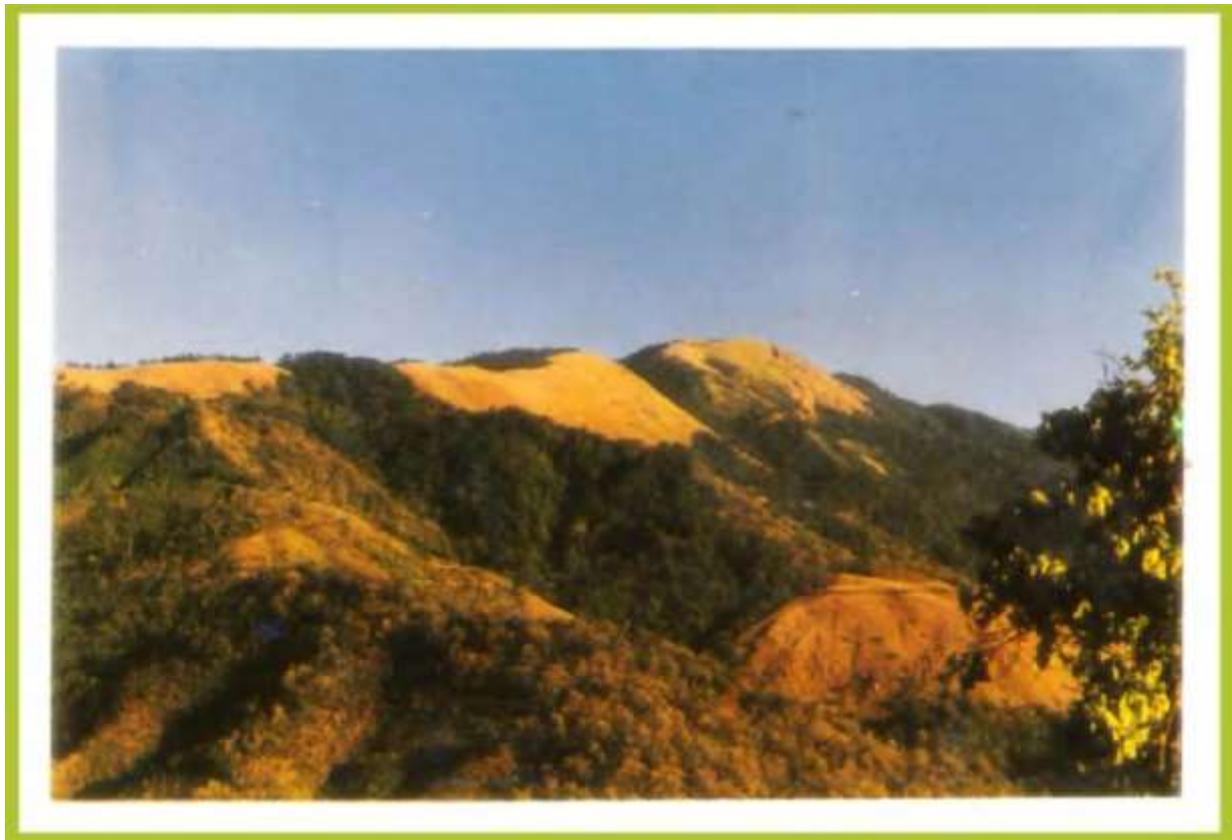


India
Flora of
Series-2

FLORA OF MANIPUR

VOLUME 1

(Ranunculaceae Asteraceae)



India
BOTANICAL SURVEY OF INDIA
Flora of
Series-2

FLORA OF MANIPUR

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(Ranunculaceae — Asteraceae)

Editors

N. P. Singh

A. S. Chauhan

M. S. Mondal



BOTANICAL SURVEY OF INDIA

India

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Front Cover Photo : A view of Sirohee hills

Back Cover Photo : A view of Loktak lake

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FOREWORD

The state of Manipur is situated in North Eastern India bordering with Myanmar and harbours interesting flora. It offers a rich, scenic grandeur and panorama of contrasting landscape and many picturesque spots. The state is nature's paradise for its wild fauna and flora. It harbours over 3000 species of higher plants within an area of 22,327 sq. km and contributes an important source for germplasm. A number of wild relatives of cultivated plants, endemics, rare and threatened plants, medicinal and other ethnobotanically important plant species etc. occur in this state.

The old literature, epics and myths, etc. speak about the richness in biodiversity and culture of its people. A large number of different tribal population inhabit forest areas in this state and depend on the forest wealth for day to day needs. They have lived in complete harmony with the nature since time immemorial. However, due to biotic pressure, shifting cultivation, socio-economic development, hydroelectric projects, development of communication network, transformation of forest land for rehabilitation and agricultural purposes, etc. have contributed a lot for depletion of the floral wealth of this part of the country. The forest areas are shrinking day by day due to population expansion and live-stock pressure as well as increasing demand on forest resources for

sustenance of the human at large. As a result, several species are facing threat of survival in their natural habitats and many may disappear before the inventorisation, assessment and utilisation of their economic potentialities for better human survival. Therefore, sustainable utilisation and conservation must be practiced to save the phytodiversity of this

The Botanical Survey of India is publishing the flora of the country under four series viz., (1) National Flora of India, (2) State Flora of State Flora Analysis, (3) District Flora of flora of some rich biodiversity hotspot area of the country and (4) Monographs and revisionary studies etc. Flora of Manipur is being published under state flora series. The publication of the Flora of Manipur was a long felt need and was overdue. In recent years it has assumed special importance due to increased progress of scientific activities with several new economic species. The present publication embodies plant resources available at this very moment in this state. The preservation and conservation of plant diversity will not only be helpful for the state policy planning of forest based industries but also to take measures to protect this natural heritage so that it can be handed over to posterity.

I hope this publication would be very interesting for students, scientists, conservationists and industrial houses dealing with plant resources as raw material. The authors have done a commendable job in completing this work.



(N. P. Singh)

Director

Botanical Survey of India

8th May, 2000

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8th May, 2000

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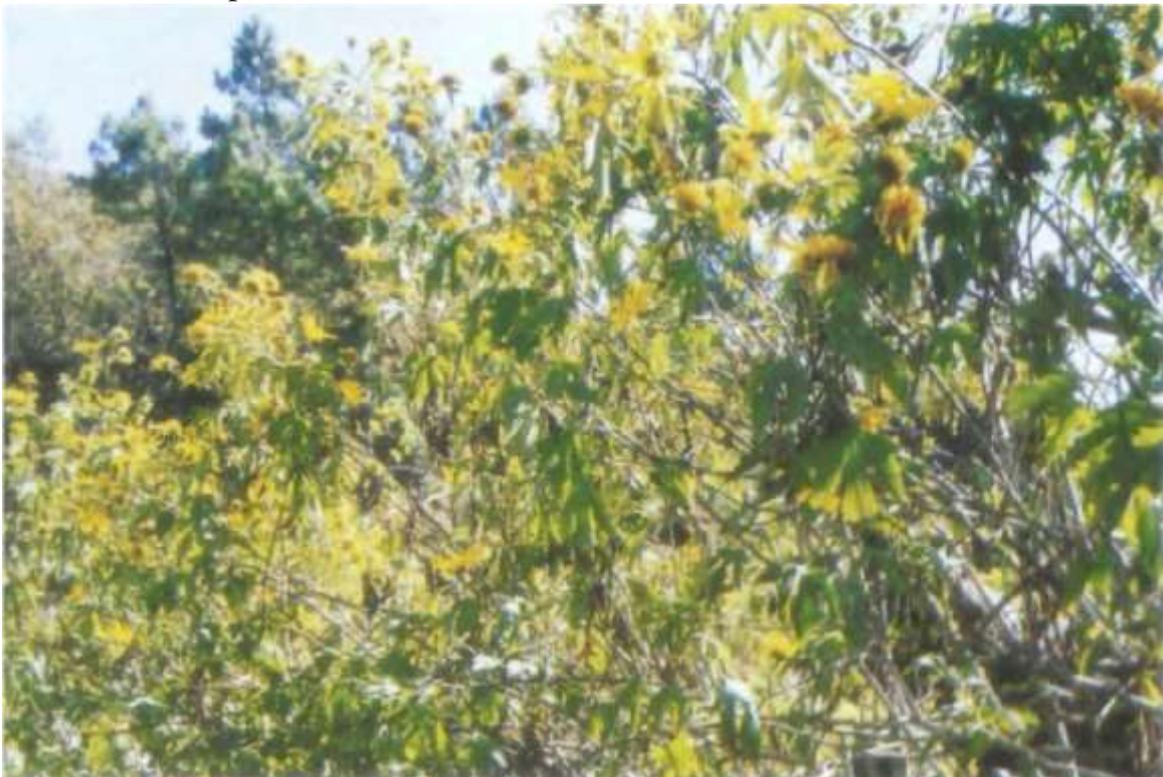
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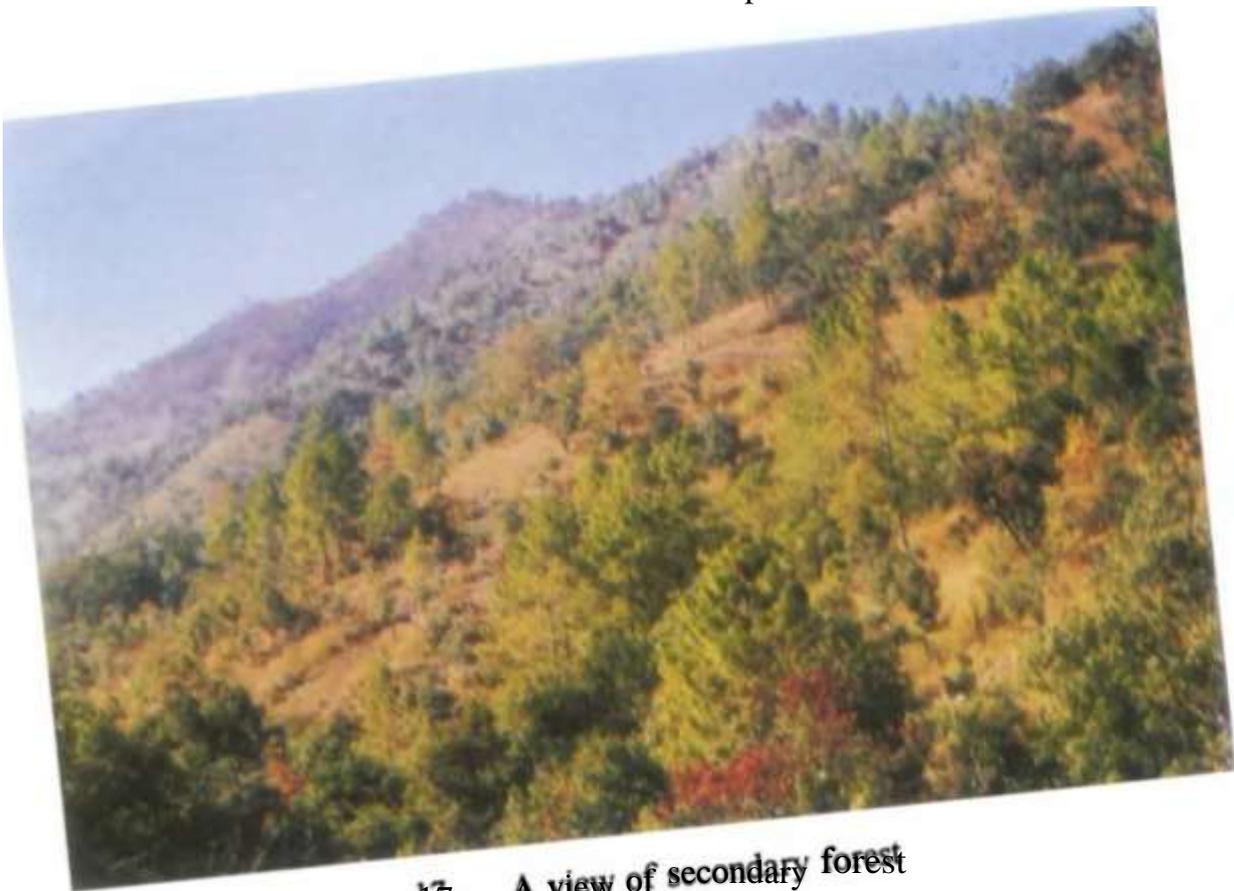
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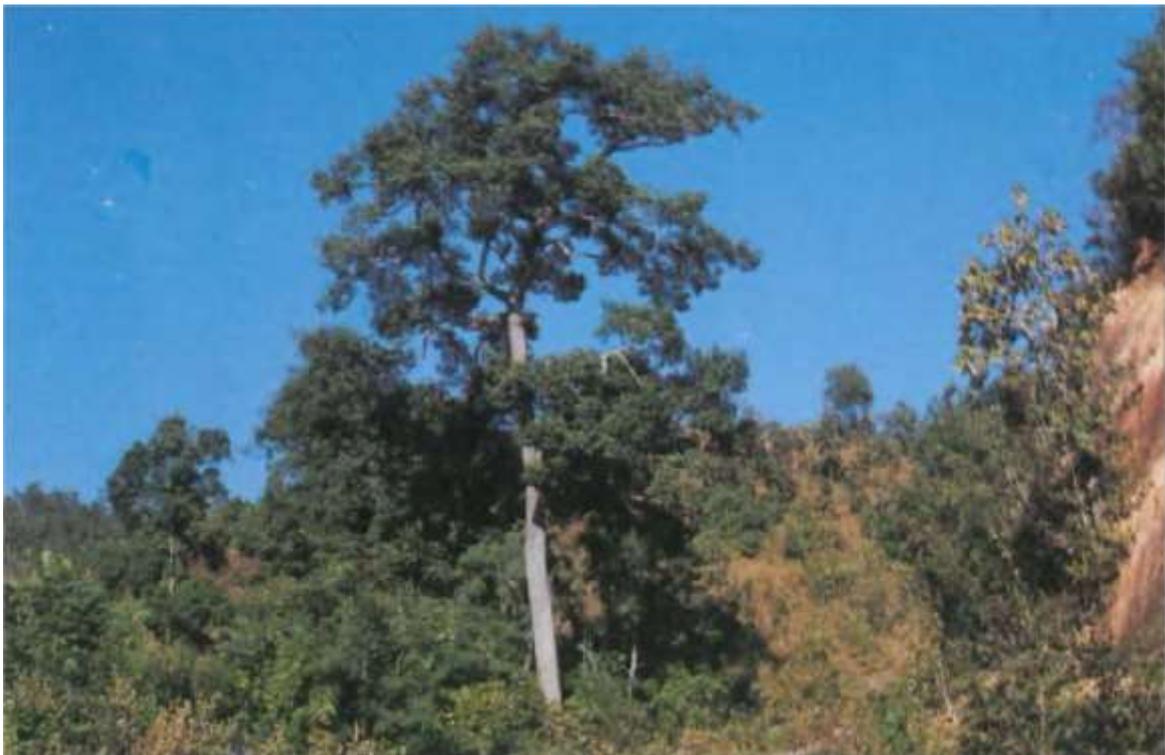
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INTRODUCTION

(A. S. Chauhan)

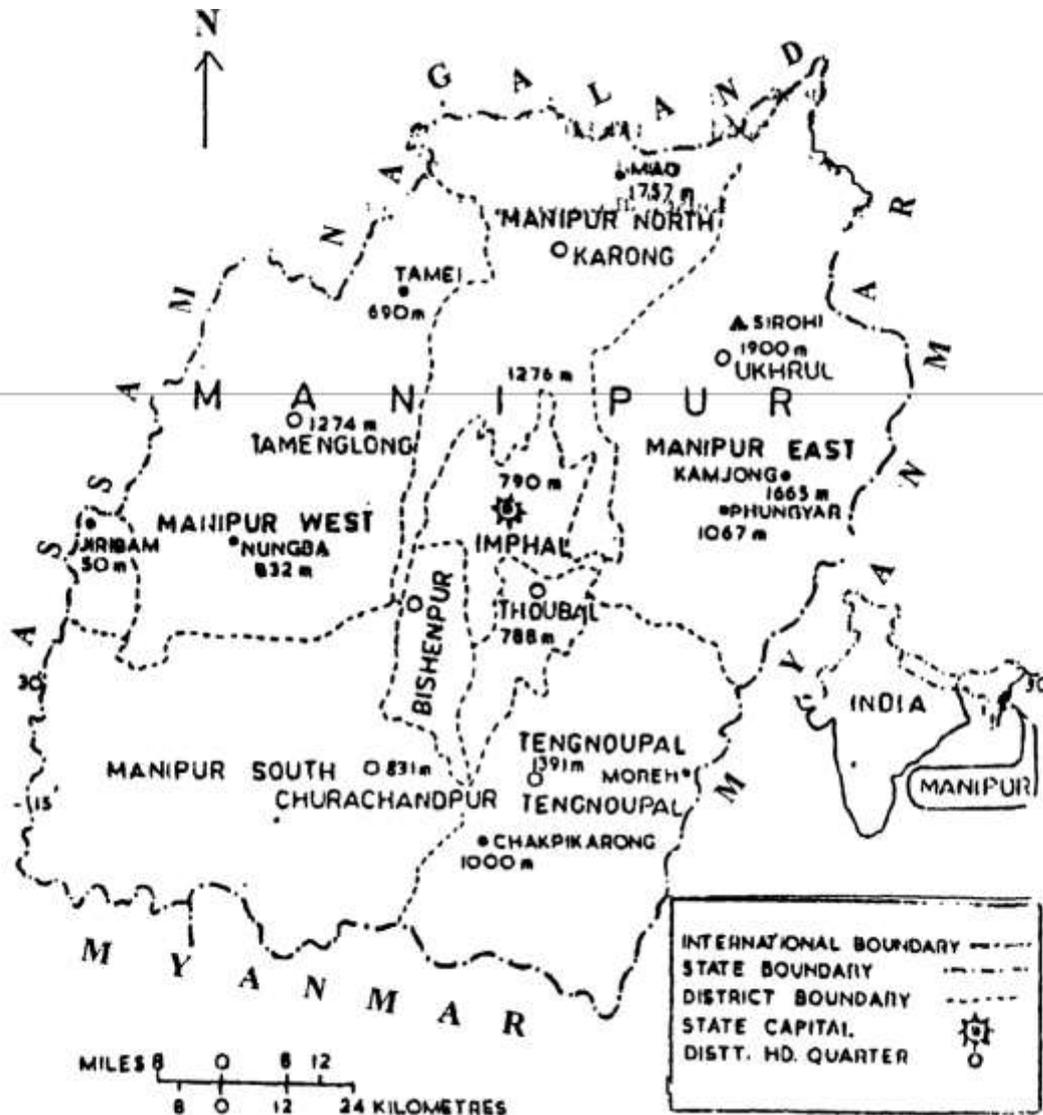
The state of Manipur is situated in North-east India bordering with Myamnar and harbours an interesting flora. It offers a rich scenic grandeur and a panoramic view of contrasting landscape with many picturesque spots and mountain slopes which are more rugged and inaccessible. Late Prime Minister Pandit Jawaharlal Nehru described it as, "Jewel of India", as the state is nature's paradise for its wild fauna and flora in general and rich heritage of wild orchids in particular. The first botanical exploration of Manipur was made by G. Watt, who was deputed as a Botanist member of the boundary commission of 1881-82 set up by the British Govt. Since then, the flora of this state attracted the attention of many western explorers like C.B. Clarke, 1885; A. Meebold, 1906-1907; Sir Anandale, 1921; D. C. Kaith, 1932; N. L. Bor, 1938, 1942, 1948, 1960; F. Kingdonward., 1927, 1935, 1945) from time to time. Later U. N. Kanjilal, a forest officer made extensive collections through forest officials from the whole of Assam and Manipur for the publication of Flora of Assam (Kanjilal et al., 1934-1945) forms a landmark in the history of botanical studies in North-eastern region, but this flora is incomplete in the study of monocots.

With the reorganisation of Botanical Survey of India in 1954, a separate regional circle was set up in Shillong to explore the botanically rich area of North eastern region and to write a detailed flora. The noteworthy publication on the floristic account of Manipur State is by Deb 1961. Besides, sporadic contributions have appeared on the floristic accounts of Manipur (Mukerjee, 1953; Jain & Shukla, 1979; Shukla & Baishya, 1979; Kataki, Jain and Sastry,

1984 (a, b); A. S. Rao & Verma 1982; Deb 1956 & 1957; Katakai, 1987; Rao, 1968 & 1974, sastrv & Hajra, 1983; Malick & Safui, 1987; Phukan, 1999). The establishment of Manipur University, Imphal has further accelerated the floristic studies on the flora of the state subsequently, a number of papers have been published on various aspects (Sharma. 1986: Singh & Singh, 1983; Singh & Singh, 1985: Sinha, 1986. 1987: Sharma. 1987; Singh. 1990. Singh. 1999). But none of these studies have given a comprehensive detailed account of the state flora and only checklist of plants of Manipur has been provided. Besides, till several far off areas which were difficult to approach. especially bordering Myanmar were left out. During the recent past, the natural forests, which are playing key role for economic upliftment of the people of the state are being destroyed extensively either for age old practice of shifting cultivation by the local people or in the name of developmental activities. All these have resulted in depletion of the genetic wealth of the state considerably. The population of several species are facing threat of survival in their natural habitats, while few are already on the verge of extinction. The situation has reached an alarming stage and it would worsen

if immediate conservation measures are not undertaken. Moreover, for socioeconomic development of the state on scientific lines, it is a prerequisite to have a detailed flora with complete inventory of all plant wealth before loss of many of these species.

Keeping these aspects in a view, the present work has been undertaken so that a long felt need for a detailed flora of the state could be met. This flora of Manipur, based on intensive survey as well as critical study of herbarium specimens housed at different herbaria in the country is presented here.



Map of Manipu r

FLORA OF MANIPUR

Physical Geography and Location

Manipur, a small land-locked hilly state just north of Tropic of Cancer, lies between 23° 50' and 25° 45' north latitudes and 93° 06' and 94° 47' east longitudes. The state is bounded on the north by Nagaland, on the south by Mizoram and Chin Hills of Myanmar, on the east by Chin State of Myanmar and on the west by Cachar and North Cachar districts of Assam. The state has an area of ca 22327 sq. km. The arm of the Himalayas, which sweeps round the southern side of the Assam valley divides Cachar from Upper Myanmar and further south, Chittagong and Arakan from lower Myanmar. The major portion of the state consists of hill ranges with a north and south general trend. A central stream has been blocked by some convulsion of nature just below the points at which five streams join. Alluvium has been deposited instead of being carried off, and the flat and elevated valley of an area of about 1545 sq km has been formed (central valley). The state has an elevation ranging from 550—3,600 m above the mean sea level.

Topography

The major portion of the territory is covered by hill ranges. In the centre lies the valley which is ca 48.3 km in length and 32.2 km in breadth. Series of low hills crop up here and there within the valley. The hills are generally of irregular serrated ridges, occasionally rising into conical peaks and flattened cliffs. The hill ranges attain their greatest height towards the north-east, about 8000 m from the valley rising about 3.6 km above the level of the sea. From this point south, until the sea is reached towards Chittagong and Arakan, there is a steady decrease in the height of the hilly ranges. In the north again, until the Assam valley is reached, there is same gradual decrease in height.

Of the numerous peaks of the notable ones are (1) Surma 2938 m (2) Chekka 2845 m (3) Kasom 2681 m (4) Khayang Phung 2832 m (5) Khumho 2681 m (6) Kopa medza 2553 m (7) Koupru 2564 m (8) Langol 1136 m (9) Maram 1867 m (10) Nonglaining 1564 m (11) Sirohee furar 2566 m (12) Surma north Deak m and (13) Tusom 2516 m.

Geology and Soil

Geologically the state is of recent origin. Greater part of the state is occupied by a series of slate and stones. The upper tertiary continues through Mapum and passes through the Kopamedza range in the Angami Nagaland. Lime stone of Kasom range and Nungshongkhong valley are of cretaceous age. Soil is recent alluvium in the valley. At the base of the hills it is derived from sandstone rocks. At Langol it is ferruginous clay to clayey loam. A lot of work has been done on the geology of the state.

The earliest geological work carried out in North Eastern India was that by Middelton (1865). Thereafter, Mallet (1876) published a valuable geological document of his extensive reconnaissance in North Eastern Region, which laid down the foundation of the stratigraphy of Upper Assam and its adjoining areas including Manipur-Nagaland and still remains a standard reference of any stratigraphic studies of these areas. In later years Godwin Austen (1874), Hughes (1874), La Touche

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(1883), Oldham (1883), Smith (1898), Maclaren (1904), Simpson (1906), Hayden (1910),

Oldham

Pascoe (1912), Goggin Brown (1912), Stuart (1922) and Palmer (1924) had worked from time to time in Assam and adjoining Manipur-Nagaland in limited areas of economic interest mainly for coal and oil, and added further knowledge to the geological and stratigraphic understanding of North East Region. Evans (1932) had brought out an extensive account of the tertiary succession in Assam and adjacent areas mainly based on the work done by the geologists of the then Burma Oil Company during the year 1913 to 1915.

The Tertiary sedimentary units cover about 90% of the area of Manipur are documented. The stratigraphy of the ophiolitic belt is discussed separately as it constitutes a distinct geological entity. The detailed discussion about the Disang, Barail Groups and ophiolitic sediments which are exposed in eastern part of Manipur and Chandel district is given.

Disang Group was first described by Mallet (1876) as Disang series which consists of a great thickness of splintery grey shales interbedded with fine grained sandstones. Towards upper part it passes into a sequence of thinly bedded sandstones. A large tract of the interior hills of Manipur is occupied by the Disang Group rocks. The Disang rocks are not yet known from NW of Haflong — Disang thrust (Evans, 1932).

In Manipur the Disang rock consists of monotonous sequence of dark grey, splintery shales (Pascoe, 1912) and subdivided into Lower Disang Upper Disang formations. The Disang have a thickness approximately 3000 m (Mathur and Evans, 1964) though it is difficult to estimate the exact thickness because of tightly and repeatedly folded nature of its strata and due to intermittent dissection by a series of faults. The Lower Disang formation is constituted mainly of argillaceous lithounits such as phyllitic shales, phyllites, slates and slaty shales with interbedded minor sandstones/siltstones. It is usually devoid of any megabiota but leaflets and broken impressions of Poaceae are quite common and represents the rock types originating in a distal shelf facies. The Upper Disang formation which lies over the Lower Disang comprises a rhythmic sequence of alternate shale/ siltstone and sandstone beds.

The Disang Group is overlain by the Laisong Formation (sandstones) of Barail Group.

Barail Group

The name Barail was taken from the Barail range which forms the backbone of North Cachar Hills. The Barail rocks overlying the Disang occur mainly in the Kohima synclinorium, in the Schuppen belt as tectonic slices and in the inner Palaeogene fold belt along the cherts of ynclinal ridges in Manipur. The sandstones of Manipur are divided into three formations.

Laisong Formation : It is the lowest subdivision of the Barail, about 200 m to 2500 m in and consists largely of very hard, thin bedded, indurated, grey sandstones alternating with hard sandy shales. In eastern Naga Hills and Manipur, the Laisong is at places underlying by a ferruginous nodules bearing horizon of Upper Disang Formation.

Jenam Formation : The Laisong Formation passes upward into a more argillaceous lithoformation known as Jenam Formation which consists of shale, sandy shale and carbonaceous shale with a relatively thin bed of sandstones. There are occasional streaks, lenses, and beds of coal asociated with ddis formation. The Jenam is not recorded from the inner Palaeogene fold belt of Nagaland and Manipur. It is found that the development of workable coal seams is restricted

to the Jenam Fr uznuauvau in the northern part of the Schuppen belt.

Renji Formation : Above the soft Jenam beds there occurs a great thickness of hard, ferruginous, massive to thick bedded, multistoreyed sandstone with small proportion of shale/sandy shale known as Renji Formation. The formation constitutes the hills known as Renji hill to the north of Badarpur in Cachar (Assam). Well developed section of Renji sandstone occur in Changkikong range in the Schuppen belt, Kohima synclinorium including the Japvo range, and Pherima—Piphima road section of N.H 39. The outcrops of Japvo range extend southwards along the eastern limb of the Kohima synclinorium into the hills of northern and western Manipur.

Surma Group

In the Surma valley, and parts of Naga-Manipur Hills the Barail Group of rocks is found to be unconformably overlain by a thick sequence of alternate beds of shale, sandy shale, mudstone, siltstone, and sandstone having thickness of about 35()0 m and as a whole being known as the Surma Group. In western Manipur they occur forming a part of the eastern limb of the Kohima synclinorium. The uncomformity at the base of the Surma has a characteristic basal conglomerate. It has been divided into two formations.

Bhuban Formation. : The Bhuban Formation as a whole consi<s of alternation of shales, siltstone, shaley sandstone and sandstone beds. The lower

Bhuban is not represented in Manipur Hills where the Surma sedimentation starts with

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the deposition of middle Bhuban represented by a conspicuous rhythmic sequence of shale/siltstone and fine grained sandstone with ripple marks, cross laminations and intraformational grit beds. It is exposed in western Manipur along the eastern limb of the Kohima synclinorium. In Naga Hills, the Bokabil has much less thickness compared to its large thickness of 900 to 1200 m in the Surma valley.

Bokabil Formation : The formation is made up of sandy shale and alternation of clay/shale and ferruginous sandstones. Sandy shale often grades into finely laminated siltstone. As a whole, this formation forms a sort of transition zone from the Bhuban to Tipam sandstone.

Tipam Group

This group of rocks was first described by Mallet (1876) as Tipam Series consisting of coarse grained, ferruginous sandstones with partings of sandy shale and a sequence of mottled clays at the top. The Tipam Group has been subdivided into broad formations, namely the Tipam sandstone Formation and Girujan clay Formation.

Tipam Sandstone Formation : The Tipam Sandstone Formation was first identified in the Tipam river section of upper Assam by Mallet (1876). It consists mainly of coarse grained massive to thick bedded, occasionally gritty, ferruginous sandstones, on weathering it changes to orange, brown, yellowish-brown and reddish-brown with elephant—skin texture on the surface. The sandstone beds are sometimes interbedded with thin partings of sandy shale, thin streaks of coal and medium to large size sand balls do also occur in this formation.

Girujan Clay Formation : Above the Tipam Sandstone Formation there occurs a distinct group of rocks in which mottled clays are predominant. It is an argillaceous group of rocks consisting of mottled clays with alternation of minor mottled sandstone bands. Red brown, purple and blue mottled clays are most common. At places, characteristic pink and white clays are also present. The formation is about 1500 m in thickness. The coarse, ferruginous sandstones occurring in the lower part of the Girujan Clay Formation closely resemble the Tipam sandstones. The formation is unconformably overlain by a group of sandstone, coal (lignite), conglomerate and grit beds known as Namsang.

Namsang Formation / Dupitila Beds

Dupitila beds were first described by Mallet (1876) from the Jaintiapur hills of Sylhet district (now in Bangladesh) for a group of rocks consisting of coarse, ferruginous sandstones with numerous layers of quartz and coal pebbles bearing channel conglomerates and grit beds overlying the Girujan clays. In Naga Hills, these beds have been referred to as Namsang Formations while in Upper Assam the name Dupitila is retained.

The Namsang Formation consists of quartz and lignite pebble conglomerate, grit, ferruginous sandstone and intermittent, mottled, sandy clay bed. In Surma valley, however, the Dupitilas are not marked by distinctive lignite pebbles as observed in Naga Hills and Upper Assam.

Quaternary Group

The Pleistocene to recent alluvial deposits consisting of partially consolidated to unconsolidated boulders, pebbles, sands, silt and clay which had undergone various degrees of oxidation occur in different topographic levels and places of Naga Hills and Manipur. There are at least three Quaternary terraces of alluvial deposits encountered at different levels of altitude. Many of the low hills in the intermountain valley areas are completely made up of alluvial deposits. The Quaternary alluvial deposits lie unconformably over the older group of rocks like Dihing, Namsang, Tipam, Surma and Barail. In Imphal valley, they rest over Dieng and Barail Groups.

Oceanic Pelagic Sediments

A group of pelagic sediments represented by siltstone, shale, fine grained sandstone, chert and limestone often occur in association with ophiolite masses and these have been designated as oceanic (OPS) to differentiate them from the adjacent Disang sediments do also occur in the vicinity. The association cherts are rich with and the limestones with microforaminiferas. This group of sediments is extensively developed in Ukhrul and Chandel districts of Manipur. The OPS are quite in its associated rock types, fossil contents, and relatively deep water environment of deposition which is in contrast with the plant fossils bearing **conglomerate** sandstone shale beds of Pokphur Formation deposited in a nearshore, open marine to paralytic environment.

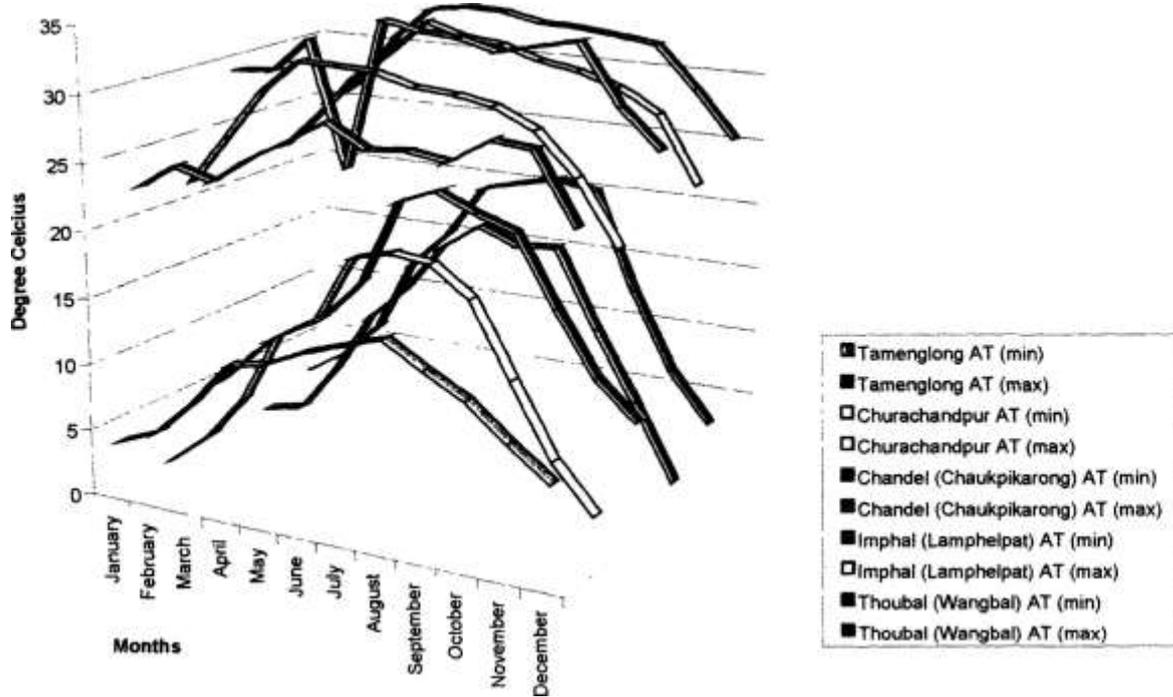
Ophiolite Cover Sediments

The rock types are conglomerate, gritty sandstone, sandstone and chocolate-brown shale. Minor pockets of coaly and carbonaceous matter do also occur associated with this formation. This formation is correlatable with the Mithakhari Group of rocks of Palaeocene-Eocene age; which lies unconformably over the ophiolites of the Andaman-Nicobar islands.

Drainage

The natural drainage system is maintained by numerous streams, rivers and

Monthly air temperature (AT) pattern (1983-1990) derived from various recording stations in different districts of Manipur



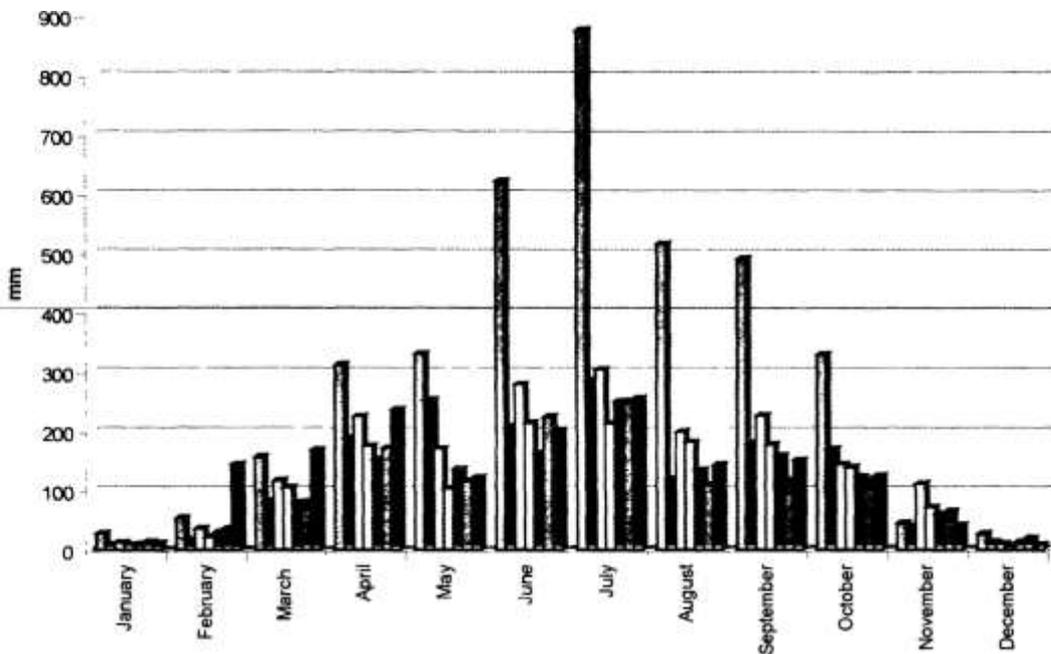
BOTANICAL SURVEY OF INDIA

lakes & jheels. All the rivers in the Imphal valley take their origin in the hills to the North-west and are insignificant in size and breadth, although carrying a large body of water with a rapid current during the rainy seasons. The main rivers are Imphal, Iril, Thoubal, Nambul and Nambol. The first three, rising in the hills to the north, flow eastward to the Loktak and do not fall into it: while other two rise north and North-west, fall into the Loktak. The hill river Barak and its tributaries, on the western parts of the state are very deep and swift during the rains. The rivers on the North are not so swift and large and do not contain the masses of large boulders, but flow easily in almost uniformly shingly beds. In the eastern hills there are minimum small streams which drain the Yu and then into the Chindwin.

The Loktak is the largest lake, having an area of about 100sq km and is one of the chief and most striking feature of Manipur. The edges are swampy or are floating beds of reeds and aquatic plants. Towards the southern end, there are some small islands which rise steeply from the water. The largest is named Thanga. The surface is every where dotted with floating islands, composed of matted roots of aquatic plants, which are used by the local people for fishing purposes. Besides, there are numerous jheels or beels in the valley, many of which dry up completely during winter.

Climate

Temperature : At Imphal the capital of the state of Manipur, the mercury touches the lowest degree during the month of January. It ranges from 1—3 °C. rarely it goes down to -1 °C. In other places e.g. Senapati, Tamenglong, Churachandpur, Chandel and Thoubal districts the minimum temperature remains bit higher. The monthly mean temperature rises steadily and reaches the maximum i.e. 32-38 °C during the months of August and September then goes down and reaches the minimum in January. The mean monthly temperature is almost the same from April to September and fluctuates just the fraction of a degree or so. At Ukhrul the mean monthly temperature is least in January then it increases and reaches the highest during August—September, then it again decreases and reaches the lowest in January. Similarly at Ukhrul the mean monthly temperature is lowest in January then it steadily increases and reaches the



highest in August September.

Rainfall : Though a small territory Manipur, experiences a remarkably erratic distribution of rainfall. This can be explained by considering the mountain ranges of the surrounding areas which controls its rainfall. Normal annual rainfall at Imphal is 2040 mm, at Kongpokpi, 1600 mm; at Ukhrul it is 1780 mm; at Tamenglong ca 1602 mm; at Morch ca 2010 mm, at Chandel, 3430 mm; at Churachandpur, 3055 mm and at Jiribam, 3430 mm. A little rainfall is received at the end of February every year and it gradually increases and reaches the peak during the months

Monthly rainfall pattern (1983-1990) derived from various recording stations in different districts of Manipur

Months

of June or July. Sometimes it extends up to August also and then gradually decreases up to October. In December it is less than 50 mm at almost every place of the state.

Humidity : The mean of the daily humidity is highest during the months of July—September, which varies from 80—96% and differs, place to place. The humidity at Churachandpur remains highest during the year, while other places, e.g. Tamenglong, Senapati and sometimes at Jiri and Moreh it goes down and varies from 80%—92% depending upon other factors. Generally, it has been observed that humidity goes down to lowest in March (45%). The low humidity combined with an easterly wind, which often reaches the force of a gale, results in a period during which grassland and deciduous forests dry up and forest fires are a common feature at this time of the year.

Botanical Exploration in Manipur

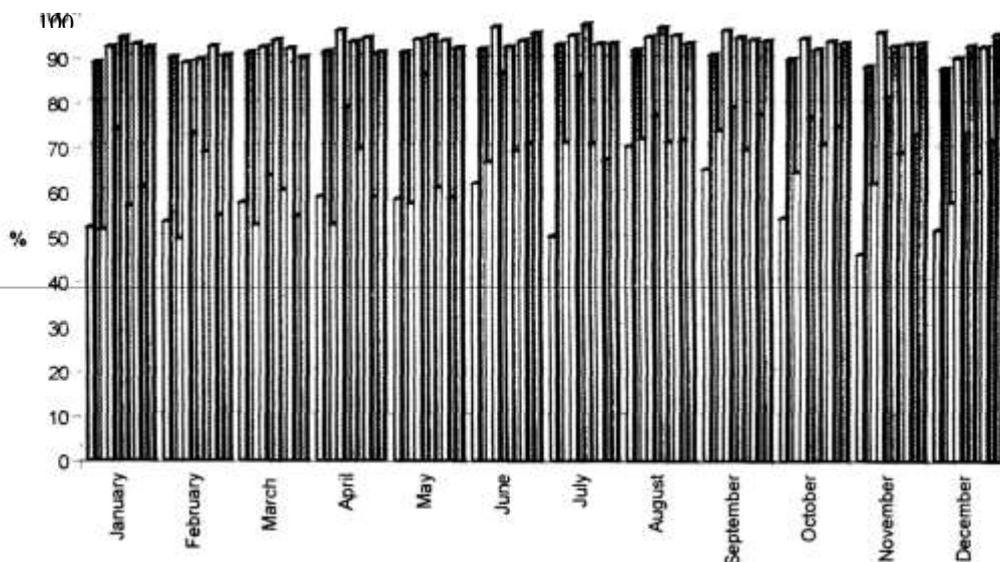
The first person to begin a systematic collection of Manipur plants was G. Watt (1881-82), who was deputed as botanist member to the boundary commission between Manipur and Burma by the then British Government of India. Watt marched from Golaghat, Assam via Kohima and Manipur to Cachar in spring. He made a huge number of collection of herbarium specimens, the exact number is not known. One set each of his collection was deposited to the herbarium Royal Botanical garden, Kew. Royal Botanical Garden, Edinburgh and the Indian Botanical garden, Howrah. The detailed account of Watt's botanical collection of Manipur was not published. Later, Watt (1890) published a series of articles in *Indian Forester on Forests of Manipur*, in these articles, he himself named a number of species from these collections and classified the state in 3 well marked viz. The Western Wall, the Central Undulating region of Low hills and valley, and the Eastern Wall. Later on, several of his new species were described by Bailey and Balfour (1920), Smith and Cowan (1936) and others. The second plant explorer of Manipur plants was C.B. Clarke (1885), who traversed through the same route as Watt and Clarke (1889) published his account as *Plants of Kohima and Munneypore* in the *Journal of Linnean Society* and observed. " On comparing my own plants in the Kew Herbarium. I have on several occasions found that Watt had named in manuscript the same species which I collected. In these cases. I have accepted Watt's names for the species, if undescribed. Dr. Watt's collections being distributed in the Kew herbarium. I have not compared it thoroughly. So far as I have seen it, I should infer that collecting along the same routes, have collected mainly the same plants" HC described in his publication altogether 1050 species of flowering plants and ferns spread over 533 genera in 114 different families. which also includes the description of about 87 new taxa from that area. In that list he recorded 422 species from Manipur. of which ferns are represented by 60 species distributed

over 15 families. while dicots by 248 sppccs embracing 57 families. These plants show great affinity to Khasia and Sikkim flora and only 13 additional species could be

Monthly relative humidity (RH) pattern (1983-1990) derived from various recording stations in different districts of Manipur

O Tamenglong RH (min) (min) "Thoubal wangbal) RH (max) Months
 RH (max)
 OlmptEl (Lamphelpat) RH n Tamenglong RH (max) OChurachandpur RH (min)
 "Chandel (Ctzukpikarong) RH (min) UChandel (CYBukpikarong) RH (max)
 Olmpt-el (Lamphelpat) RH (max) "ThOLbal (Wangbal) RH (min)

added from Manipur State, while the Chinese and Malayan elements have been represented very poorly. Mecbold (1906—1907) explored Manipur and made a large number of collections, which are mainly housed in the Central National Herbarium, Calcutta and few duplicate herbarium sheets are also lying in Assam herbarium at Shillong. Most probably, he followed the same route of his predecessors. Neither did he publish any account of his collections from Manipur



nor did he keep any tabulation of the same. Sir J.D. Hooker (1906) in his phytogeographical divisions of India, placed Manipur in Subzone Northern Burma of his 8th division, which includes the Garo, Khasi, Jaintia, Nowgong, Naga, Patkoi and Manipur hills. Besides, he made sporadic mention about the plants of Manipur in his Flora of British India.

As far as the aquatic flora is concerned, Sir Anandale (1921) made the first collection of plants from the Loktak lake for the Botanical Survey of India, which created interest among Indian Botanists towards the flora of Manipur. Biswas (1930) visited Manipur and made a good collection from different parts in general and from the Loktak lake in particular.

In 1932, D. C. Kaith. of Assam Forest Service, was deputed to report on the working plan of Manipur Forests. He identified about 200 sppccs in the field itself and published an account of Manipur forests in 1934, dividing the state into four botanical regions, viz., Cachar border forest, Imphal valley forests,

FLORA OF MANIPUR

Northeastern Khasia Pine forests and Burma border forests. Subsequently, with the enthusiastic encouragements from Sir Archdale Earle, then Chief Commissioner of Assam, U. N. Kanjilal began extensive collections with a view to bringing out a Flora of Assam. But this Flora of Assam (1934-40) refers to only about species of Manipur. N.L. Bor (1938-45) visited Manipur and collected the specimens which were presented to the Forest Research Institute, Dehradun and Forest Herbarium, Shillong. Some of his collections were published as new species or records from time to time by Bor (1940), Raizada & Chatterjee, (1948) and Chatterjee (1939, 1962).

F. Kingdon Ward, the famous plant explorer visited Manipur several times on different occasions during 1927, 1935, 1945 and 1948. "Plant hunter in Manipur" Kingdon-Ward (1952), is the embodiment of his vast experience in Manipur. Besides, Botanical exploration in Manipur, he published number of papers from time to time in the Journal of the Royal Horticultural Society (1946, 1948 and 1949). S. K. Mukerjee of the Indian Botanic Garden, Calcutta accompanied Kingdon-Ward in 1948 and explored the flora of Ukhrul subdivision bordering Myanmar and made a collection of plants especially orchids. "An enumeration of the orchids of Ukhrul" in Notes Royal Botanical Garden, Edinburgh in 1953. is the result of this exploration where he enumerated 73 species of Orchids.

In recent past. D. B. Deb made a more or less thorough collection from tropical, subtropical forests as well as aquatic flora of water bodies, especially Loktak, other Jheels and riverine vegetation. His publication on the floristic account of the state of Manipur was published in Bulletin Botanical Survey of India in 1961, where he enumerated in all 2013 taxa (dicots 1573 and monocots 440), which included all previous collections of G. Watt, C. B. Clarke, A. Meebold, F. Kingdon Ward, S. K. Mukerjee, N. L. Bor and all earlier published species from Manipur, in addition to his own. He contributed some new and important findings from Manipur viz. *Alchornea cordata* W. & A. and *Sapria himalayana* Griffith and also added few novel taxa to science from that state.

An effort to complete the hitherto incomplete "Flora of Assam" with special reference to monocots, plant collections from different parts of North-Eastern Region including Manipur were augmented in the Assam herbarium at Shillong and in several instances live collection brought together in the experimental garden for their critical studies. Based on these, a study of the Cyperaceae, has been completed by D. M. Verma, while several other monocot families have been worked out and published by A. S. Rao and D. M. Verma. One or two short exploration tours to the Manipur state were also taken by S. K. Jain, U. Shukla and A. K. Baishya. As a result they published "A notes on grasses of Manipur" and "A Contribution to the Flora of Manipur" in 1979. K. C. Mallick collected plants from the Jiribaln subdivision and Tamenglong district besides Nungba, Kangpokpi and adjacent forests of Imphal valley in 1973 and enumerated 173 species and 3 varieties as addition to the Flora of Manipur in 1987. Recently, Th. Priyobar Singh published a book entitled, "Orchids of Manipur, preserved at Orchid Preservation Centre, Khonghampat", in 1999.

Vegetation Types

Phytogeographically, C. B. Clarke (1898) classified the whole of North eastern India in two distinct regions, i.e. Assam and Eastern Himalayas. Hooker (1906) in his botanical division of India, included major parts of Assam with the Ganggetic plains, treating the Eastern Himalayas as a separate area by itself and considered the hill areas of Assam including Shillong plateau, Patkoi, Nagaland, Manipur, Mizoram and Tripura as an integral part of Burma. Chatterjee (1962) followed C. B. Clarke (l.c) and treated Assam as an area distinct from the eastern Himalayas because of its unique flora. Ridley (1942) emphasized 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 Manipur have been classified by different authors based on various criteria. Kaith (1936) classified the forests of Manipur into four regions. Deb (1961) also classified the forests depending upon the Clementsian system. The earlier workers have laid more emphasis on floristic composition in their classifications. Based on the

ecological classification of Champion and Seth (1968) the forests of Manipur have been classified

into (i) Tropical wet evergreen (ii) Tropical moist deciduous (iii) Sub-tropical broad leaved hill (iv) sub-tropical pine and (v) Montane temperate forests (Singh, 1971). So far as the botanical regions are concerned, there is usually a distinct correlation between altitude and vegetation. From this point of view, the vegetation of whole North-eastern region may be broadly 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 Himalaya mainly followed Champion and Seth (1968) to describe the forest types, viz. (1) Tropical evergreen (2) Sub-tropical (3) Temperate (4) Sub-alpine and (5) Alpine to arctic. Later, Mehra (1983) also followed the same system of classification. However, their observations are based on the floristic studies of some selected forest areas of North-eastern region, with special reference to Assam and Eastern Himalayas and not of Manipur. Based on all previous works on classification of the vegetation types and the present observations, the forests of Manipur can be classified into the following types:

- i) Tropical moist deciduous forests
- ii) Tropical evergreen and semi evergreen forests
- iii) Sub-tropical mixed forests iv) Sub-tropical pine forests
- v) Sub-tropical and temperate grasslands, and vi) Temperate forests

Tropical Moist Deciduous' Forests

The tropical moist deciduous forests are confined up to an altitude of 900 m. Besides the Imphal valley, such forests are also met at Senapati in North-west, at Vangoi, Bishenpur in South-west, and at Moreh and Chandel in South-east Manipur, where the annual rain-fall is 150-225 cm, having a definite dry period with less than 5 cm of rainfall for 2-3 months. The temperature is comparatively high during the summer with a definite cold weather also. Frost is occasional at Imphal in the valley and occurs between the third week of December and the first week of February. Humidity is high during the monsoon and is ca 80% in the 11th of July and August but falls to 45% during February-March. It is imperative to mention here that typical natural deciduous forests do not occur anywhere in the state of Manipur but are only sub-climax or man made forests. These forests are characterised by seasonal leaf shedding and profuse flowering of the trees. These man made deciduous forests are much extensive in their distribution and include many economically important tree species like *Acacia decurrens* Willd., *Albizia lucidior* (Steud.) Nielsen, *A. procera* (Roxb.) Benth., *Artocarpus chanja* Buch.-Ham., *Ailanthus integrifolia* Lam. subsp. *calycina* (Pierre) Nootb.,

,41stonia scholaris (L.) R. Br., Bischofia javanica Blume, Bonibax ceiba L.
Diptemcarpus

tuberculatus Roxb., D. turbinatus Gaertn. f., Drbnycarpus racemosus (Roxb.) Hook.
f. & Benth, Duabanga grandiflora (Roxb. ex DC.) Walp., Garuga pinnata Roxb. .
Gmelina arborea Roxb., Ifaldina cordifolia (Roxb.) Ridsdale., Kydia calycina
Roxb., Lagerstroemia parviflora Roxb., L. speciosa (L) Pers., Neolamarckia
cadmna (Roxb.) Bosser, Spondias pinnata (L. f.) Kurz, Sterculia villosa Roxb.
ex Smith: T&ctona grandis L.f., Tetradium fraxinifolium (Hook.) T. G. Hartley
Tetrmne/es nudiflora R. Br., etc.

The second storey is composed of Aglaia spectabilis (Miq.), S. S. Jain & Bennet, Aphanamixis polystachya (Wallich) R. N. Parker, Bauhinia purpurea L., B. variegata L. , Callicarpa arborea Roxb., Canarium strictum Roxb., Careya arborea Roxb., Chukrassia tabularis A. Juss., Cryptocarya amygdalina Nees, Dalbergia sissoo Roxb. ex DC., D. stipulacea Roxb., Dillenia pentagyna Roxb., Dysoxylum alliariwn (Buch. -Ham.) Balakr., D. binectariferum Hook. f. ex Beddome, A/facaranga denticulata (Blume) Muell.-Arg. Melia spp., Persea villosa (Roxb.) Kosterm., Stereospermum personatum Chatterjee and Turpinia pomifera (Roxb.) DC. , etc. The shrubby layer is often gregarious and forms an impenetrable thicket during rainy season. The chief component of this layer are Alloph.yllus cobbe (L.) Raeusch., Buddleja asiatica Lour. , Carex baccans Nees, Clerodendrtnn kaempftri (Jacq.) Siebold. ex Stcud., Desmodium oblongum Wallich ex Benth., D. laxiflorum DC., D. triangulare (Retz.) Merr., fledychium villosum Wallich, Indigofera cassioides Rottl. ex DC. , Leea asiatica (L.) Ridsdale, L. crispa Willd., L. indica (Burm. f.) Merr, Licuala peltata Roxb., Micromelum integerrimum (Roxb. ex DC.) M. Roem., Murraya paniculata (L.) Jack. Lianas are fewer but scandent shrubs viz. Aspidopterys, Bridelia, Combretum, Entada, Hiptage, Mussaenda, Phanera, Spatholobus, Tinospora, etc., along with the species belonging to the families Vitaceae and Menispermaceae are frequent. The under growth of these forests vary from place to place according to changes in rainfall and soil composition. In most of the places species of Desmodium, Licuala, Phlogacanthus, Impatiens, Adimosa, Oxalis, etc. form dominant under growth. In open areas Eupatorium. Lantana and IVfikania grow profusely without any competition. Bamboo thickets are also found every where in these forests as successional vegetation in jhum abundant areas. Avenue trees viz. Acacia melanoxylon R. Br. and Parkia timoriana (A. DC.) Merr., are commonly seen on the both side of roads in the valley. The young fruits of Parkia are eaten as vegetable and chutney also.

It would not be out of the place to mention here that species composition differ at different ecological niches, based on the geology, soil and topography as well as climatic conditions etc. For example in the forests along the Myanmar border in Manipur on the foot hills of Kabaw valley, the species composition of Dipterocarpus tuberculatus Roxb., D. turbinatus Gaertn. f. , Melanorrhoea usitata

Wallich *Melocanna bmnbusoides* Trin. and *Tectona grandis* L. f. Ctc. predominate, while in the Jiri sub-divisional forest areas species of *Bauhinia*, *Elaeocarpus*, *Ficus*, *Ixora*, *Kydia*, *Mussaenda*, *Pterospennum*, *Saraca*, *Saurauia* and *Thespesia*, etc. are commonly seen. In the reserve forests of Langool, Scpramaina, Senapati and adjoining areas *Castanopsis tribuloides* (Smith) A.DC. *Lithocarpus elegans* (Blume) Soepadmo, *L. fenestrata* (Roxb.) Rehder, *Quercus serrala* non Thunb. form conspicuous flora of that area in addition to *Carex arboæa* Roxb., *Lagerstroemia*, *Garuga*, *Terminalia*, etc. These species are generally¹, not met in corresponding forests in other parts of eastern India.

There are several lakes, but the great one to the south and east of Bisenpur, the Loktak needs a special mention. The lake is surrounded by high hills on all the side with only one outlet for the water. Thus the saucer like, the valley of Manipur is hemmed in on all the sides, and bears abundant evidence that the Loktak is perhaps but the remains of a lake of inland sea that once covered the whole area. Besides Loktak, numerous salt springs also exist, from which the local inhabitants manufacture salt for their daily use. The Loktak lake is studded with immense floating islands of weeds that are gradually subsiding under the accumulation of drift soil and decaying vegetable matter which seem to have taken no inconsiderable part in drying up of the lakes. In the lake the American duck weed, along with *Azolla pinnata*, *Lemna*, *Pistia* and *Salvinia*, etc. form so dense a scum that boating is often impossible excepting along the channels kept clear by the fisherman. The graceful leaves of *Nelumbo nucifera* Gaertn. form dense expanses within which thousands of duck and teal sport themselves. *Euryale ferox* and *Trapa bispinosa* Roxb. form the predominant aquatic vegetation of the lake. The fruits of these plants are edible and sold in the market. Besides, the species of *Acorus*, *Alisma*, *Carax*, *Caldesia*, *Colocasia*, *Butomopsis*, *Cyperus*, *Clinoune*, *flydrilla*, *Hydrocharis*, *Eichhornia*, *Juncus*, *Monochoria*, *Najas*, *Lemna*, *Potamogeton*, *Fimbristylis*, *Ottelia*, *Typha* and *Vallisneria*, etc. are growing on its subsiding islands floating or submerged or on shallow margins on the lake. Various species of chlorophycean algae like *Chara* and *Nitella*, etc. are also growing on the shallow edges. *Callicarpa*, *Quercus*, *Cycas*, *Phoenix* and pine etc. form a rich arborescent vegetation, which greatly enlivens this tropical lake scenery. It is interesting to add that *Cycas* occurs only on these humid island-peaks while alpine date palm reappears on the mountain region of the state of Manipur.

It is interesting to mention that dispersed among the indigenous plants there occur many of the invading exotic elements that are claiming so much of tropical vegetation of rest of the country, such as *Argemone mexicana* L., *Bixa orellana* L., *Jatropha curcas* L., and *Nicotiana tabacum* L., etc. The other introduced hedge plant *Brugmansia suaveolens* (H.B. ex Willd.) Bercht. & Prchl., with its long pendulous white flowers is much appreciated by the local people.

Tropical Evergreen and Semi-evergreen Forests

The tropical evergreen and semi-evergreen forests are confined up to an elevation of ca 1200 m above sea level with an average annual rainfall of 300—500cm coupled with high relative humidity. Due to the effect of physiographic, edaphic and other exogenous factors, these forests seldom form continuous belts in the state of Manipur, but harbours rich species diversity. Such forests are now restricted to inaccessible hills as well as near catchment areas, unsuitable for cultivation or to areas protected as reserved forests. These forests display a close canopy of trees with a dense and rather impenetrable herbaceous growth. The bewildering wealth of species of these forests are not all often common to all these areas, even the dominant species also differ area wise.

The top canopy of vegetation is composed of the trees like *Acrocarpus fraxinifolius* Am. ex Wight, *Aglaia spectabilis* (Miq.) S. S. Jain & Bennet, *Ailanthus integrifolia* Lam. subsp. *calycina* (Pierre.) Nooteb., *Artocarpus chmna* Buch. Ham., *A. heterophyllus* Lam., *Canarium strictum* Roxb., *Castanopsis echinocarpa* Miq., *C. kurzii* (Hance) Biswas, *C. tribuloides* (Smith) DC., *Celtis tetrandra* Roxb., *Cinnamomum glaucescens* (Nees) Hand-Mazz, *Duabanga grandiflora* (Roxb. ex DC.) Walp., *Elaeocarpus serratus* L., *E. tectorius* (Lour.) Poiret, *Endospermum diadenum* (Miq.) Airy Shaw, *Maniltoa polyandra* (Roxb.) Harms, *Mesua ferrea* L., *Neolamarckia cadamba* (Roxb.) Bosser, *Polyalthia longifolia* Benth & Hook. f., *Premna benghalensis* C.B. Clarke, *Spondias pinnata* (L.f.) Kurz, *Stereospermum colais* (Dillw.) Mabblerley, *Terminalia bellirica* (Gaertn.) Roxb., *T. citrina* (Gaertn.) Roxb. ex Fleming, *T. myriocarpa* Van Heurck & Muell.-Arg., *T. trameles nudiflora* R. Br., *Vitex pinnata* L., and *Xemspannum glabratum* (Kurz) Radlk., etc. The middle storey which is almost obscure comprises of *Alstonia scholaris* (L.) R. Br., *Aporosa dioica* (Roxb.) Muell.-Arg., *Antidesma acuminatum* Wallich, *Bischofia javanica* Blume, *Bridelia monoica* (Lour.) Merr., *Castanopsis indica* (Roxb.) DC., *Cryptocarya andersonii* King ex Hook. f., *Dalbergia assamica* Benth., *Dillenia indica* L., *D. pentagyna* Roxb., *Dysoxylum binectariferum* (Roxb.) Hook. f. & Beddome, *D. gobarum* (Buch.-Ham) Merr., *Ficus racemosa* L., *Garcinia cowa* Roxb. ex DC, *Gynocardia odorata* R. Br., *Magnolia griffithii* Hook. f. & Thomson, *Mangifera sylvatica* Roxb., *Michelia champaca* L., *Phoebe attenuata* Nees, *P. goalparensis* Hutch., *Prumnopitys bracteata* Wallich ex C.B. Clarke, *Pterospermum lancifolium* DC., *Sapium baccatum* Roxb., *Schima wallichii* (DC.) Korth., *Syzygium cumini* (L.) Skell., *S. jambos* (L.) Alston, *Sterculia hamiltonii* (O. Kuntze) Adelb. and *Vatica lanceaefolia* (Roxb.) Blume, etc. The lowermost storey of trees in these forests is represented by the plant species like *Actephila excelsa* (Dalz.) Muell. -Arg., *Alangium chinense* (Lour.) Harms, *Alchornea tiliacifolia* Muell. -Arg., *Antidesma buniis* (L.) Spreng., *Boehmeria hamiltoniana* Wedd., *Brassiopsis glomerulata* (Blume) Regel, *Callicarpa arborea* Roxb., *Cinnamomum glaucescens* (Nees) HandMazz, *Goniothalamus sesquipedalis* (Wallich) Hook. f. & Thomson, *Litsea cubeba* (Lour.) Pers., *Macaranga denticulata* (Blume) Muell.-Arg.,

Macmpanax undulatus (Wallich ex G. Don) Seem, *Styrax hookeri* C. B. Clarke, etc.

Of the various large shrubs or small trees which inhabit these forests. the predominant are *Abroma augusta* (L.) L. f. , *Acacia Jhrnesiana* (L.) Willd. *Aralia annata* (G. Don) Scdm. , *Ardisia floribunda* Wallich, *A. paniculata* Roxb., *A. lhopsonii* (C. B. Clarke) Mez., *Boehmeria macmphylla* D. Don, *Callicarpa macmphylla* Vahl, *Camellia sinensis* (L.) O. Kuntze var. *smensis*, *Canthium angustifolium* Roxb., *Coffea khasiana* Hook. f., *Lasianthus sikkimensis* Hook. f. , *Leea asiatica* (L.) Ridsdale, *Maesa indica* (Roxb.) Wallich, *Microtropis discolor* (Wallich) Arn., *bfhnosa rubicuulis* Lam. subsp. *himalayana* (Gamble) Ohashi, *Murraya paniculata* (L.) Jack, *Phlogacanthus thyrsoiflorus* (Roxb.) Nees, *Solanum anguivi* Lam. and *Zanthoxylum oxyphyllum* Edgew. etc. The conspicuous lianas intertwining the trees in these forests are *Acacia pennata* (L.) Willd., *Ampelocissus divaricata* (M. Lawson) Planch., *Beaumontia grandiflora* (Roxb.) Wallich. *Cayratia japonica* (Thunb.) Gagnepain, *Cissus assamica* (M. Lawson) Craib. *Dioscorea* spp., *Combretum dasystachyum* Kurz, *Entada rheedei* Spreng., *Hodgsonia macrocarpa* (Blume) Cogn., *Lasiobema scandens* (L.) De Wit, *Millettia extensa* (Benth.) Baker, *Mucuna imbricata* DC. ex Baker, *Paederia scandens* (Lour.) Merr., *Spatholobus parviflorus* (Roxb.) O. Kuntze, *Tetrastigma* spp., and *Thunbergia grandiflora* Roxb., etc.

The ground in these forests is dark and moist due to lofty trees with thick canopy and has a thick layer of undisturbed humus, and has many fleshy fungi as well as saprophytic flowering plants. The common herbs in these forests are *Ilophyllus cobbe* (L.) Rausch. , *Alpinia nigra* (Gaertn.) Burtt, *Andrographis paniculata* Nees, *Ainomum aromaticum* Roxb., *Blumea Jimulosa* (Roxb.) Kurz, *Coslus speciosus* (Koenig) Smith, *Crassocephalum crepidioides* (Benth.) S. Moore, *Curcuma* spp., *Glycosmis pentaphylla* (Retz.) DC., *Hedychium* spp., *Hedyotis auricularia* L., *Ophiorrhiza nutans* C. B. Clarke ex Hook. f., *Panax pseudoginseng* Wallich and species belonging to the families *Acanthaceae*, *Asteraceae*, *Balsaminaceae*, *Begoniaceae*, *Fabaceae*, *Lauraceae*, *Oxalidaceae* and *Poaceae*, etc. Besides, *Apostasia wallichii* R. Br., *Galeola falconeri* Hook. f. , *Paphiopedihnn* spp., *Phaius flavus* (Blume) Lindley, *P. tankervilliae* (Aiton) Blume, *Tropidia angulosa* (Lindley) Blume and *Zeuxine* spp., etc. are scattered in the ground layer.

Epiphytes and other climbers are *Aeschynanthes acuminatus* Wallich. *A. bracteatus* Wallich ex. DC.. *A. superba* C.B. Clarke, *Agapeles variegata* (Roxb.) D. Don ex G. Don, *Piper* spp., *Pothos cathcartii* Schott. , *P. scandens* L., *Procris crenata* Roxb., *Rhaphidophora decursiva* (Roxb.) Schott, *R. hookeri* Schott, *R. lancifolia* Schott, etc. and the stem parasites viz. *Cuscuta reflexa* Roxb..

Dendrophthoe umbellata (Blume) Miq., *Helixanthera parasitica* Lour., *Scurrula parasitica* L., *Taxillus* spp., etc. Besides, the tree trunks in these forests are mossladen and host multitudes of epiphytic orchids, ferns, fern-allies, bryophytes and lichens.

Sub-tropical Mixed Forests

Sub-tropical broad leaved forests are confined at the altitude from 1000-1800

111. Rainfall also varies from 2000-4500 cm or more in certain areas. Such forests are spread over in different parts of the state of Manipur, with a quite varied floral constituents from place to place based on the local climatic and edaphic conditions. These climatic climax forests are seen scattered and never form a continuous stretch of vegetation not only in Manipur state but also in the entire North-eastern region. The trees are generally dwarf and of a bushy appearance as compared to the tropical zone. Plants with buttresses are rare in these forests. Shrubs and herbaceous layer are well marked and form impenetrable thickets in certain places. The height of the trees in general are up to 20 m, with evergreen to semi evergreen appearance depends on the multitude of rainfall in that area. The trees of upper storey are *Alnus nepalensis* D. Don, *Albizia chinensis* (Obs.) Merr., *Artocarpus* spp., *Betula alnoides* Buch.-Ham. ex D. Don, *Castanopsis purpureila* (Miq.), *Balakr.*, *C. tribuloides* (Smith) A. DC., *Cinnamomum bejolghota* (Buch. Ham.) Swpet, *C. glaucescens* (Nees) Hand-Mazz. *Cryptocarya amygdalina* Nees, *Dysoxylum binectari* Hook. f. & Beddome. *Elaeocarpus* spp., *Engelhardtia spicata* Leschen ex Blume. *Erythrina stricta* Roxb., *Magnolia insignis* Wallich, *Blichelia cathcartii* Hook. f. & Thomson. *Randia wallichii* Hook. f., and *Terminalia myriocarpa* Van Heurck & Muell.-Arg. and *Tetradium fraxinifolium* (Hook.) T. G. Hartley, etc. Occasionally, *Schinus molle* (DC.) Korth., can also be seen in certain forests. The second storey is composed of *Acer oblongum* Wallich, *Alangium chinense* (Lour.) Harms., *Albizia odoratissima* (L.f.) Benth., *Bischofia javanica* Blume, *Bucea mollis* Wallich ex Kurz, *Corylopsis himalayana* Griffith, *Dysoxylum gobarum* (Buch. -Ham.) Merr., [*tea chinensis* Hook. f., *I. macrophylla* Wallich, *Ixora subsessilis* Wallich ex G. Don, *Micromelum integerrimum* (Roxb. ex DC.)

M. Roem. *Lithocarpus elegans* (Blume) Hatus ex Soepadmo, *Jitsea monopetala* (Roxb.) Pers, *Neolitsea umbrosa* (Nees) Gamble, *Persea parviflora* (Meissner) Haridasan & Rao, *Rhus semialata* Murray. *Picrasva javanica* Blume, *Styrax hookeri* C. B. Clarke., *Syzygium jambos* (L.) Alston, *Ipodemia asiatica* (L.) Lam., etc. *Anneslea fragrans* Wallich is confined only to Manipur and Nagaland areas in India.

These forests are especially rich in shrubby and herbaceous' layers. The common shrubby species are *Ardisia depressa* C. B. Clarke, *A. japonica* (Horn.) Blume, *Baliospermum meeboldii* Pax ex Hoffm., *Breynia retusa* (Dennst.) Alston, *Camelia* spp., *Clerodendrum viscosum* Vent., *Crotalaria* spp., *Debregeasia*

longifolia (Burm. f.) Wedd., *Eurya nitida* Korth., *Goniothalamus sesquipedalis* (Wallich) Hook. f. & Thomson, *Leucosceptrum canum* Smith, *Maesa indica* (Roxb.) Wallich. *Micromelasma integerrimum* (Roxb. ex DC.) M. Roem., *Mussaenda glabra* Vahl, *Neillia liversiflora* D. Don, *Rubus birmanicus* Hook. f., *R. ellipticus* Smith. and *Zanthoxylum oxyphyllum* Edgew. and various species of Acanthaceae and Araliaceae, etc. The forest floor is densely covered with fungi, mosses and various herbaceous angiosperms belonging to the families Araceae, Balsaminaceae, Begoniaceae, Commelinaceae, Zingiberaceae, etc.

Sub-Tropical Pine Forests

Such forests occur at an elevation of 900-1800m, with moderate rainfall areas of the state. These pine forests are interspersed by a few tree species such as *Cinnamomum* spp., *Engelhardia spicata* Leschen. ex Blume. *Erythrina orientalis* L., *Lithocarpus dealbata* (Miq.) Rehd. *Myrica esculenta* Buch.-Ham. ex D. Don, *Persea odoratissima* (Nees) Kosterm., *Quercus griffithii* Hook. f. & Thomson ex DC., *Schilna wallichii* (DC.) Korth. var. *khasiana* (Dyer) Bloem., *Synplocos* spp. etc. *Pinus kesiya* Royle ex Gordon (Khasi pine) occurs in pure patches with under growth of broad leaved species viz., *Cassia floribunda* Cav., *Eupatorium adenophorum* Spreng., *Daphne papyracea* Wallich ex Steud., *Lyonia ovalifolia* (Wallich) Drude, *Myrsine semiserrata* Wallich, *Rhus* spp., *Rubus ellipticus* Smith, *R. rosifolius* Smith, *Viburnum* spp., etc. *Pinus kesiya* Royle ex Gordon, being one of the fast growing tree 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 *Agrimonia pilosa* Ledeb. var. *nepalensis* (D. Don) Nakai, *Anemone rivularis* Buch.-Ham. ex DC., *Artemisia nilagirica* (C.B. Clarke) Pamp., *Elsholtzia blanda* Benth., *Potentilla fulgens* Wallich ex Hook., *Ranunculus cantoniensis* DC., etc. grow profusely during rainy season. Besides, plants like *Crotalaria ferruginea* R. Graham ex Benth., *Desmodium heterocarpon* (L.) DC. subsp. *heterocarpon* Ohashi, *Smithia blanda* Wallich ex Wight & Am., *Tephrosia candida* (Roxb.) DC., etc. add to the nitrogen content of the soil in these forests. Most of this herbaceous flora either perish or lie dormant during winter. The orchid species belonging to *Bulbophyllum*, *Cymbidium*, *Dendrobium*, *Eria*, *Luisia*, *Otochilus*, *Pholidota*, *Vanda* and others are quite common in these forests. Several terrestrial and epiphytic ferns also form gregarious patches, some of them are *Dicranopteris linearis* (Burm. f.) Underw., *Lepisorus excavatus* (Willd.) Ching. *L. thunbergianus* (Kaulf.) Ching, *Lycopodium japonicum* Thunb., *Selaginella chrysocaulos* (L. & Grev.) Spring, *Blechnum orientale* L., *Cyclosorus flaccuosus* (D. Don) C. Chr., *Pteridium aquilinum* (L.) Kuhn, *Pyrosia mannii* (Gies.) Ching and *P. mollis* (Kuntze) Ching etc. Grasslands of savannahs that occur in riparian flats and slopes are not of a climax type, these grasslands have developed only as a result of removal of original forest cover. In some places *Rhododendron* spp. are also seen sporadically.

Sub- Tropical and Temperate Grassland

The grasslands wherever present are a biotic climax due to removal of original forest cover. The rolling grasslands around Limatol, Chingmairong, Mao, Shugnu, Litan, Ukhrul, Thoubal and Chandel areas can be seen sporadically. The effect of denuding of forest is every where, even today large herds of cattle may be seen grazing on these rich grassy slopes. Most of the rounded hillocks within the Imphal valley rise up exposing their barren red dry heads, which on closer inspection are often 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 fully devoid of forest cover. The dominant grasses in these grasslands are *Arundinella bengalensis* (Spreng.) Druce, *Chrysopogon aciculatus* (Retz.) Trin., *Imperata cylindrica* (L.) P. Beauv., *Neyraudia reynaudiana* (Kunth) King ex Hitchc., *Oplismenus bunnannii* P. Beauv., *Panicum atmsanguianum* R. Rich., *P. khasianum* Hook. f., *Pennisetum glaucum* (L.) R. Br., *Saccharum* spp. and *Thysanolaena maxima* (Roxb.) O. Kuntze. etc. In other places, the association of *Agrostis nicrantha* Steud., *Brachypodium sylvaticum* (Huds.) P. Beauv., *Coelorachis striata*

(Nees ex. Steud.) *A. Camus*, *Cynbopogon khasianus* Stapf ex Bor. *Eragrostis nigra* Nees ex Steud. and *Phacelurus zea* (C. B. Clarke) Clayton, etc. are seen in the state of Manipur. These grasses are associated with sedges like *Carex speciosa* Kunth, *C. phacota* Spreng., *C. redia* Nees, *Fimbristylis dichotoma* (L.) Vahl, *Cyperus rotundus* L., *C. tenuicubitus* Boeck., *Pycreus flavidus* (Retz.) T. Koyama, *Scleria terrestris* (L.) Fass, and species of *Bunnaniaceae*, *Eriocaulaceae*, *Juncaceae*, *Liliaceae* and *Zingiberaceae*, etc., with a few species of *Asteraceae*, *Balsaminaceae*, *Melastomataceae*, *Polygonaceae*, etc. Apart from these, some insectivorous plants viz. *Drosera pellata* Thunb. var. *lunata* (DC.) C. B. Clarke and *Utricularia* spp. also grow in these grassland. *Lilium mackliniae* Sealy, a rare and endemic species of *Liliaceae*. is found growing profusely on the top of the Sirohee hills amongst _____ the rolling grasslands in the Ukhrul district of Manipur, which shows a restricted _____ range of distribution.

Temperate Forests

The temperate vegetation is usually found above an altitude of 1500 m to 2500 m (M.S.L.), and are confined to small pockets at Ukhrul, Chingsaw, Maoching, Koupru, Japvo areas in the Manipur. These are close evergreen forests with trees of medium height and trees more than 20 m in height are rarely met within these forests. Large and old trunks are festooned with mosses, ferns and other epiphytic growth. At lower elevation, the forests show an intermixing of elements from tropical and sub-tropical zones 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 are *Dalmanella oblongata* Wallich ex DC., *Dalmanella nepalensis* D. Don, *Beilschmiedia assamica* McIsn., *Betula alnoides* Buch.-Ham. ex D. Don, *Castanopsis armata* Spach., *C. castanicaarpa* Spach. *C. purpurella* (Miq.) Balakr.,

Cinnamomum bejolghota (Buch.-Ham.) Sweet. Echinocarpus dasycarpus Benth., Elaeocarpus braceanus G. Watt ex C.B. Clarke, Engelhardtia spicata Lcschn. ex Blume, Eurya acuminata DC., E. nitida Korth., Exhucklandia populnea (R. Br. ex Griffith) R. W. Brown. Ilex mnbellulata (Wallich) Loesn., Lithocarpus dealbata (Miq.) Rehder, Magnolia insignis Wallich. Mvrlca esculenta Buch.-Ham. ex D. Don, Persea odoratissima (Ness) Kost.. Pinus kesiva Royle ex Gordon, Prunus cerasoides D. Don, P. domestica L. subsp. domestica Ghora & Panigr., P. nepaulensis (Seringe) Steud., Quercus griffithii Hook. f. & Thomson ex DC., Rhododendron arboreum Smith, R. johnstoneanum G. Watt ex Hutch.. R. triflorum Hook. f. R. vaccinioides Hook. f. and Symplocos spp., etc. In some places, species of Albizia, Cinnamomum, Juglans, Magnolia, Michelia, Persea, Quercus, Rubus, etc. along with Ehretia acuminata R. Br., Erythroxylon kunthianum Wallich ex Kuntz, Euonymus hamiltonianus Wallich, Helicia nilagirica Beddome, Ilex khasiana Purkay., I. embelioides Hook. f., Ligustrum spp., Lindera nacusua (D. Don) Merr, and Viburnum spp. are present. There is a gradual change in the composition and diversity of the species with increase in altitude. At higher elevations, Rhododendron spp. predominate with Eriobotrya, Prunus, Spiraea and other members of Rosaceae. The mountain bamboo Yushania naling (Ganibic) R. Majumdar are found throughout the moist temperate forests. A rare and interesting species Sorbus polycarpa (Hook. f.) Rehder has been collected recently from the Sirohec forest.

In the shrubby layer predominant taxa are Ardisia depressa C. B. Clarke, Clerodendrum wallichii Merr., Celastrus paniculatus Willd., Illicium griffithii Hook. f. & Thomson, Euonymus theifolius Wallich ex M. Lawson, Luculia pinceana Hooker, Maesa Indica (Roxb.) Wallich, Macropanax dispennus (Blume) O. Kuntze. Panax assamica R. N. Banerjee., P. pseudo-ginseng A. DC., etc. The herbaceous layer comprises of Begonia roxburghii A. DC., B. Thomsonii A. DC., Brachystemma calycinum D. Don, Galium elegans Wallich ex Roxb., Hedyotis pinifolia Wallich ex G. Don, Ophiopogon dracaenoides Hook. f., Pilea hookeriana Wedd., Peperomia pellucida (L.) Kunth. and Strobilanthes maculatus Nees, etc. The other fascinating group of plants, because of their beautiful long lasting ornamental flowers are orchids. About 249 species of Orchids flourish in this state of Manipur. which include many highly ornamentals like Aerides, Bulbophyllum, Coelogyne, (*vpnbidilln, Dendrobium, Paphiopedillum, Phaius, Pleurozia, Renanthera, Rhynchostylis and Vanilla species, etc.

The ferns and fern allies like Asplenium laciniatum D. Don, Athyrium chepanopterum (Kuntze) A. Br. ex Nilde, Lycopodium japonicum Thunb., Selaginella chrysochaeta (Hook. & Grev.) Spring, Lygodium japonicum (Thunb.) Sw., Pteris biaurita L., Microsorium spp., Dryopteris spp., Plagiogyria spp. etc. Saprola hualqvana Griffith, a parasite on Cissus species. collected from temperate forests of Koupru hills of Manipur. At the elevation more than 1000 m in Dzuko valley.

Koupru, Maoching and Sirohcc hill forest areas, the vegetation shows a typical dense growth of small crooked gnarled and stunted trees and shrubs. The dominant species are *Aconitum elitesii* Stapf, *A. nagarwn* Stapf, *Igapetes nilrarioides* Hook

f. , *Berberis manipurana* Ahrendt, *Berberis sublevis* W. Smith var. *sublevis*, *B. sublevis* W. Smith var. *microcarpa* (Hook. f. & Thomson) Ahrendt., *Corydalis*

Chaerophylla DC., Dichroa febrifuga Lour., B'fahonia manipurensis Takeda, M. mxburghii (DC.) Takda, Rhododendron elliottii G. Watt ex Brandis, R. niacabeanii G. Watt ex Balfour. f., R. maddenii Hook. subsp. crassum (Franchet) Cullen, R. wattii Cowan. Selinum striatum C.B. Clarke, and Carex manipurensis C.B. Clarke, etc. Three species of rare and interesting gymnosperm i.e. Cephalotaxus griffithii Hook. f., C. mannii Hook. f. and Taxus wallichiana Zucc. have also been collected from the Manipur state. Besides, other economic plants eg. Gaultheria, Gentiana and Swertia spp. are 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, Saxifragaceae, and Poaceae 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 (sensu lato), Poaceae, Asteraceae, Rubiaceae, Acanthaceae, Euphorbiaceae, Lamiaceae, Cyperaceae and Scrophulariaceae. In comparison to this, the first ten families in the Manipur state are:

Table 1 : Ten dominant families of Phanerogams

S.NO	Families	Genera	Species
1.	Orchidaceae	69	249
2.	Poaceae	87	
3.	Leguminosae (sensu lato)	65	168
4.	Asteraceae	63	84
5.	Rubiaceae	35	84
6.	Euphorbiaceae	25	52
7.	Acanthaceae	22	
8.	Cyperaceae	10	49
9.	Rosaceae	14	48
10.	Lamiaceae	32	43

Table-2 : 1() Dominant families of Dicots

S.NO	Families	Genera	Species
1.	Leguminosae (sensu lato)	65	168

2.	Asteraceae	63	84
3.	Rubiaceae	35	84
4.	Urticaceae	21	82
5.	Euphorbiaceae	25	52
6.	Acanthaceae	22	50
7.	Rosaceae	14	48
8.	Lamiaceae	32	43
	Lauraceae		39
10.	Scrophulariaceae	18	36

Table-3 : Ten dominant families of Monocots

S.No	Families	Genera	Species
1.	Orchidaceae 69	249	
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		8
10.	Smilacaceae	2	8

Orchidaceae (ca 249 species), Poaceae (ca 200 species) Leguminosae (ca 168 species), Asteraceae (ca 84 species), Rubiaceae (ca 84 species). Euphorbiaceae (ca 52 species). Acanthaceae (ca 50 species), Cyperaceae (ca 49 species). Rosaceae (ca 48 species) and Lamiaceae (ca 43 species (Please see Table 1 3). The single largest genus is Dendrobium with 43 species, Polygonum with 23 species, Impatiens with 17 species and 4 varieties, Ficus with 18 species, Coelocline with 16 species. Carax with 15 species. Crotalaria with 14 species, Cyperus, Cymbidium and Jasminum with 13 species each. About 2380 species belonging to 1052 different genera spread over 205 families are have already been recorded in the state of Manipur. In the state of Manipur the dicot flora is

spread over 172 families. Not a single angiosperm family is endemic to this state. Though it is beyond the scope at this juncture to give detailed family wise statistical analysis, as part 26 of the state bordering Myanmar is not explored well however, the details of

some families are given below. The dicot families Nelumbonaceae, Bixaceae, Tamaricaceae, Actinidiaceae, Geraniaceae, Tropaeolaceae, Erythralaceae, Moringaceae, Saxifragaceae, Rhizophoraceae, Sonneratiaceae, Punicaceae, Caricaceae, Datisceae, Aizoaceae, Nyssaceae, Dipsacaceae, Sphenoclcaceae, Pyrolaceae, Monotropaceae, Sarcospermaceae, Polemoniaceae, Hydrophyllaceae, Pedaliaceae, Cuscutaceae, Basellaceae, Phytolaccaceae, Podostemaceae, Rafflesiaceae, Saururaceae, Proteaceae, Elaeagnaceae, Burseraceae, Cannabaceae, Myricaceae, Salicaceae, Ceratophyllaceae are represented by a single genus having a single species each. Some of the other poorly represented species are Lardizabalaceae, Trapaceae, Schizandraceae, Pittosporaceae, Portulacaceae, Crassulaceae, Cactaceae, Alangiaceae, Buddlejaceae, 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 Bctulaceae have been represented by two genera and two species each.

The herbaceous family Ranunculaceae is well represented in this state with endemic species like *Aconitum elwesii* Stapf, *A. nagarum* Stapf and *Clematis apiculata* Hook. f. & Thomson along with other nine species of *Clematis*, etc. Primitive families Annonaceae, Chloranthaceae, Hamamelidaceae, Lardizabalaceae, Lauraceae, Magnoliaceae and Schimndraceae, 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 genus is now confined only to the Moreh area of the state.

The family Balsaminaceae have been represented by 17 species and four varieties out of ca 20() species reported from India. Several species of *Impatiens* like *Impatiens gibbiseptala* Hook. f., *I. laevigata* Hook. f. & Thomson, *I. longirama* Hook. f., *I. odontoseptala* Hook. f., *I. spissiflora* Hook. f., etc. are endemic to this state. The family Rosaceae is well represented by the species of *Agriynoma*, *Docynia*, *Fragaria*, *Neillia*, *Photinia*, *Potentilla*, *Prunus*, *Pyrus*, *Rosa*, *Rubus*, *Sorbus* and *Spiraea* etc. *Sorbus polycarpa* (Hook. f.) Rehder a rare and endemic species to Meghalaya has been recently collected from the Sirohee hills. The family Begoniaceae is represented by eight species. 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*, few species of which are endemic to this

state. Families Fagaccac. Moraceae and Urticaceae are also very well represented in Manipur.

In the Manipur state, monocots are represented by 33 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