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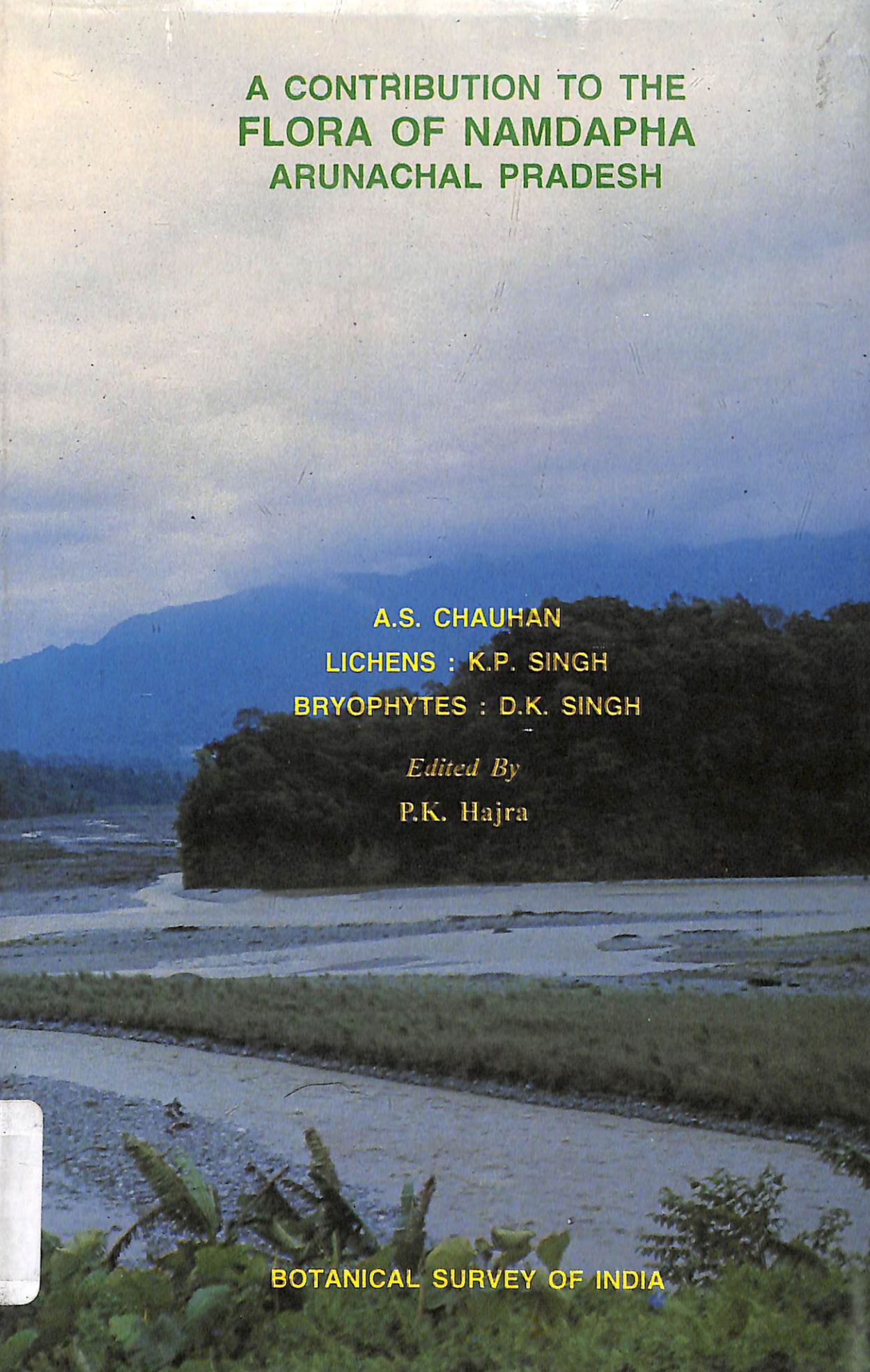

BOTANICAL SURVEY OF INDIA

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INTRODUCTION

Before the advent of man on the earth, the green mantle or the vegetation in the form of existing plantlife could exist without man, the converse is not true. The dependence of man on plants for various needs is well known and need not be emphasized. However, in recent times the combined factors of population growth, the over utilization of plant resources and degradation of natural ecosystems have threatened to destroy the delicate equilibrium that exists between the man and the nature. The expansion of biotic activities into the primeval forest areas and exploitation of ever shrinking natural resources have disturbed the fragile ecosystems, thus accelerating environmental degradation throughout the globe.

The entire world is now highly concerned about the imminent environmental disaster and the need for conservation of environment is widely discussed. It is realised world over our environment and that biodiversity holds the key for future quality of human life on this earth.

It has also been realised that only 10 - 15% of the total number of species of organisms have so far been discovered and described and for the majority, we do not have even a record of their existence and any knowledge of their biology. This rich genetic diversity is being depleted rapidly through indiscriminate exploitation, habitat destruction, rapid deforestation and urbanisation on the one hand and spread of harmful chemicals, introduction of alein species and lack of proper exploration and taxonomic studies on the other. The 7000 million hectares of forests which we had in the world in the last century, has already dwindled to 2000 million hectares by now.

At global level, forests are being destroyed at the rate of one football field worth every second and the area equalling Portugal worth every year. An enormous hole in the Ozone layer jeopardizing the earth's ability to protect life from deadly ultraviolet radiations is the recent discovery causing grave concern to all. Huge quantities of chemical wastes viz. carbon dioxide, methane and chlorofluorocarbons are being dumped in to the atmosphere, trapping the heat and raising global temperature.

In India, we are left with a paltry 19.4%. of the total land area under the forest cover, as against a mandatory 33%. Besides, the forestry in India has been regarded as revenue generating sector which has thus contributed a lot in depauperisation of forest cover. Ironically to

some extent, the same philosophy persists even at present. The alarming pace of destruction of the plant habitats has resulted in the fragmentation of their populations, and the genetic flow thereby, leading to the loss of viability and diversity. The depletion of one species in such ecosystem has led to the loss or migration of several dependent species of flora and fauna. The rapid shrinkage of the forests has resulted in the depletion of vegetal wealth considerably, bringing a few thousands of species to the verge of extinction. These include several taxa of potential importance for food, medicine and horticulture development, etc.

Alarmed at the unprecedented rate of vanishing of living species the International Union for Conservation of Nature and Natural Resources (IUCN) has estimated that *ca* 10% of the total taxa are presently threatened with depletion or extinction. Myers (1980) observed that atleast one species is lost every day in the tropical forest alone and the situation may worsen to an extent when even one species may disappear every hour. According to one estimate *ca* 30% of our genetic diversity may be lost for ever by 2050 A.D.

Viewing the urgency, plant conservationists concerned are on this matter, especially on the possible consequences of species elimination in the fragile ecosystems in the tropics which harbour maximum concentration of plant diversity. In India, the North East region being the primary centre of origin of angiosperms, or to put in the words of Takhtajan, the cradle of flowering plants ; the need for detailed studies has been felt. These areas have contributed more to our domesticated plants and are still the centres of maximum plant and animal diversity.

The importance of conservation of tropical habitats and species diversity for the survival of the humanity is now widely recognised. An exhaustive inventory of tropical plants is one of the primary objective for the plant taxonomists throughout the world, but the goal remains a far cry, especially in the developing and underdeveloped countries in the tropics of the world.

This is true for the North-eastern India too, which comprises the seven sister states of Arunachal Pradesh, Assam, Nagaland, Manipur, Mizoram, Tripura and Meghalaya, with about 1, 21, 828 sq km under forest and approximately 7000 plant species (*ca* 50% species of known flowering plants in India). The region represents a wide range of physiography and eco-climatic conditions and is endowed with vast and luxuriant vegetation ranging from tropical to alpine, with rich gene pool of both wild and cultivated plant species. Though the flora of this region 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.

The rich plant diversity of the region include *ca* 600 species. of Orchids, more than 450 species. of grasses, *ca* 68 species. of bamboos, *ca* 65 taxa of Rhododendrons, *ca* 42 species of *Impatiens, ca* 34 species of *Hedychium,* besides a number of species of canes, *Musa, Citrus, Piper, Dioscorea Cinnamomum* and Primulas, etc. grow profusely in this region.

In the recent past wanton clearance of forests, slash and burn mode of cultivation, forest fires and other biotic interferences have led to the reduction of forest cover and what is equally ominous is the depletion of forest which is still going on unabated in some states, *viz.* Assam, Mizoram, Tripura and Meghalaya. Consequently, *while ca* 700 taxa of this region are facing threat for their survival in wild. Vast area of land has transformed into barren and unproductive wastelands, Besides, due to an ever widening gap between demand and supply on natural resources, the feasibility to bridge the gap between our annual increase of forestry stock and natural regeneration on one hand and from plantation on the other due to heavy population growth and livestock pressure, is also becoming inadequate.

The idea of setting up Biosphere Reserves and their total conservation was evolved from the initiative of the International Biological Programme (IBP) started in 1964 under the auspices of the International Council for Scientific Unions (ICSU). The importance of IBP study for conservation of plants and animals has been properly assumed and as a result, the UNESCO took initiative and launched the 'Man & Biosphere' Programme (MAB) on global basis in 1974, which envisages the study of the structural and functional aspects of various ecological systems and setting aside unique natural biomes as 'Biosphere Reserves' for posterity and for environmental research. The recognition of Biosphere Reserve concept is of vital interest and importance to the world as it helps in conservation of genetic material in natural habitats and the role they will play in scientific research and education. They will serve as bench marks against which ecological changes can be measured and the performance of other ecosystems judged. The objectives of the International Network of Biosphere Reserve are:

(i) To conserve for present and future use the genetic diversity of biotic communities of plants and animals within the natural ecosystem on which their continuing evolution depends.

(ii) To provide areas for ecological and environmental research including (Particularly) baseline studies both within and adjacent areas to these reserves.

(iii) To provide facilities for education and training.

Recently, under the World Conservation Strategy, Talbot (1980) added the following three additional and extremely relevant objectives :

(i) To maintain essential ecological processes and life support systems.

(ii) To preserve genetic diversity, and

(iii) To ensure that the utilisation of living resources and ecosystems in which they are found are sustainable.

Subsequently, in India, late Mrs. Indira Gandhi, the then Prime Minister, launched a Conservation Strategy' on 6th March, 1980 with the following objectives:

(i) Maintenance of essential ecological processes and life support systems on which human survival and development depend.

(ii) Preservation of genetic diversity.

(iii) Ensuring sustainable utilisation of species, which support rural communities and major industries.

To formulate the National Conservation Strategy in our country, there can hardly be few areas of more than one or two thousand square kilometres extent without a multitude of humanity living at the subsistence level. Such areas include the cold desert of Ladak, the dry hot deserts of the Thar, the salt marshes of Rann of Kutch and a few inaccessible regions of the Eastern Himalaya in Arunachal Pradesh.

Out of the above mentioned areas, if one considers a potential area for tangible benefits for mankind, the area should have significant biotic wealth. The priority, therefore, gets restricted to the tropical Eastern Himalaya rather than the bleak deserts of snowy (waste-land) areas. In the tropical Eastern Himalaya, significantly large areas, both accessible as well as inaccessible, with natural biota are restricted to Changlang and Lohit districts of Arunachal Pradesh. Here again, the biotic richness, genetic diversity and ecological considerations compel us to choose Namdapha area that extends over 2500 sq km of uninhabitated land spread over in Changlang and Lohit districts of Arunachal Pradesh.

The Namdapha area identifies one of the ecologically richest biotic communities in India. The area is covered with virgin lush evergreen dense tropical forest extending over 4000 sq km between the altitudes of 200 to 4571 m. The forest wealth is by far the richest natural endowment of the area. The great strength of this natural wealth lies in their utter immensity, density and vitality. The tropical humid

climate coupled with heavy rainfall facilitates dense floristic growth, and everything in these forests grow with almost insane vigour. These natural virgin forests in the remote corner of the country, at the trijunction of India, Myanmar and China, exhibiting the tropical, subtropical, temperate and even apline ecosystems are so complex, delicate and fragile that a minor imbalance could be detrimental to the interest of human beings who inhabit this natural environment.

Though Namdapha falls in the remote corner of the country, yet it could not escape from human interference. Destruction of biotic potential under optimal productivity of the land is obvious in this area. Forests have been extensively felled unchecked for timber and jhum cultivation leading to instability in the mountain slopes in this earthquake prone area. Extensive clearance of forests has been made particularly around Nampong, Deban, M' Pen, Manbum, West side of Tezu, Tiskar Road, Glao lake area, Gandhigram and Vijoynagar, etc. for settling refugees, *viz.* Chakma from the Chittagong hill tracts of Bangla Desh, Lamas from Bhutan, Tikhak, Tangsa, Mogbu, Tibetan, etc. in Manabum, Diyan areas and Jayrampur Nampong areas respectively. Gandhigram and Vijoynagar areas are occupied by the Lisu tribe who migrated from China through Myanmar. Besides, Ex-Assam Rifles Jawans, comprising 200 families of Nepalis and 14 families of Mizos, etc., have also been settled in the Vijoynagar settlement area. Considerable damage has been done in Littoral forests along coast-line at Manabum and Diyum areas.

In the project document of the proposed Namdapha Biosphere Reserve, prepared by Dr. S.S. Nair and published by the Ministry of Environment and Forests, New Delhi, it has been stressed that the deforestation should be halted immediately and a landuse capability survey with the help of latest scientific methods should be carried out to define the landuse pattern taking into consideration the climatic, edaphic and topographic factors. Nair (1981) also suggested for setting aside some areas as **'Biosphere Reserve'** so that these may serve as the gene pool reserve for the threatened species of the plants and animals. A serious concern has been expressed over the deforestation in these forests which could affect or deestablise the ecosystem and environment. It is stressed to establish nature reserves in different ecotypes not only to prevent destruction of gene reservoirs, but also to make it available for scientific and conservational studies.

With a view to establish a Biosphere Reserve in this remote corner of the country, the MAB Committee of Government of India launched a project through the Botanical Survey of India entitled "Study and Conservation of the Plant resources of the proposed Namdapha

Biosphere Reserve, Tirap District, Arunachal Pradesh", with the following objectives :

1. To conduct studies on the flora and vegetation for preparing a detailed status report on the proposed Namdapha Biosphere Reserve with emphasis to ascertain the uniqueness of the flora.
2. To find out the taxa unique to the area both new and rare.
3. To find out the taxa known only from other regions so far, but could be available in this region.
4. To report the abundance and frequency of taxa with special reference to rare, endangered and threatened species.
5. To study the inter and intraspecific variations of species met in the region.
6. To find out genetic diversity among the wild relatives of the cultivated plants like *Musa, Citrus, Piper,* etc.
7. To find out the availability of primitive plants and their frequency.
8. To make a detailed study of the orchids, palms and canes.
9. To make the inventory of taxa of Indo-Tibetan, Indo-Chines, Indo-Malayan and Indo-Myanmaries affinities in particular and other countries in general.
10. To find out occurrence of plants of ethnobotanical importance, *viz.* wild edible plants, medicinal plants and other plants of economic potentiality.
11. To suggests and attempt measures for conservation of plant resources by demarcating the core zone, buffer zone and manipulation zones etc. which will serve as nature's referred system.

PHYSIOGRAPHY

The proposed Namdapha Biosphere Reserve is situated in the North East corner of India in the Changlang and Lohit districts of Arunachal Pradesh between 27.51' - 28. 51 N Latitude and 95.45' - 97.30' E Longitude. It is bounded in the North by the Mishmee hills, on the East by Homekharan Bum (with extensive table-land and high peaks over 4000 m, the highest being Dapha Bum at ca 4571 m above MSL) on the West by Dibrugarh District of Assam whereas its southern limit extends into Patkoi hills in Myanmar. In general, its geographical position is unique being situated at the junction of the outspurs of North Eastern Himalaya and Patkoi ranges of Myanmar (Burma).

Topography : The proposed Namdapha Biosphere Reserve is highly rugged area with deep valleys and hill ranges running in different directions. The Great Himalaya at its eastern end take a mighty sweep around the peak of Namcha Barwa (7,765 m) in Tibet and swings forwards to south-east. The high table-land of Tibet lies towards the North and South Chinese Szechwan mountains lie towards the East. The Eastern Himalaya trails off towards the South in a narrow ridge which are slightly forwards to the East meeting the eastern end of the Patkoi mountains at Chaukam pass. The eastern side of the moutains are drained in the Irrawady basin while the western slopes are drained in the Brahmaputra basin. Parallel to but North of Patkoi there is a higher ridge, stretching from East to West called the Dapha Bum ridge which has many high peaks of over 4500 m. This ridge separates the Noa-Dihing drainage basin from the northern Lohit river basin. The Dapha Bum ridge meets the tail end of the Eastern Himalaya where the Changlang and Lohit district boundaries meet in an area of glaciers and snow covered peaks which continues north-east along the Indo-Myanmar border to the trijunction of India, Myanmar and China. These higher areas in the catchments of the southern tribal areas of Lohit, such as the Kamlang, Lati and Kulung, are unexplored. From these main high mountain ridges, several other ridges, *viz.* Kumon Bum, Lamgatka Bum, Nanan Bum, Nshand Bum, Miao Bum, etc., radiate. These hill ranges rise abruptly to substantial height resulting in a spectacular panoramic view of the reserve. The altitude of Namdapha varies from 200 m to 4571 m (Dapha Bum) above mean sea level. It has moderate slope at centre of the present Tiger Reserve (Diyun Valley), i.e. from Happy valley via Bulbulia, Firmbase to Embiong area. Along the northern bank of Noa-Dihing river the land gradually become steeper in the Dapha Bum range of the northern part of the Tiger Reserve and in the Patkoi range in the southern part of the Biosphere Reserve. Parts of the Dapha Bum ridge with its extensive forests lie in some of the most earthquake prone areas in India.

The Diyun valley is the only route, free from snow, linking upper Myanmar with the Assam Valley, besides the one through the Pangsu pass further West. Many Arunachal Tribes who trace their origin from Thailand or further East might have moved in along this valley.

The Dapha Bum ridge is drained towards the North by the Kamlang, Lati and Kulung tributaries of the Lati river which finally join the mighty Brahmaputra. The main river in the proposed Biosphere is the Noa-Dihing, which originates from the mountains near the Chaukam pass on the Indo-Myanmar border and flows in east-west direction finally joining Brahmaputra. The other major river, Namdapha originates

from the Phonga pass and runs in north-south direction and finally joining the Noa-Dihing at 55 Km point. The Deban river orginates from Dapha Bum and runs south wards. It also joins Noa-Dihing at Deban. Another perennial and dangerous water stream, Burma Nala originates from the Patkoi ranges and runs northwards finally joining Noa-Dihing at 64 km point. Similarly, Namphai and Namphuk rivers originate from the Patkoi ranges and run north-west to ultimately join. Noa-Dihing. Apart, there are innumerable seasonal streams and streamlets which swell with a surfeit of water during the rains, casting and widly tumbling in river falls and rapids in the rugged hill areas before quieting into river Noa-Dihing. Most of these rivers are perennial and fed by snow. Besides, some natural pools, locally called 'Beels', *viz.* Pani Jheel, Rani Jheel, Ganga Jheel, Moti Jheel, M'pen Jheel, Dipi Lake, Glao lake etc. are also found in the proposed Biosphere Reserve. These ponds vary in size from 200 to 1000 sq m or even more with the depth varying from 1 m to 3 m or more. During winter, most of them dry up and remain muddy. It is interesting to point out here that maximum concentration of the animals have been observed in these areas.

GEOLOGY

Geologically the proposed Biosphere Reserve area is of recent origin and owes its formation to the upheavel of the Himalayas in pleiocene period of the Tertiary age. The geological information of this area dates back to 1886 when La Touche (1886), during his reconnaissance traverse of the Noa-Dihing valley up to Chaukam Pass, visited Miao Bum and referred to thin coal reams exposed on the hill slopes at a distance of 2.4 km from Dihing at an elevation of 433 m above Dihing. The information so far has led to the deciphering of various geological aspects, structural, tectonic and geomorphic in broad patterns and has helped to some extent in establishing the mineral resources of the park. Tertiary and Quarternary sequence of the area is the extension from Nagaland and upper Assam.

Disang of rocks are restricted around Nampong, in the southern parts of the park area. It consists of dark grey, splintery shales and thin grey sand stone bands. The over lying Barail group is classified into three well marked formations. The lower most Naogaon formation consists of fine grained, hard and compact flaggy sand stone with grey shale, sand shale and Carbonaceous shale. The over flying Baragoloi formation comprises hard, massive grey and reddish stones with clay carbonaceous shale and numerous inpersistent coal seams. The topmost Tikak parbat formation extends from Nampong area and goes up to Vijoynagar along the southern bank of Noa-Dihing river. Near Vijoynagar

it occupies the Noa-Dihing valley. It consists of medium to course, grey and light coloured sand stone with minor grey shale, white clay and carbonaceous shale. Thick workable coal seams are found at the legal part in the upper Assam area where as in the park area the persistent coal seams range from 0.5 - 1.5 m thick.

Barail group of rocks generally overlain by Myanmar group of rocks are not exposed in the park area. Tipam group of rocks are quite thick in the park area and well exposed in Noa-Dihing and Namphuk river valleys. Tipan group contains fragments of silicified and semicarbonised fossil tree trunks. The Tipam group includes several soil and sand horizon in upper Assam. Well preserved dicot leaf impressions have been collected from Tipam sandstone formation.

Nam Rong Khu formation chiefly consists of coarse, loose, poorly consolidated ferruginous, bluish grey sand and grey clay with layers of pebbles. These beds are well exposed near period on Miao-Vijoynagar road and Miao Nala. Dihing formation seam along the southern and northern banks of Noa-Dihing river up to Deban where from it takes a MNE turn and abuts against the Dapha Bum range. The Dihing group is inconformably overlain by the alluvium. This consists of bluish or grey clay with sand lenses, shingle gravel and boulder deposits. A major part of Noa-Dihing river valley is covered by recent alluvial deposits. Alluvium shows much variation from place to place.

SOIL

Soil is characterised by a loamy surface layer of considerable depth and texture with colour varying from yellow to reddish. It is acidic in nature. Deep layer of sandy loam soil, rich in vegetative matter is also found in the lower gentle slopes of the hills which support the best, fully stocked *Dipterocarpus* forests. On the ridges and precipitive slopes, the soil depth becomes shallow while on the areas near the river banks, liable to frequent inundation, the soil tends to be sandy on the sloping grounds and loamy on flat grounds.

In flat lands and along stream banks, the soil is fresh water alluvium. The rich grey, brown and red soil, derived from the calcareous sand stone support the luxuriant tropical forest vegetation. Heavy clays to clay loams are found mostly in valley areas. The soil depth varies with slopes with shallow soil characterising higher elevations and deep soil in the valleys and river sides. The profile shows no visible stratification into horizons.

The high rainfall causes an almost continuous percolation of water through the streams and beels into the main rivers and the soil has very low moisture retaining capacity. Humus or organic matter, being washed away by the heavy rainfall assisted by the steep slopes and loose texture of soils, is comparatively poor in the hill slopes. The soil is highly permeable and thus strongly leached. The soil of the rain forests of Jhum lands are generally poor in nutrient content which is a characteristic feature of the tropical "Ombrophilous" forests. This is due to the fact that in tropical rain forests favourable climatic conditions facilitate quick mineralisation and dead biotic materials and the released nutrients are immediately absorbed by the roots of dense vegetation. Therefore, the amount of nutrients in the soil at any given time is considerably reduced. The entire nutrient capital necessary for the continuous growth of this type of lush tropical vegetation is tied up in the living plant itself.

CLIMATE

The area falls within the geographically subtropical zone, and enjoys subtropical climate with a distinct, though short, cold weather from November to February in the lower reaches. This is the most pleasant period when humidity in the air is least. However, the cold season persists for longer period at higher altitudes as in other Himalayan region. With the onset of south-west monsoon, the humidity starts rising in the month of May. This, coupled with the rise of temperature, makes the weather oppresive especially during the months of June, July and August. The tract is highly malarious.

Due to the altitudinal variations between 200 to 4571 m, the area being the zone of heavy rainfall, the climate varies at different heights. Since the entire high altitudinal area has not been explored as yet, the climatological classification for those zones is not feasible at this moment. On the other hand there is no meteorological observatory in the adjacent areas. However, on the basis of the experience and available information, seasons can be classified as follows:-

(i) The cold season, from December to February

(ii) The premonsoon season, from March to May

(iii) The monsoon season followed by South-west monsoon till September

(iv) The postmonsoon season from October to November. It is also a period of transition

The varied topography has profound influence on the climate which varies according to elevation and location. The mountainous part

of the territory enjoy, what is known as montane type of climate while the low lying narrow peripheral plains and the valleys experience tropical climate.

The montane type of climate is characterised by the terrain in relation air to temperature and its variation which in turn cause other weather phenomena like occurrence of fog, thunder-storm etc. There are large diurnal variations of temperature particularly in the valleys.

RAINFALL

Heavy rainfall during the monsoon is an important feature of this territory. The area receives its winter rainfall, particularly in the northern parts, from western disturbances. Narrow peripheral strip of land below the elevation of 1000 m surrounding the Brahmaputra valley is the rainiest part of the territory, receiving more than 250 cm of rain annually. In this region, the rainfall increases to 400 cm towards east. The number of rainy days with more than 2.5 mm of rain averages between 125 to 150 annually.

An entirely dry month is rare, except in the western fringes of the Biosphere Reserve, where December and January are usually dry. The monsoon which lasts till September, contributes nearly about 75% of annual rainfall in the area. June, July and August are typical monsoon months experiencing the heaviest downpour. March, April and May months receive comparatively less rainfall. Floods are frequent in some parts.

TEMPERATURE

December and January are generally the coldest months, when the mean maximum temperature in the plains (below 900m) is normally about 20° C whereas the mean minimum temperature ranges between 5°-20° C. Much lower temperature is experienced at higher elevations above 3000 m where it is usually is below freezing point. The months of July and August are normally the warmest when the mean daily temperature hovers around 27° C at places below 900 m where as at the elevation of 3000 m, the mean daily temperature is usually around 25° C.

RELATIVE HUMIDITY

Relative humidity is always high except in the winter months. Clear or partially clear skies are common during the post-monsoon season. During summer the relative humidity is between 60-70%.