NATUTAL VEGETATION OF NORTH EAST INDIA

Of the total forest area of around 68 million hectares in India, the North-Eastern states account for over 17 million hectares, roughly one-fourth of the forest area of the country. All the states of North-East India, with the exception of Assam, have 50–80 % of their area under forests. High temperatures, combined with heavy to very heavy rains, have stimulated the growth of forests at lower levels. Even in the mountainous regions, there are heavy rains in summer, and lower temperatures during winter don’t cause excessive evapotranspiration and thus limit the possibility of any moisture stress in the soil. The forests in the hilly regions, despite the destruction of forests by slash and burn cultivation, have survived and are regenerated. These forests have enormous variation in their typology and ﬂ oral characteristics, ranging from tropical evergreen at lower altitude in upper Brahmaputra valley to pine forests in the Himalayas and birch–rhododendron scrub at still higher levels. Dipterocarpus macrocarpus (Hollong in Assamese) and Mesua ferrea (Nahar in Assamese) are the principal type trees of Assam valley tropical evergreen forests. In the tropical moist deciduous forests, Shorea robusta is the principal species with several associates like Schima wallichii (Makna Sal). The subtropical wet hill forests, as in Meghalaya, have several varieties of oak (Quercus spp.). Richness of ﬂora because of the wet hills presents a climate condition, which combines the characteristics of tropical as well as temperate climate. At higher altitudes, mixed coniferous and coniferous forests occur followed by sub-alpine pastures, rhododendrons and scrubs at still higher altitudes. North-East India is known for its biodiversity. It is one of the two biodiversity hotspots of India. Half the total number of ﬂ oral species, known in India, occurs here, and the region forms the richest reservoir of genetic variability. An important aspect of the forests of the region is the profusion of orchids. The North-East region has 876 orchid species, which constitute 70 % of the total orchid ﬂ ora of India. To preserve the biodiversity of the region, a number of biospheres, national parks and wildlife sanctuaries (2004) are established in the region.

Plants are the earliest form of organism to colonise the earth, much before the animals and humans appeared on the scene. They are most vital for other forms of life, as they are the producers, the rest being all consumers. For millions of years, plants evolved, developed and spread over different parts of the earth. The only constraints were then, as they are today, the climo-edaphic factors. Their distribution is inﬂuenced by temperature conditions with their determinants latitude and altitude, amount, intensity and seasonal distribution of precipitation and to some extent soils. Plant exist today either as natural vegetation or cultivars. Original, though changing, distribution of natural vegetation has been grossly disturbed during the last several thousand years, following the advent of agriculture and progressively increasing conversion of land under natural vegetation into agricultural land. Increasing population meant not only more land for agriculture but even for other purposes, like industries, urban growth, growing socio-economic institutions and other infrastructures. The land under natural vegetation gradually shrank, and what we see today as natural vegetation is only the pale shadow of what once existed as a glorious mantle of vegetation, before the humans entered on the scene, and civilizations destroyed a large part of that vegetal. The higher the concentration of population in a region, the greater is the destruction of natural vegetation and its replacement by croplands and commercial plantations. While discussing the vegetation North-East India, a simpliﬁed approach, which gives prominence to the character of the vegetation-covered land, is adopted. The land colonised by natural vegetation is usually grouped under three categories: forests, grasslands, (savanna, grass lands and steppes) and scrubland. India is among the ﬁrst ten countries, in terms of area under forests, trailing behind countries like Russia, Canada, Brazil, China, the USA and Congo. The country has around 68 million hectares (67,700,800 ha, according to Forest Survey of India 2006) of forest, accounting for 20.6 % of its geographical area. Of the total forest area in India, one-fourth (17,331,600 ha) is conﬁned to the seven North-Eastern states. These states, with barely 8 % of geographical area of the country, carry more than 25 % of its forest cover.

**Abundance of Forest in the North-East**

No other state of India, except the island states of Lakshadweep and Andaman and Nicobar, has such a large part of its area under forest cover as North-Eastern India. Assam is the only state in the North-East which has a lower percentage, though above national average, of forests than several other states, like the coastal states of Goa and Kerala and the Central Indian state of Chhattisgarh. The controversy about the discrepancy centred on the ‘area recorded as forests’ by the State Governments and the actual forest area has been going on since the 1980s. The application of ‘remote sensing techniques through satellite images’ has produced a picture, quite different from what was normally believed earlier.

Today, according to Forest Survey of India, only 20.6 % of the geographical area of the country is under forest cover, in contrast with 25 % that was quoted officially earlier. Even, this one-ﬁfth of the geographical area of the country (20.6 %) is not fully covered with very dense forests, which account for only 8 % of the total forest area in the country. Much of the forest cover in the country consists of moderately dense and open forests, the former accounting for 49 % and the latter for 42 % of the total forest cover of India.

Table 1: Distribution of forest cover in the North-Eastern region (km2)

|  |  |  |  |
| --- | --- | --- | --- |
| States of India | Geographical area (km2) | Recorded forests | Actual forest cover |
| Area | % | Area | % |
| Arunachal Pradesh | 83,743 | 51,540 | 61.55 | 68,019 | 81.22 |
| Assam | 74,438 | 27,018 | 34.45 | 27,826 | 35.48 |
| Manipur | 22,327 | 17,418 | 78.01 | 17,219 | 77.12 |
| Meghalaya | 22,429 | 9,496 | 42.34 | 16,839 | 75.08 |
| Mizoram | 21,081 | 16,717 | 79.30 | 18,430 | 87.42 |
| Nagaland | 16,579 | 8,629 | 52.05 | 13,609 | 82.09 |
| Sikkim | 7,096 | 5,841 | 82.31 | 3,262 | 45.79 |
| Tripura | 10,486 | 6,293 | 60.01 | 8,093 | 77.18 |
| Total for NE States | 263,179 | 142,952 | 54.31 | 173,297 | 65.80 |
| Total for India | 3,287,263 | 774,740 | 23.57 | 678,333 | 20.64 |

Source: Forest Survey of India (2003) Sate of Forests Report, Dehradun

**Forest Types in the North-East Region**

 The broad types of forests in North-Eastern India are as follows:

1. Tropical wet evergreen forests
2. Tropical semi-evergreen forests
3. Moist forests
4. Swamp forests
5. Khair-Sissoo forests (Acacia catechu and Dalbergia sissoo)
6. Subtropical hill forests and savanna
7. Pine forests
8. East Himalayan wet temperate forests
9. East Himalayan moist temperate forests
10. East Himalayan dry temperate coniferous forests
11. East Himalayan sub-alpine birch–ﬁr forests
12. Birch–rhododendron scrub
13. Dry alpine scrub
	1. **Tropical Evergreen Forests**

Tropical evergreen forests in the North-Eastern region are conﬁned to Assam valley including upper Assam and Cachar with cane and bamboo brakes. In Assam valley and the alluvial plains, these forests occur in areas with 2,500– 3,500 mm of rains and are found on high alluvial deposits near the foothills of Darrang, Lakhimpur and eastern part of Dibrugarh and Tinsukia districts as well as on the southern bank of Brahmaputra and the undulating older alluvium of Dihang River. These extend further into North-East covering the lower region of Tirap, Lohit and Dibang valley districts and the lower Siwalik region of the Himalayas. Besides, the evergreen forests occur also on the lower hills and hill slopes of Cachar Hills district and the southern part of Khasi and Jaintia hills. In Tripura, these forests occur on isolated hills called tillas but more extensively in East and Southeast Tripura especially Dhalai district in Tonglarai valley and Kanchanpur area of Tripura. The lower region of Naga and Patkai hills also carry tropical evergreen forests. Most of the evergreen forests have only three dry months, from November to January. The mean monthly temperature does not exceed 32 °C and mean minimum for January is close to 10 °C. Though locally these areas are subtropical, they have always a favourable moisture regime. Rajkhowa (1961a, b) has divided the evergreen forests into (1) sub-montane evergreen and (2) tropical evergreen. In the former category, he includes Khasi and Jaintia hills and North Cachar Hills, and in the latter category, he includes different types of evergreen forests based on ﬂoristics. Besides some of the common trees that occur in most parts, individual formations characterise speciﬁc regions.

Assam Valley Tropical Evergreen Forests

In the valleys, in upper parts where the land is not used for cultivation or plantation, the evergreen forests have a ‘Dipterocarpus - Mesua formation’ also known in Assamese as ‘Hollong – Nahar forests’. More trees are added in this formation in order of strength. The forests contain the following species: Dipterocarpus macrocarpus – (Hollong – Assamese), Mesua ferrea – (Nahar – Assamese), Shorea assamica, Antigimia excels, Dysoxylum procerum, Artocarpus chaplasha. In the valley, there may be other formations like Vatica lanceaefolia – Eugenia spp. – Garcinia cowa. Also, there are occasional bamboo brakes consisting of Dendrocalamus hamiltonii.

Upper Assam Valley

The forests in the upper part of Assam valley, though evergreen, have a different formation owing largely to altitude, lower temperature and less moisture loss and a better seasonal distribution of rainfall regime. The formation in upper Assam is commonly known as ‘Kayea assamica’ formation. Here Dipterocarp is absent (Rajkhowa 1961a, b) as seen in Dulong Reserve. The composition in Dulong Reserve is as follows: Kayea assamica – 68%, Pterospermum lanceaofolium – 6.25%, Canarium spp. – 4.3 %, Echino carpus – 3.7%, Mesua – 3 %, Terminalia chebula – 3 %. In the higher areas of Eastern Assam and parts of Arunachal Pradesh, the formation is slightly different and can be termed Shorea assamica – Mesua ferrea formation or sometimes Dipterocarpus plosus – Mesua ferrea formation commonly known as Hollong – Nahar type. The latter of these two evergreen formations is represented by upper Dihing Reserve and Jeypore Reserve.

The evergreen forests in Tinsukia (Assam) and Tirap (S. Arunachal Pradesh) are four-storeyed closed forests, averaging a height of 30 m with Mesua dominating the top storey. The second storey is at 17 m. There is frequent occurrence of ﬁcus at lower heights and climbers are rare. In the foothill region of Arunachal Pradesh, the evergreen forests have a slightly different composition that is formed by Mesua ferrea, Ailanthus grandis, Echino carpus, Michelia doltsopa and Quercus lamellosa. In Cachar Hills region, the evergreen forests have a composition that is exempliﬁ ed by the forests Inner Line Reserve. Here the main constituent is Palaquium (20 %) followed by Diospyros tapioca (9 %) and Mesua (7.5 %). The cane brakes in Cachar Hills are formed of the various species of calamus, but particularly Calamus tenuis.

**1.2 Tropical Semi-evergreen Forests**

The semi-evergreen forests are largely evergreen, with varying proportions of deciduous trees. Usually such forests have a broken top storey and are less uniform in composition and far less imposing than the luxuriant evergreen forests. But in an overall assessment, they have very many large trees and their middle storey is dense. Trees are often characterised by buttressed trunks. Unlike evergreen forests, because of the light ﬁltering through the opening in the top storey, there is an undergrowth of trees, and sometimes there are cane clumps. There are creepers and strangulating lianas. Such forests occur in Assam valley proper, in the sub-Himalayan light alluvial plains including Sadiya region, Diyung valley of Nagaland, Dhansiri valley of Sibsagar district and western part of Goalpara district.

Brahmaputra Valley

The ﬂoristic composition of the semi-evergreen forests is formed by Cinnamomum spp., Amoora wallichii, Phoebe spp., Dysoxylum spp. and Syzygium spp. On the southern bank of Brahmaputra, there is virtually no dominant species and trees such as Castanopsis indica, Dysoxylum procerum, Stereospermum personatum (7.8%), Mesua, Magnolia and Canarium. All these occur in almost equal proportion.

The Sub-Himalayan Region and Western Nagaland in Diyung Valley and Dhansiri Valley

The composition of forest in these areas is represented by Terminalia – Phoebe association with Terminalia myriocarpa and Phoebe cooperiana as the principal trees. Mesua ferrea, Dillenia indica and Meliosma gynocardia are occasional trees. Several species of calamus occur.

Western Assam

In western Assam, particularly Goalpara western division, semi-evergreen forests are represented by Syzygium – Tetrameles – Machilus subtype. The dominant trees are as follows: Syzygium (Eugenia) 25%, Tetrameles 17%, Machilus bomycina 15%, Stereospermum personatum 4%.

High Savanna–Syzygium Parkland

This type of evergreen forests consists of low-branched trees about 3–4 m high, growing in asavanna grassland where the grasses are about 2 m high. It occurs in heavy soils in areas waterlogged during rains and burnt annually in hot weather. Such forests occur in the vicinity of sal forests in Brahmaputra valley. The short trees are often Syzygium cumini, Emblica ofﬁcinalis, Gmelina arborea and Semecarpus anacardium besides Glochidion assamicum. The grass in such savanna consists of Imperata, the dominant grass, with Saccharum spontaneum, Ophiuros and Vetiveria.

Cachar and Eastern Hilly Semi-evergreen Forests

By typology, the semi-evergreen forests of this category are known as ‘Cachar tropical semi-evergreen forests’, but since they extend to the hilly area of Manipur and Mizoram, additional area like Eastern Hilly areas is included. Many of these forests could also be included in the category of deciduous forests as there is no sharp demarcation line between the two and they often overlap and are named subjectively by the investigator or a silviculturist. S uch forests occur in the lower slopes of Cachar Hills, in parts of Barak valley, Manipur, Mizoram Hills and the Hills of Tripura. In Cachar Hills, these semi-e vergreen forests have a ﬂoristic composition marked by the following: (1) Artocarpus chaplasha, (2) Dipterocarpus turbinatus, (3) Palaquium polyanthum , Eugenia spp., Vitex peduncularis , Pterospermum acerifolium , Melocanna bambusoides and evergreen shrubs. In eastern Manipur, the forest is dominated by Dipterocarpus tuberculatus, and Artocarpus chaplasha is virtually absent. The ﬂoristic composition of Manipur and Mizoram semi-evergreen forests is as follows: Dipterocarpus turbinatus, Dipterocarpus tuberculatus, Melanorrhoea usitata, Duabanga grandiﬂora, Dillenia pentagyna, Lagerstroemia parviﬂora, Terminalia tomentosa, Gmelina arborea. Since the semi-evergreen and deciduous forests have been subjected to repeated jhuming, many areas have degenerated into bamboo brakes with scattered trees. The following species of bamboo thrive in these areas: Melocanna bambusoides, Teinostachylum dulloa, Bambusa balcooa.

* 1. **Tropical Moist Deciduous Forests**

Also known as very moist Sal-bearing forests, moist areas having sal (Shorea robusta) are different from the sal areas with moderate rainfall as in Madhya Pradesh. In the North-East region, areas with 2,000–5,000 mm carry these forests. Such forests are distributed on the lower slopes of the Himalayas, i.e. sub-Himalayan region of Bhabar and Tarai plains, in Garo, Khasi and Jaintia hills of Meghalaya and in Karbi-Anglong district. In Khasi Hills, these occur at altitudes ranging from 150 to 650 m, i.e. upper parts of the Khasi foothills. Sal in this area occurs in pure stands, or as a dominant element, among the mixed deciduous species, mainly on ridges. Typical associates of sal are: Shorea robusta (principal tree), Schima wallichii ( Mukna Sal – Assamese), Adina cordifolia ( Haldu – Hindi, Bonglong , Raghu – Assamese), Premna spp., Dendrocalamus hamiltonii.

The foothill forests of Khasi Hills extend lower in Kamrup and Goalpara districts, where the ﬂ oristic composition is the same as above, with some more species like Gmelina arborea, Dillenia pentagyna , Vitex peduncularis and Terminalia bellerica. In the depressions, Dendrocalamus hamiltonii occurs in profusion. Moist sal also occurs in western part of Assam in Goalpara division and elsewhere. Such forests also occur in lower Bhabar and Duar region. Sometimes, the sal trees are more scattered and appear to occur in a savanna context, besides the Imperata cylindrica grass, other trees that occur are Careya arborea, Emblica ofﬁcinalis, Wrightia tomentosa and Randia.

Eastern Hillock Forests

These are high-level riverine forests of Assam with a rainfall of about 1,500 m, where the trees experience some moisture stress during summer. These grow on light soils. The principal elements in these forests are Terminalia myriocarpa and Lagerstroemia speciosa with accounting for 40–45 % of the trees.

**1.4 Sub-montane Hill: Valley Swamp Forests**

Creeper Swamp Forests

Low-lying site in Brahmaputra valley at 150–200 m ASL with heavy soil in very moist and low-lying area is dominated by creeper swamp forests. These are thick impenetrable forests with trees less than 10 m high supporting a mass of creepers and are overgrown by them. These contain pockets of Phragmites and patches of Cephalanthus. The forests have the following composition: Magnolia grifﬁthii, Litsea spp., Quercus listeri, Altiginia. At places these Machilus gamblei and Syzygium cumini are also found.

Tropical Seasonal Swamp Forests

Besides the creeper forests, there are seasonal swamp forests. These are usually named by silviculturists as Altiginia – Machilus – Syzygium forests. A typical forest of this type is Sonebheel forests in Cachar which carry Barringtonia acutangula.

Eastern Dillenia Swamp Forests

These are dense forests of medium height and are known as inundation forests, which get inundated during high ﬂoods. These occupy heavy Khurkani soils on ﬂat surfaces ﬂooded during wet season. The principal associations of the species are Dillenia – Bischoﬁa and Dillenia – Mesua.

**1.5 Eastern Wet alluvial Grassland**

This kind of forest is formed by treeless grassland, in areas of cut-off meanders, river islands and low alluvial sites. These occur usually in the eastern part of Assam valley. These are well ﬂooded during monsoon with about 3-m deep water. In summer, the stiff heavy soil (Khurkani soil) dries out completely. With a very severe condition for tree growth, the grasses grow rather well. Such forests are also subjected to annual ﬁre that stops the progression that could take place. Kaziranga Sanctuary is an example of this type. The grasses usually consist of Phragmites and Saccharum procerum. These attain a height of 5 m or more, are very dense and provide a protection and a hiding ground to wildlife, particularly the unique one-horned rhinos and elephants.

**1.6 Subtropical Broadleaved Hill Forests**

 These are divided into two groups: 1. East Himalayan subtropical wet hill forests, 2. KhasiHills subtropical wet hill forests. In the latter category, the hills of Manipur, Nagaland, Mizoram and Tripura are also included.

East Himalayan Subtropical Wet Hill Forests

In Arunachal Pradesh, this type could also be called montane subtropical forests. These occur on the lower slopes of Eastern Himalayas at a height of 1,000–2,000 m. These are evergreen forests with occasional deciduous species. The trees attain a height of 20–30 m, but seem to reach a height of 50 m. The canopy is less dense than the tropical evergreen forests. Shrubby undergrowth is always present. Grass is absent and bamboo is not seen, but climbers are numerous.

Floristoc: These forests are characterised by oak and chestnut. These two species are always present with other temperate trees; they are Alnus (alder), Prunus (prune) and Betula (birch). Schima terstroemiaceae is very characteristic throughout its range, and extends downward to the tropical forests. Occasional Dipterocarp or Shorea may be seen but are rare. Pinus are either absent or conﬁ ned to drier areas or welldrained ridges. In Manipur these broadleaved forests occur between 800 and 1,100 m altitude. The ﬂ oristics here are deﬁ ned by Quercus – Laurus – Schima – hylium combination. D. B. Deb has found the following composition in the Langool Reserve. The ﬂoristic composition is as follows: Lithocarpus spicatus , Quercus vercus ( fenestrata ), Quercus serrata , Castanopsis , Schima , Cinnamomum , Saurauya (spp.), Litsea spp., Machilus , Syzygium and Cedrela toona.

Khasi Subtropical Wet Hill Forests

Subtropical wet hill forests include hilly parts of Manipur, Shillong plateau evergreen forests and Tripura montane subtropical forests. These are dense evergreen forests of no great height, rarely exceeding 30 m in height with smooth cylindrical boles and branches making the crown. A second storey is hardly discernible in these forests, and there is a variable growth of shrubs. Here, forests have a heavy growth of epiphytes, mosses, ferns and phanerogams. The distribution of these broadleaved forests is conﬁ ned to upper slopes of Khasi and Jaintia hills and the higher reaches of Garo Hills, usually above 1,300 m.

Floristic Composition: Oak and its varieties ( Quercus spp.) are accompanied by Manglietia insignis , Beilschmiedia , Cinnamomum spp., Machilus spp., Schima khasiana and Bucklandia . The richness of the ﬂora is remarkable, and the main reason is that it represents a mixture of both tropical and temperate ﬂoras. There are no tree ferns.

Sacred Groves and Richness of Flora in Meghalaya

The richness of ﬂora of these subtropical wet hill forests is well preserved in the sacred groves of which as many as 79 are recorded (Tripathi, 2005). These sacred groves known as ‘Law Kyantang’, ‘Law Niam’ and ‘Law Lyngdoh’ in Khasi Hills; ‘Khloo blai’ in Jaintia Hills; and ‘Asheng Khosi’ in Garo Hills are under the control of clan councils or local village Durbars or Syiemships or Dolloiships or Nokmaships. More than 12.5 % of these sacred groves are undisturbed with 100 % canopy cover, 25 % are dense with more than 40 % canopy cover and 20 % are sparse (10–40 % canopy cover), while 42.5 % of the groves are highly degraded. The richness of the original ﬂora on Meghalaya plateau, as it was before being subjected to anthropogenic impact, is evident from the fact that the ﬂora in the sacred groves has 514 species representing 340 genera and 131 families (Tripathi 2005). The most representative forests of Meghalaya plateau can be seen in these sacred groves and the Nokrek Biosphere Reserve in Garo Hills area. On Meghalaya plateau, shifting cultivation has greatly changed the original forest cover, presumed to have been broadleaved with or without pine. Similarly, considerable areas of open grassland, with scattered trees and adjoining pine or broadleaved forests in Nagaland Hills, are completely transformed into treeless grassy hilltops. Clearly, these are degraded and denuded forests, following centuries of shifting cultivation.

**1.7 Subtropical Pine Forests**

 These forests are very similar to Himalayan pine forests. These are very frequently subjected to ﬁre caused by local communities who are ever on look out for some land for shifting cultivation. These occur in Khasi Hills, Naga Hills and Manipur. These often grow on well-drained sandy soil. Near Shillong such forests occur in red soils. The observation of the present author is that the well-drained red soil, as seen near Shillong, has resulted from the weathering of Shillong group of rocks largely composed of quartzite. Such forests, though largely cleared, can still be seen on the campus of the North-Eastern Hill University. The variety of pine that occurs in Khasi Hills, Naga Hills and Manipur is Pinus insularis widely known as Pinus khasya. These occur as pure stands, as seen on granite hills or in association with other trees. Though known typically as pine forests, other ﬂoral associates also occur. Collectively these forests are ﬂoristically known as Pinus – Quercus formation, greatly impacted by anthropogenic causes.

**1.8 Montane Temperate Forests**

This zone incorporates the Eastern Himalayas, largely Arunachal Pradesh and parts of Manipur and Nagaland. In the description given below, Eastern Himalayas refers to the area above.

East Himalayan Wet Temperate Forests

I n Arunachal Pradesh, such forests occur between 1,750 and 2,750 m altitude ASL and upper levels in Manipur, Nagaland and Mizoram. There is an altitudinal zonation, and three typical species occupy three altitudinal zones. The altitudinal zone and the predominant species are as follows:

 Altitudinal zone (m) Predominant species

1,800–2,100 Lauraceae , Laurel ( Machilus michelia )

2,100–2,400 Quercus lamellose

2,500–2,750 Quercus pachyphylla

These often overlap with variations in altitude and topography. In Aka Hills, in Arunachal, the most common association is Quercus– Michelia – Acer– hylium (Bor 1938) . Similar association of trees also exists in Manipur at an altitude of 1,800–2,400 m ASL, with 3,500 mm of rain. Quercus at higher altitudes is often associated with Rhododendron arboreum . In Nagaland, on higher hills, along the Nagaland–Myanmar border from 1,800 m ASL upward, wet temperate forests are found. Though on more rounded rolling plateau lands, the forests are broken by grassland, especially in areas with less than 2,000 mm of rains.

**1.9 Eastern Himalayan Moist Temperate Forests**

 These according to altitude and character are subdivided into: (a) East Himalayan mixed coniferous forests (b) Abies delavayi forests.

East Himalayan Mixed Coniferous Forests

They occur at altitudes ranging from 2,300 to 3,000 m, with rainfall of 1,500–2,000 mm. It is also given the name Oak Rhododendron– Tsuga– Abies– hylium forests. This type is formed by dense evergreen forests with oak and rhododendron, with clusters of hemlock varying in extent on drier ridges. Hemlock (Tsuga) gives way to silver ﬁr at higher levels. In these forests, mixed deciduous trees, such as magnolia, acer and betula, are also found with oak. There is occasionally a dense undergrowth of bamboos and abundance of epiphytes. In Mishmi Hills, ferns are abundant sometimes attaining a height of 6 m. Oak in a mixed coniferous type of forest occupies a portion midway between the wet and moist temperate forests.

Abies delavayi Forests

A species of ﬁr, Abies delavayi believed to be a Chinese species, common in Szechuan province, occurs in pure stands conﬁned to the northern slopes of the mountains, limited to a zone between 2,750 and 3,350 m altitude. Abies shows a height of 20 m possessing a girth of about 2 m.

Variations Because of Edaphic Control and Seral Types

In the general category of moist temperate forests of Arunachal, there are variations caused by soil conditions or variations representing a stage in succession, called seral type.

Cypress Forests: These occur in the middle ranges (1,800–2,800 m ASL), highly localised usually in limestone areas.

Alder Forests: Commonly found at 1,800–2,000 m ASL, they have been reported by Bor. The association of trees given with alder is: Populus, Alnus hylis, Fraxinus ﬂoribunda, Prunus nepalensis, Michelius edulis with occasional Pinus wallichiana. There are also blue pine forests on the foothills of Bhabar region.

**1.10 East Himalayan Dry Temperate Forests**

 The dry temperate forests of Arunachal Himalayas occur in areas with less than 1,500 mm of rainfall, usually at a height of 2,700–3,400 m ASL. These are mixed coniferous forests consisting largely of hemlock and spruce and varying amounts of blue pine, silver ﬁ r and juniper with species of rhododendron. The ﬂoristics of the dry temperate forests is as follows: Pinus spinulosa – dominant species Pinus wallichiana, Tsuga dumosa, Juniperus wallichiana, Rhododendron spp.

Larch Forests

Larch forests occur associated with conifers above 3,000 m ASL, usually near moraine area, in relatively open patches: Floristically the following species are common: Larix grifﬁ thiana – larch dominant species Pinus wallichiana, Abies, Piceae, Tsuga and Rhododendron.

Eastern Himalayan Dry Juniper/Birch Forests

Juniper and birch occur at still higher levels ranging in height from 2,800 to 4,500 m. The species most common in this zone in Arunachal Pradesh are: Juniperus wallichiana, Juniperus macropoda. Junipers here don’t exceed 15–18 m in height. In some areas, above 3,000 m, Hippophae myricaria scrub, usually 3–6 m high, occur on gravel deposits and even colonise earth slides.

East Himalayan Sub-alpine Birch–Fir Forests

Above 3,000 m in the sub-alpine region, only these species survive. These are ﬁ r, birch and rhododendron, with occasional stunted Quercus semecarpifolia.

**1.11 Sub-alpine Pastures**

There are grasses making pastures in the sub-alpine region with very few trees of silver ﬁ r and spruce. The grasses in high altitude pastures in Arunachal Pradesh close to the Indo-Tibetan border consist of the following species: Agropyron longearistatum, Agropyron semicostatum, Brachypodium sylvaticum, Bromus asper, Bromus japonica, Dactylis spp., Danthoria spp., Festuca spp., Milium effusum, Oryzopsis, Phleum. These are the grazing grounds of the pastoral people in high Himalayas.

**1.12 Moist Alpine Scrub (3,000 m ASL and Above)**

Birch–Rhododendron Scrub Forests

These are low evergreen forests almost entirely of rhododendron sp. with some birch and a few other deciduous trees. The stems of these trees are bent because of snow pressure during winter. These stunted trees are not more than 60 cm in girth. Moss or ferns cover the ground with shrubs and ﬂowering herbs. In areas with heavy snowfall, a thick layer of black humus is usually present. The species that represent scrubland are Betula utilis (Himalayan birch) Rhododendron campanulatum and Sorbus foliolosa.

Dwarf Rhododendron Scrub

Further up, above 3,500 m ASL, the rhododendron thickets become a dwarf, attaining a height of 1.5–3 m in clusters of dense thickets in small patches. Rhododendron is mixed with various proportions of Sorbus foliolosa below. These rhododendron scrubs, though dominant between 4,600 and 5,000 m, ascend up to 5,500 m. The highest belt is occupied by Rhododendron lepidotum and Rhododendron hypenanthum . Rhododendron nivale occurs on rocks and glaciers.

**1.13 Dry Alpine Scrub**

These usually occur in the trans-Himalayan region with rainfall below 400 mm, as in Tibet. The characteristic plants in this region are Eurotia ceratoides which provide winterfat for grazing animals and fuel wood and thus are endangered. Juniperus wallichiana and Juniperus communis occur on the Tibetan side. Dwarf juniper patches are seen on the Indian side occasionally. Juniper is not eaten by grazing animals and is thus surviving.