6.	7.
Araceae	16	29	55.17	37	150	24.66
Bromeliaceae	1	1	100.00	1	1	100.00
Burmaniaceae	1	2	50.00	1	8	12.50
Cannaceae	1	1	100.00	1	3	33.33
Commelinaceae	7	14	50.00	20	89	22.47
Costaceae	1	1	100.00	1	2	50.00
Cyperaceae	14	38	36.84	125	545	22.93
Dioscoreaceae	1	4	25.00	13	35	37.14
Eriocaulaceae	1	1	100.00	20	70	28.57
Flagellariaceae	1	1	100.00	1	1	100.00
Graminae (Poaceae)	150	264	56.80	433	1291	33.33
Hydrocharitaceae	7	9	77.70	9	18	50.00
Hypoxidaceae	1			2		
Iridaceae	3	5	60.00	4	21	19.00
Juncaceae	2	2	100.00	10	53	18.86
Lemnaceae	2	4	50.00	4	13	30.76
Liliaceae	20	42	47.60	30	47	63.82
Marantaceae	3	6	50.00	3	14	21.42

1	2.	3.	4.	5.	6.	7.
Musaceae	1	2	50.00	5	25	20.00
Najadaceae	1	1	100.00	5	14	35.70
Orchidaceae	43	184	23.36	112	1229	9.13
Palmae (Arecaceae)	15	24	62.50	26	94	27.65
Pandanaceae	1	2	50.00	4	17	23.52
Pontederiaceae	2	2	100.00	3	3	100.00
Potamogetonaceae	1	1	100.00	5	18	27.77
Ruppiaceae	1	1	100.00	1	1	100.00
Smilacaceae	1	2	50.00	10	33	30.30
Typhaceae	1	1	100.00	2	3	66.66
Xyridaceae	1	1	100.00	2	6	33.33
Zanichelliaceae	1	1	100.00	1	1	100.00
Zingiberaceae	9	23	39.10	30	189	15.87

From Table II it is evident that on the basis of the number of species, the family Graminae shows the maximum diversity represented by 433 species followed by Leguminosae *(s.l.)* with 324 species, Compositae with 133 species, Cyperaceae with 125 species, etc. For clear expression of the status of diversity, some dominant families based on the number of species with their corresponding number in India is given in the Table III.

Table III
Some dominant families based on the number of species

Sl. No.	Name of the family	No. of species in West Bengal	No. of species In India	Percentage
1.	Graminae	433	1291	33.53
2.	Leguminosae (*s.l.*)	324	1141	28.39
3.	Compositae	133	803	16.56
4.	Cyperaceae	125	545	22.93
5.	Acanthaceae	120	500	24.00
6.	Rubiaceae	116	616	18.83
7.	Orchidaceae	112	1229	9.11
8.	Euphorbiaceae	111	523	21.22
9.	Scrophulariaceae	64	368	17.39
10.	Convolvulaceae	57	184	30.97
11.	Rosaceae	55	432	12.73
12.	Ranunculaceae	54	193	27.98
13.	Malvaceae	52	93	55.90
14.	Verbenaceae	50	145	34.48
15.	Ericaceae	48	199	24.12

Similarly families with regard to generic diversity is equally interesting. The position of certain families as compared to Table III deviate slightly. However, the family Graminae remains unaltered with its 150 genera. This is followed by Leguminosae (*s.l.*) and Compositae in the second and third position with 97 and 79 genera respectively. In Table IV a list of dominant families based on the number of genera with their corresponding number in India is given.

Table IV
Dominant families based on the number of genera

Sl.No.	Name of the family	West Bengal	India	Percentage
1.	Graminae	150	264	56.80
2.	Leguminosae *(s.l.)*	97	167	58.08
3.	Compositae	79	166	47.59
4.	Acanthacaea	46	92	50.00
5.	Rubiaceae	44	113	38.90
6.	Orchidaceae	43	184	23.36
7.	Euphorbiaceae	37	84	44.04
8.	Asclepiadaceae	29	57	50.87
9.	Scrophulariaceae	24	62	38.70
10.	Apocynaceae	23	47	48.90
11.	Umbelliferae	21	72	29.16
12.	Cucurbitaceae	20	39	51.28
13.	Malvaceae	17	22	77.27
14.	Araceae	16	29	55.17
15.	Palmae (Arecaceae)	15	24	62.50

The species diversity at the generic level is also quite interesting. The maximum species diversity is observed in the genus *Cyperus* which is represented by 53 species against the 99 species hitherto reported from India. It is followed by the genus *Ficus* (37 species), *Rhododendron* (35 species), *Impatiens* (32 species), etc.

A comparative analysis of the dominant genera based on the number of species is given in the Table-V.

Table V
Dominant genera based on the number of species

Sl.No.	Name of the genera	West Bengal	India	Percentage
1.	*Cyperus*	53	99	53.53
2.	*Ficus*	37	70	52.85
3.	*Rhododendron*	35	80	43.75

Sl.No.	Name of the Genera	West Bengal	India	Percentage
4.	*Impatiens*	32	175	21.14
5.	*Fimbrystylis*	27	50	54.00
6.	*Polygonum*	26	80	32.50
7.	*Indigofera*	21	50	42.00
8.	*Rubus*	20	50	40.00
9.	*Strobialanthus*	19	–	–
10.	*Crotalaria*	18	86	20.93
11.	*Begonia*	17	45	37.77
12.	*Eragrostis*	16	32	50.00
13.	*Solanum*	15	40	37.50
14.	*Primula*	14	115	12.17
15.	*Dioscoria*	13	50	26.00
16.	*Eriocaulon*	20	55	36.36
17.	*Habenaria*	16	100	16.00
18.	*Cassia*	16	24	66.66
19.	*Lindernia*	14	27	51.85
20.	*Acacia*	13	25	52.00
21.	*Glochidion*	13	30	43.33
22.	*Phyllanthus*	13	40	32.50

The statistics of the species diversity is also spectacular. It shows maximum diversity among genera having one species as shown in Table VI.

Table VI
Species diversity

Sl. No.	Categories	No. of Genera	
		Dicot	Monocot
1.	Genera with 1 species	517	171
2.	Genera with 2 species	230	55
3.	Genera with 3 species	87	23
4.	Genera with 4 species	47	19

Sl. No.	Categories	No. of Genera	
		Dicot	Monocot
5.	Genera with 5 species	30	11
6.	Genera with 6-10 species	64	25
7.	Genera with 11-20 species	32	13
8.	Genera with 21-30 species	4	1
9.	Genera with 31-40 species	3	
10.	Genera with 41-50 species		
11.	Genera with 51-60 species		1

The Table VI shows that the major genera of both the groups belong to the categories 1, 2 and 3 and only 1 genus in the category 11 i.e. with more than 50 species.

PHYTOGEOGRAPHICAL AFFINITIES

The past vegetational pattern of West Bengal particularly of the lower Gangetic plain as revealed from the excavated wood from deep core indicates the presence of a dominating mangrove forest which has now migrated to southern part of 24-Parganas.

The coal basin of Raniganj area in western region which is an outcome of upper series of Gondwana system shows remarkable prevalence of Ferns, Cycads and Conifers whereas the lower series of Gondwana predominates in *Glossopteris*, Equisetaceous elements and Cordaitean system.

The varied climatic and ecological conditions in its entire length and breath, the West Bengal offers very favourable spots where a variety of floristic elements have migrated from several near and far-off lands.

The vegetation in the western part of the state represents a type of flora related to the drier areas of the adjoining states of Bihar and Orissa. The occurrence of several taxa of Peninsular and Tarai Himalayan region, has rendered the vegetation of the western part of the state quite interesting in reference to the phytomigratory influence on distribution of the taxa in

marginal areas. The occurrence of *Acampe praemorsa, Desmodium benthamii, Drosera indica, Hedyotis puberular, Jatropha heynei, Mitrasacme pygmaea* var. *malaccensis, Rotala verticillaris, Rhynchospora longisetis, Sphaeromorphaea russeliana,* etc. in Birbhum district shows the extension of these typical Central and Peninsular Indian species to these bordering districts. Like wise, some Himalayan taxa, viz. *Hypericum japonicum, Atylosia vollubilis, Vallaris solanacea, Uvaria hamiltonii,* etc. have also been seen from Birbhum south-wards.

Some of the floristic elements which are common with other countries or biogeographic regions of the world are given below

Some Plants common with North America

Alternanthera pungens, Argemone mexicana, Bromus willdenowii, Cassia floribunda, Centrosema virginiacum, Eleutheranthera ruderalis, Erigeron karvinskianus, Eupatorium adenophorum, Gnaphalium pensylvanicum, Hyptis pectinata, Malachra capitata, Malvastrum coromandelianum, Melichia pygramidata, Neptunia plena, Nothosaerua brachiata, Opuntia stricta, Oxalis latifolia, Parthenium hysterophorus, Passiflora foetida, P. suberosa, Petivieria alliacea, Pseudoelephantopus spicatus, Solanum glaucum, Setaria paniculifera, Tithonia diversifolia, etc.

Some plants common with South America

Alternanthera ficoidea, Boerhavia erecta, Croton bonplandianum, Gomphrena celosioides, Ipomoea carnea, I. indica, Solanum viarum, Spermacoce latifolia, Turnera subulata, Echinochloa cruspavonis, Eichhornia crassipes, Paspalum dilatatum, Solanum diphyllum, etc.

Some plants common with Africa

Cleome rutidosperma, Cressocephalum crepidioides, Euphorbia chamaesyce, Gisekia pharnaceoides, Hibiscus ovalifolius, Indigofera spicata, Ludwigia erecta, Fissendocarpa linifolia, Micrococca mercurialis, Mitracarpus verticillatus, Brachiaria mutica, Melinus minutiflora and *Rhynchelytrum repens.*

Some plants common with Europe

Chrysanthemum leucanthemum, Convolvulus arvensis, Anthoxanthum odoratum, Phalaris minor, Lathyrus aphaca, Vicia sativa, Senebiera pinnatifida, Alyssum maritimum, Lepidium sativum.

Some plants common with Malaysia and Australia

Dentella serphyllifolia, Eryngium foetidum, Lobelia chinensis, Pseudarthia viscida, Rothia indica, Digitaria adscendens, D. longiflora, Eulalla amaura, etc.

Some plants common with China and Japan

Hydrangea macrophylla, Primula malacoides, Viola thomsonii, etc.

Some plants common with West Asia

Aeluropus lagopoides, Capsella bursa-pastoris, Euphorbia helioscopia, etc.

ENDEMISM

Inspite of the poor representation of endemics in the Indo-Gangetic region (Chatterjee, 1940), a number of new taxa have been described in the recent past. They are *Cardenthera uliginosa* var. *birbhumensis* from Birbhum district, *Cuscuta sharmanum* from Midnapore district, *Hydrocotyle himalaica* from Darjeeling district, *Hypericum assamcum* from Darjeeling and *Dalbergia duarensis* from Alipurduar, North Bengal. Besides these newly described endemic species, other endemic species are *Acer osmastonii, Bulbophyllum roxburghii,* etc.

THREATENED AND RARE TAXA

The flora of West Bengal has been under great pressure due to various biotic factors leading to destruction of the diversity. Tourist activities and large scale collection of the class room materials by the students and teachers from all over the country and by the material suppliers have almost fully denuded the vegetation of Darjeeling and suburbs. As a result, many species have become rare and threatened. Some of the rare and threatened taxa of the state are given in Table VII.

Table VII
Rare and threatened taxa

Name of the species	Family	Distribution
Acer hookeri var. *major*	Aceraceae	Darjeeling
A. osmastonii	Aceraceae	Darjeeling
Aconitum ferox	Ranunculaceae	Darjeeling
Arundinella decempadalis	Gramineae	Precise locality not mentioned.
Begonia satrapis	Begoniaceae	Darjeeling
B. rubella	Begoniaceae	Darjeeling
Bulleyia yunnanensis	Orchidaceae	Darjeeling
Calamus inermis	Arecacae	Kurseong
Ceriops decandra	Rhizophoraceae	Sundarban
C. tagal	Rhizophoraceae	Sundarban
Christella clarkii	Thelypteridaceae	Darjeeling
Cissus spectabilis	Vitaceae	Siliguri
Codonopsis affinis	Campanulaceae	Darjeeling
Crotolaria filipes var. *trichocarpa*	Fabaceae	Precise locality not mentioned.
Commelina appendiculata	Commelinaceae	Bengal
Cymbidium eburneum	Orchidaceae	Darjeeling
Cymbopogon gidarba	Gramineae	Precise locality not mentioned.
Diplomeris hirsuta	Orchidaceae	Darjeeling
Dimeria mooneyi	Gramineae	Precise locality not mentioned.
Hedyotis scabra	Rubiaceae	Precise locality not mentioned.
H. brunonis	Rubiaceae	Precise locality not mentioned.
Heritiera fomes	Sterculiaceae	Sundarban
Ischaemum duthiei	Gramineae	Precise locality not mentioned.

Name of the species	Family	Distribution
Ischaemum hirtum	Gramineae	Precise locality not known.
Metathelypteris decipiens	Thelypteridaceae	Darjeeling
Nipa fruticans	Arecaceae	Sundarban
Panax pseudoginseng	Araliaceae	E. Himalaya.
Pandanus unguifer	Pandanaceae	Precise locality not known
Phoenix rupicola	Arecaceae	Darjeeling
Pimpinella tongloensis	Apiaceae	Darjeeling
Polypodiodes wattii	Polypodiaceae	E. Himalaya
Picrorhiza scrophulari flora	Scrophulariaceae	Precise locality not known
Pseudoraphis minuta	Gramineae	Precise locality not mentioned
Rhizophora apiculata	Rhizophoraceae	Sundarban
R. mucronata	Rhizophoraceae	Sundarban
Rhododendron edgeworthii	Ericaceae	Darjeeling
Tricarpelema gigantenum	Concalvulaceae	Darjeeling

Aldrovanda vesiculosa which was known to occur in Saltlakes, Calcutta seems to have become extinct. Only one plant survives under controlled conditions at the Cambridge University Botanic Gardens.

ECONOMIC PLANTS

Ethnobotanical studies conducted in the State have revealed that over 1600 species are put to different uses by the tribal people. Of these, about 850 species are of medicinal importance. The other species are used in various ways. Some of the plants occurring in the area are as follow.

Medicinal Plants

West Bengal is very rich in the diversity of the medicinal plants. Some of the species are given in Table VIII.

Table VIII
Medicinal Plants

Name of the species	Local name	Family	Uses
Abelmoschus moschatus	Mushakdana	Malvaceae	Stimulant, tonic
Abrus precatorius	Kunch	Fabaceae	Nervous disorder, skin disease
Achyranthes bidentata	Bankhat	Amaranthaceae	Diuretic, astringent
Aconitum ferox	Mithavish/Bish	Ranunculaceae	Leprosy
A. laciniatum	Kalo-bikhoma	Ranunculaceae	Fever
Acorus calamus	Bach	Araceae	Diarrhoea and dysentery
Adhatoda zeylanica	Vasak/Bakas	Acanthaceae	Cold and cough
Adina cordifolia	Kelikadam	Rubiaceae	Febrifuge
Alstonia scholaris	Chhatim	Apocynaceae	Bark for pneumonia
Andrographis paniculata	Kalmegh	Acanthaceae	Tonic
Aristolochia indica	Isharmul	Aristolochiaceae	Gastric stimulant
Artemisia nilagirica	Teetapati	Asteraceae	Asthma
Asparagus racemosus	Satamul	Liliaceae	Demulcent
Asystasia gangetica		Acanthaceae	Anthelmiatic
Azadirachta indica	Neem	Meliaceae	Skin disease
Bacopa monnieri	Bramhi	Scrophulariaceae	Brain tonic

Name of the species	Local name	Family	Uses
Bauhinia purpurea	Rakta kanchan	Leguminosae	Carminative
Berberis aristata	Darhaldi	Berberidaceae	Menorrhagia and jaundice
Bergenia ligulata	Pathaschuri	Saxifragaceae	Tonic of Fever
Boerhavia repens	Punarnava	Nyctaginaceae	Expectorant
Butea monosperma	Palash	Leguminosae	Astringent
Calotropis gigantea	Akanda	Asclepiadaceae	Skin disease and dysentery
Cannabis sativa	Ganja/Bhang	Cannabinaceae	Sedative
Capparis zeylanica	Kalokera	Capparidaceae	Sedative
Cassia alata	Barachakunde	Leguminosae	Skin disase
Cephalis ipecacuanha	Ipecac	Rubiaceae	Emetic
Cinchona succirubra	Cinkona	Rubiaceae	Antimalarial
Cipadessa baccifera		Meliaceae	Fever.
Cissampelos pareira	Akanadi	Menispermaceae	Antiperiodic
Clerodendrum viscosum	Bhant	Verbenaceae	Vermifuge
Cordia dichotoma	Bubbara	Boraginaceae	Astringent.
Costus speciosus	Banada	Zingiberaceae	Tonic
Croton bonplandianum		Euphorbiaceae	Checks bleeding
Cryptostegia grandiflora		Asclepiadaceae	Toxic
Curcuma longa	Halud	Zingiberaceae	Stomachache
Cuscuta reflexa	Sarnalata	Cuscutaceae	Jaundice

Name of the species	Local name	Family	Uses
Cymbopogon citratus	Gandhabena	Gramineae	Antiperiodic.
Datura metal	Dhutra	Solanaceae	Antispasmodic.
Dichroa febrifuga	Aseru	Saxifragaceae	Malarial fever.
Digitalis lanata		Scrophulariaceae	Cardiac stimulant.
D. purpurea		Scrophulariaceae	Cardiac stimulant.
Dioscorea prazeri	Kencheong	Dioscoreaceae	To kill lice
Drymeria diandra	Abhijal	Caryophyllaceae	Laxative
Entada phaseoloides	Gila	Leguminosae	Anthelmintic
Erythrina variegata	Palita	Leguminosae	Laxative
Erycibe paniculata		Convolvulaceae	Cholera
Evolvulus alsinoides	Sankhapushpi	Convolvulaceae	Tonic
Fagopyrum dibotrys		Polygonaceae	Choleric diarrhoea
Gloriosa superba	Ulatachadal	Liliaceae	Tonic
Glossogyne bidens		Asteraceae	Toothache
Gynocardia odorata	Chalmogra	Flacourtiaceae	Leprosy and other skin disease
Hemidesmus indicus	Anantmul	Asclepiadaceae	Demulcent
Helicteris isora	Atmera	Sterculiaceae	Antiflatulent
Holarrhena pubescense	Kurchi	Apocynaceae	Astringent/Antidysentric
Ipomoea pes-tigridis	Langulilata	Convalvulaceae	Purgative
Mahonia nepaulensis	Chatri	Berberidaceae	Diuretic

Name of the species	Local name	Family	Uses
Mentha arvensis	Podina	Labiatae	Carminative
M. spicata	Pudina	Labiatae	Antispasmodic
Nyctanthes arbor-tristis	Sheuli	Oleaceae	Antidiabetic
Ochna obtusata var *pumila*		Ochnaceae	Epilepsy
Ocimum sanctum	Tulsi	Labiatae	Cold and cough
Phyllanthus emblica	Amloki	Euphorbiaceae	Astringent
Picrorhiza scrophulariiflora	Kuni	Scrophulariaceae	Bitter tonic
Polygala arvensis	Nepolikanti	Polygalaceae	Purgative
Rhododendron arboreum	Baras	Ericaceae	Diarrhoea and dysentery
Ricinus communis	Reri	Euphorbiaceae	Purgative
Rauvolfia sarpentina	Sarpagandha	Apocynaceae	Insanity
R. tetraphylla	Chando	Apocynaceae	Insomnia
Rubia manjith	Mangistha	Rubiaceae	Antiseptic
Scoparia dulcis	Sagoorcini	Scrophulariaceae	Antidiabetic
Semicarpus anacardium	Bhela	Anacardiaceae	Vermifuge
Terminalia arjuna	Arjun	Combretaceae	Cardiac tonic
T. bellirica	Baehra	Combretaceae	Purgative
T. chebula	Haritaki	Combretaceae	Stomachache
Tinospora cordifolia	Golancha	Menispermaceae	Dispepsia
Uraria lagopodes	Chakulia	Leguminosae	Abortifacient

Name of the species	Local name	Family	Uses
Valeriana hardwickii	Taggr	Valerianaceae	Tonic and stimulant
Vanda roxburghii	Rasna	Orchidaceae	Antiinflammatory
Ventilago denticulata	Ruktupita	Rhamnaceae	Sprains
Viscum articulatum	Paragachha	Viscaceae	Aphrodisiac
V. orientale	Banda	Viscaceae	Neuralgia
Vitex negundo	Nishindha	Verbenaceae	Vermifuge
Woodfordia fruticosa	Dhaî	Lythraceae	Seminal weakness
Zanthoxylum nitidum	Timur	Rutaceae	Stomachache/Stimulant
Zingiber officinale	Ada	Zingiberaceae	Tonic
Ziziyphus oenoplia	Sakul	Rhamnaceae	Healing wounds

Wild Edible Plants

A considerable number of wild edible plants also occur. Cucurbits contribute the major share among the green vegetables followed by the members of Amaranthaceae, and several others. The tender fern-fronds and leaves and seeds of *Urtica ardens* (Sisnoo) are cooked and eaten in the hilly areas. Some wild edible plants occurring in the state along with their local names are given in the Table IX.

Table IX
Wild Edible Plants

Name of the species	Family	Local name
Alternanthera philoxeroides	Amaranthaceae	Burma Sag
A. giganticus	Amaranthaceae	Danta
A. dubius	Amaranthaceae	Note
A. spinosus	Amaranthaceae	Kantanote
Amorphophallus campanulatus	Araceae	Ol
Antidesma acidum	Euphorbiaceae	
Basella alba	Basellaceae	Puin sag
B. rubra	Basellaceae	Puin sag
Bauhinia purpurea	Leguminosae	Rakto kanchan
Bombax ceiba	Bombacaceae	Simul
Boswellia serrata	Burseraceae	Shalga
Canavalia virosa	Leguminosae	Makhon sheem
Coccinia grandis	Cucurbitaceae	Telakucha
Colocasia affisis	Araceae	Kachu
Dillenia indica	Dilleniaceae	Chalta
Dioscorea bulbifera	Dioscoreaceae	Chuprialu
D. pentaphylla	Dioscoreaceae	Khamalu
Diospyros malabarica	Ebenaceae	Gab
Dolichos trilobus	Leguminosae	Shim
Enhydra fluctuens	Asteraceae	Hincha
Ficus racemosa	Moraceae	Jogga dumur
F. hispida	Moraceae	Khaskhase dumur
Flacourtia indica	Flacourtiaceae	Bainchi

Name of the species	Family	Local name
Gardenia latifolia	Rubiaceae	Barabhutra
Ipomoea aquatica	Convolvulaceae	Kalmi
Leucas cephalotes	Labiatae	Drone
Limonia acidissima	Rutaceae	Kath-bel
Madhuca longifolia	Sapotaceae	Mohua
Melothria perpusilla	Cucurbitaceae	Bankundri
Nymphaea nouchali	Nymphaeaceae	Shapla
N. rubra	Nymphaeaceae	Lal shapla
Oxalis corniculata	Oxalidaceae	Amrul
Pachyrrhius erosus	Leguminosae	Shankalu
Portulaca oleracea	Portulacaceae	Nunia
Schleichera oleosa	Sapindaceae	Kusum
Semecarpus anacardium	Anacardiaceae	Bhela
Sesbania grandiflora	Leguminosae	Bok phul
Spondius pinnata	Anacardiaceae	Amra
Vigna capensis	Leguminosae	Bangaugra
V. unguiculata	Leguminosae	Ghangra
Xeromphis spinosa	Rubiaceae	Gurman
Zizyphus oenoplia	Rhamnaceae	Shia-kul

Oil Yielding Plants

The state also exhibits a good diversity of oil yeilding plants. Some of such plants representing this category are enumerated below

Brassica campestris (Shorshey), *Linum usitatissimum* (Teeshi), *Sesamum indium* (Til), *Celastrus paniculatus, Helianthus annus* (Surya mukhi), *Azadirachta indica* (Neem), *Guizotia abyssinica* (Kusum), *Holoptelia integrifolia, Madhuca longifolia* (Mauha), *Prinsepia uitlis, Arachis hypogea* (Badam), *Ricinus communis* (Rari), *Schleichera oleosa, Shorea robusta* (Sal), *Gynocardia odorata*, etc.

Fodder Yielding plants

Important fodder yielding plants are *Artocarpus lakoocha, Bauhinia variegata, Dolichos biflorus, Echinochloa colona, Ficus benghalensis, F. religiosa, Impareta cylindrica, Oryza sativa, Paspaladium flavidum,* etc.

Some other plants which are used in day to day life of the people of the state are given in Table X.

Table X
Plants used in day to day life

Name of the species	Local name	Uses
Acacia catechu	Khayer	Bark yields *'Kattha'* (Catechu).
A. nilotica ssp. *nilotica*	Babla	Wood used in house construction; gum tonic; branchlets as tooth brush.
Alangium salvifolium		Dry wood rubbed to light fire.
Haldinia cordifolia	Khetkadam	Agricultural implements; comb.
Agave cantula	Sisal	Cordage from leaf fibre.
Anogeissus latifolia		For making casts.
Bauhinia vahlii		Leaves for disham and umbrella; stem for cordage.
Bombax ceiba	Shimul	Cotton for stuffing pillows; wood for making bat and boxes.
Buchanania lanzan		Wood is suitable for furniture.
Boswellia serrata	Shalga	Resin used as inscence; wood for gun powder, charcoal.

Name of the species	Local name	Uses
Carissa carandas	Ban karamcha	Roots as insect repellant and cattle diseases.
Cleistanthus collinus		Bark-juice for tanning.
Curcuma domestica		Rhizome powder used in sprain.
Dendrocalamus strictus		Walking sticks, handles; also used for fencing.
Desmodium oogeinensis		Wood is used for making carts and furniture.
Diospyros malabarica	Gaab	Fruit gum used for tanning and painting fishing net.
D. tomentosa	Kend	Wood used for furniture and leaf for making *'Biri'*
Eclipta prostrata	Keshut	Leaf-juice in cattle diseases.
Erycibe paniculata		Stem and leaf-decoction in cattle diseases.
Helicteres isora		Source of cordage.
Jatropha curcus	Varenda	Grown along fencing.
Kydia calycina		Walking sticks.
Lannea coromandelica	Jiol	For making carts, doors, etc.
Lantana camara	Chotra	Dried twigs for ignition by friction; charcoal for gun powder.
Lawsonia inermis	Mahendi	Leaf paste for colouring hairs and for decorating hands of ladies.
Mallotus philippensis		Used for thatching houses.
Morinda tinctoria	-	Wood is used for making furniture.

Name	Local name	Uses
Phoenix sylvestris		Leaves are used for making broom, hat, mats etc.
Pterocarpus marsupium	Bijasal	Water kept in tumblers made from its heart wood is very effective in diabetes; various house hold articles are made from its wood.
Sesbania aegyptiaca	Dhancha	Used along fencing; source of green manure.
Spatholobus roxburghii		Timber is used for window; bark yields cordage.
Shorea robusta	Sal	Leaves for making bowls; wood for house making.
Thysanolaena maxima	Phooljharu	Inflorescence used as broom.

WETLANDS

Approximately 3,44,527 ha. area of the state is under wetlands. The state comprises of 22 natural and one man made wetlands. The Malda district occupies the first position in having a large number of wetlands. Distribution of the wetlands are given in Table XI.

Table XI
Wetlands

Name of the wetland	Place (District)	Area (ha)
Natural		
Adh Soi	Pachia (Malda)	140
Ashi Dob	Kasimpur (Malda)	280
Balotali-Beel	Jatra Danga (Malda)	120

Name of the wetland	Place (District)	Area (ha)
Barbila Talao	Arai-Danga (Malda)	120
Bochamari	Bowalia (Malda)	120
Buxigang-Nijiarap	Haldibari (Coochbehar)	1400
Chalua	Sitagram (Uttar Dinajpur)	140
Goal Bod	Bajanna (Malda)	120
Talao Haliday Island	Namkhana (24-Parganas)	350
Hazar Takla	Mobarak Pur (Malda)	140
Jaula Para	Madarihat (Jalpaiguri)	6096
Kathambari Beel	Odlabari (Jalpaiguri)	136
Konar	Kurpur Ganj (Malda)	280
Land Thata Beel	Lang Thata (Birbhum)	2000
Lothian	Namkhana (24-Parganas)	3800
Madhaupur Bheel	Malda Town (Malda)	100
Rasik Beel	Toofan Gang (Coochbehar)	9952
Sajana Khali	Gosaba (24-Parganas)	36236
Sanak Beel	Chandipur (Malda)	200
Saltlake	Calcutta (24-Parganas)	3000
Singsar	Chandipur (Malda)	140
Teesta Nadi	Makheli Gang (Coochbehar)	1800
Man-made		
Kangsabati	Mukutmanipur (Bankura)	12400

These wetlands are very rich in plant diversity, but due to extensive urbanisation and changing land use pattern for settlement of massive migratory population after 1947, many waterbodies have disappeared. Consequently several types of aquatic and marshy elements of wetland flora are vanishing. In this context the example of *Aldrovanda vesiculosa* can be cited which was noticed from the Saltlake areas in the past but due to urbanisation most of the wetland of Saltlake have disappeared probably along with the species.

Further, due to commercial utilization of water resources for pisciculture during the past few years, the planktonic as well as the submerged

common aquatic plants are on the verge of depletion at a fast rate from the wetlands.

Some common fresh water hydrophytes under different categories belonging to angiosperms and pteridophytes are enumerated here :

Free floating aquatics (Planktons)

Azolla pinnata, Salvinia cuculata, Spirodela polyrhiza represent the pteridophytic group and the flowering plant groups are represented by the species *Lemna minor, L. trisulca, Pistia stratiotes, Eichhornia crassipes, Wolfia arrhiza,* etc.

Submerged suspended aquatic (Pleustons)

Myriophyllum indicum, M. tuberculatum, Ceratophyllum demersum, Utricularia inflexa var. *stellaris, U. flexuosa. Hydrilla verticillata, Vallisneria spiralis,* etc.

Anchored aquatics with floating leaves (Benthos)

Nelumbo nucifera, Nymphaea pubescence, N. rubra, N. nouchali, Trapa bispinosa, Aponogeton natans, A. crispus, Limnophyton obtusifolium, Hygrorrhiza aristata, etc.

Semi-aquatics or emergent amphibious hydrophytes

Aeschynomone aspera, Ammania baccifera, Limnophila indica, L. sessiliflora, Rotala densiflora, Typha angustifolia, T. elephantina, Monocharia hastata, M. vaginalis, Sagitaria trifolia, Cardenthera dijormis, Enhydra fluctuans, Acorus calamus, Polygonum orientale, etc.

Marshland and Hydrophytic weeds

Brachiaria mutica, B. reptans, Coix aquatica, Commeliana-longifolia, Crinum defixum, Cryptocorne ciliata, Anosporum cephalotes, C. exaltatus, C. compressus, C. iria, Eriocaulon sexangulare, Fimbristylis dichotoma, Hygrophila polysperma Ipomoea carnea ssp. *fistulosa, Lasia spinosa, Murdania nudiflora, Phyla nodiflora, Polygonum hydropiper, P. glabrum, P. orientale, Schoenoplectus praelongotis, S. juncoides,* etc.

CONSERVATION

The diversity associated with the pre-existing forest, vast natural water bodies and natural vegetational tracts have been engulfed by enormous developmental activities. About one third of the luxuriant forests of Sundarbans have been depleted due to expanding agriculture. The famous *'Sundri'* (*Heritiera fomes*), once a dominant component of Sundarban forests is now restricted only to small localised pockets. *Aldrovanda vesiculosa*, once an inhabitant of Saltlake, Calcutta has probably become extinct.

Industrial developments in the western part have resulted in considerable loss of rich Sal (*Shorea robusta*) forest.

The State with the population density of over 600 persons per sq km is under a severe threat of land use pattern and more land and waterbodies supporting natural vegetation are being brought under human settlements. It is due to such intense biotic factors that a host of natural habitats of plants are getting lost leading to the extinction of the many precious elements of the flora.

In the sub Himalayan region of the state the influx of tourists and students, felling of trees for timber, collection of fodder, fuel wood and other forests products for commercial purposes has caused a great deal of damage to the plant diversity.

The Government has initiated several measures to conserve the biodiversity of this state by establishing National Parks and Wildlife Sanctuaries. The list of National Parks and Sanctuaries are given in the Table XII.

Table XII
National Parks and Wildlife sanctuaries

Name	Area (sq km)
Ballavapur Wild Life sanctuary	2.00
Bethuadheri Wild Life sanctuary	1.20
Bibhuti Bhusan (Paramdan)	0.60
Buxa National Park	117.10

Name	Area (sq km)
Buxa Wild Life sanctuary	251.89
Chapramari National Park	9.60
Gorumara National Park	79.45
Holiday Island Wild Life sanctuary	5.95
Jaldapara Wildlife sanctuary	216.51
Jorepokhri Wildlife sanctuary	0.04
Lothian Island Wildlife sanctuary	38.00
Mahananda Wildlife sanctuary	127.22
Narendrapur Wildlife sanctuary	0.10
Neora valley National Park	88.00
Raiganj Wildlife sanctuary	1.30
Ramnabagan Wildlife sanctuary	0.14
Sajnakhali Wildlife sanctuary	362.40
Sinchal Wildlife sanctuary	38.60

During the last decade people's participation in management of forests have yielded good results. Awarness programmes on conservation of plant resources needs to be further intensified particularly amongst rural population.

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The dense evergreen forest of Darjeeling Himalaya

The gregarious halophytic vegetation of the Sunderbans

Nypa fruticans : the threatened palm of the saline water

Cestrum acuminatum : a common shrub of the temperate region of the Himalayas

Alstonia scholaris : the State Tree

Nycthanthes arbor-tristis : the State Flower

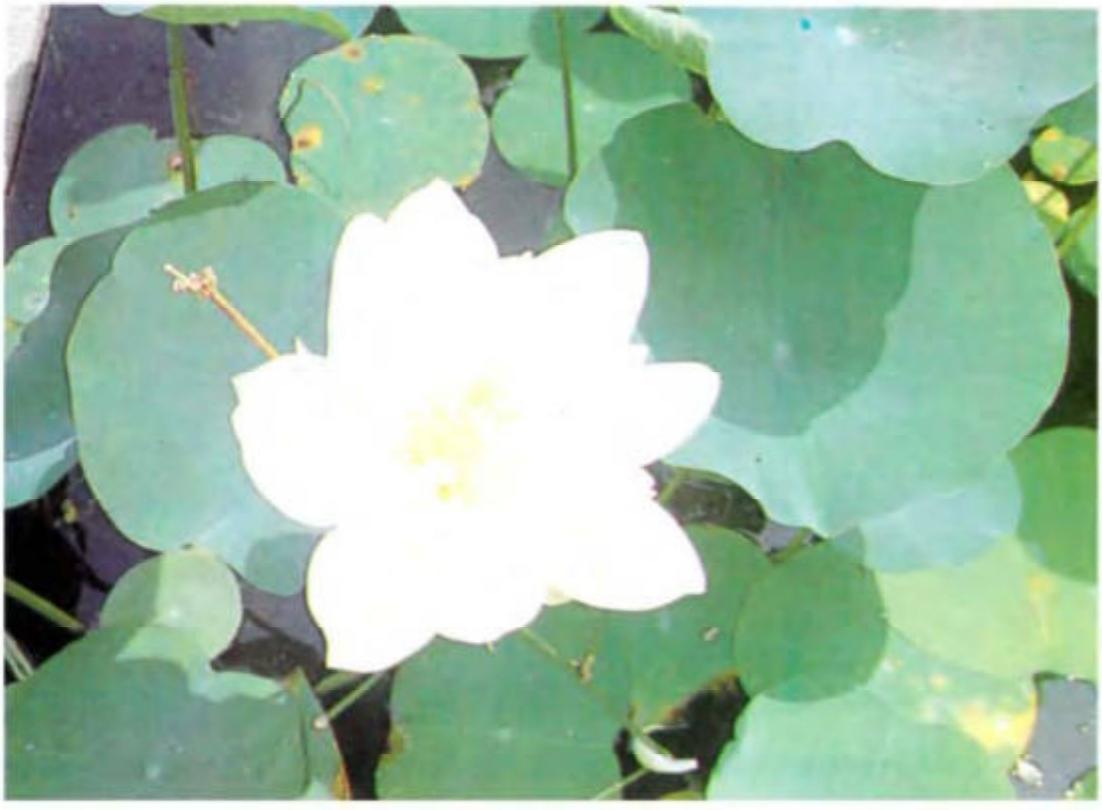
Anthocephalus chinensis : the famous 'Kadam' tree of the state

Clitorea ternatia : the climber of immense mythological importance

Michelia champaca : the flower of fragrance

Dillenia indica : a species bearing the heritages of customs and culture

Eichhornia crassipes 'Water hyacinth' : the most aggressive aquatic weed



Nymphaea pubescens : the cultivated white lotus

Cocos nucifera : a major economic crop

Carissa carandas : a minor economic crop

Camellia sinensis : a plant of hills, earning foreign exchange

Piper betle