
The
Forests
of
Burma

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THE FORESTS OF BURMA

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The forests of Burma are one of its greatest natural resources because they cover large areas and many of the trees and other plants in them have been used for timber, fire wood, and many other products. The forests are also useful because many of them are important in the conservation of water, soil, and animal life resources. The kinds and conditions of the forests and other woody vegetation need to be known so that they will be more properly used, managed, conserved and enjoyed by the people of Burma. Botanical information about them and an understanding of the climatic, soil, water and other conditions of the habitats of each type are needed, particularly by students of biology, agriculture, and forestry, so that they may do their part in using, managing and conserving these great resources. The following is a short compilation of information about the botanical and environmental features of the various types of forest and other woody vegetation that the writer hopes will be useful to both students and other citizens of Burma.

The information was compiled from many published sources, Government records, and by the aid of a number of persons. Mr. H. G. Hundley, assistant to Chief Conservator of Forests and U Aung Khin Hla, Director, Burma Forest School, Maymyo, gave much help and advice.

The Ford Foundation and the University of Florida, Gainesville, Florida, United States, very generously supplied the funds and other facilities that enabled me to live in Burma nearly two years and travel to some regions. They also helped me prepare the manuscript, map and photographs, and arrange for the publication.

First there will be a brief description of the geographical, climatic, topographic, soil and other features and habitat conditions of Burma that have a direct influence on the development of the types of forests. Then a classification of the major types and some of the minor types of forest and other woody vegetation is presented. This is followed by descriptions of these. All the details of each are not given because doing so would require a much more extensive publication. Those interested in more details may find some of them in the references cited later, and by consultation with foresters and botanists in Burma. The botanical sci-

entific names are used to insure better accuracy and for international reference. Burmese names of some are used in parts of the text and in the botanical index.

SETTING

The Union of Burma extends from 10 degrees north of the equator to north of 28 degrees and is in both the tropical and temperate zones, and the climate is tropical to temperate. It has distinctly different lowland and upland regions. The mountains cause many differences in temperature and rainfall.

The prevalent monsoon rainfall type of climate and the mountains cause great seasonal and other differences in rainfall and other precipitation. The variety of soils and rocklands, and the different conditions of surface drainage of water, soil water, and standing water affect all the vegetation and agriculture. The great variety of forests and other woody vegetation are the result of these conditions and the activities of man, among which the most common are fire, extraction of logs and other forest products, and clearing for crop cultivation. These human activities have changed much of the vegetation, but enough remains for Burma to have nearly half of the country in some type of forest. But probably half of this half has been altered.

The types of forests are both natural and altered. They are distinctly different in their composition of trees and other plants, form of growth of the plants and their seasonal habits, and in the conditions of their habitats. The types that are distinguished in this description are based on both the conditions of the habitat and the important species of trees and other plants, such as bamboos. Full details of all species present in each type are not given because this is not necessary to understand the types. Those interested in such details may use the references to get more botanical information. The references and other descriptions of forests are recommended, but many of them are not available, and some of the publications are not as comprehensive as this paper, especially for the forests of northern regions.

Burma has a north-south extent of about 1,300 miles and it is nearly 500 miles wide in the central part. Mountains trend southward from the high

Himalaya range in the north and flank both sides of the broad valley of the Irrawaddy River system, and also flank the Salween River valley. They extend southward into the Tenasserim peninsula. In the northern Kachin State some of these mountains are over 10,000 feet elevation and one is over 18,000 feet. There are distinct zones of temperature on these mountains. The climate is temperate at the high altitudes, subtropical at medium altitudes, and tropical over the low mountains and hills and the lowlands. These temperature zones are the primary cause of the development of three general types of forests; (1) Temperate, (2) Subtropical, and (3) Tropical.

The southwest monsoon rains occur over most of Burma from June through September and, after the rains, there is a long season of drought of many areas. There are also some regions where rainfall is general throughout the year. The annual amount varies from as much as 200 inches to as little as 20 inches. The Arakan Yomas and Chin Hills on the west and some of the other mountains, such as parts of the Pegu Yomas, intercept the moisture laden south-western monsoon winds and receive abundant rainfall. This interception has caused the development of a central dry zone which is in the rain shadow of these mountains. The rainfall in this dry zone is usually less than 40 inches a year, and the dry season is usually over 6 months long. It extends from Thayetmyo north to Shwebo and is mainly over the valley and plains of the Irrawaddy River basin. In the dry zone there are many xerophytic types of vegetation of which the semi-desert *Euphorbia* scrub and the sha or *Acacia* thorn type scrub forests are widespread.

Surrounding the dry zone the rainfall is more and the dry season shorter, and less xerophytic forests occur. Many of these types are dominated by deciduous species of trees. Rainfall over most of the year and other favorable conditions of moisture occur outside these two central regions and on the favorable areas are the dense forests of both evergreen and deciduous trees. The most evergreen and densest forests are where rainfall is over 100

inches a year or where surface water is abundant. These are the rain forests and swamp forests. There are both tropical and subtropical types of these rain forests.

Although rainfall, surface water, drainage of water and soil water are important the temperature conditions on the mountains also determine the type of forest, scrub forest or scrub. The high mountains have cold winter seasons and vegetation of temperate zone species. The mountains of intermediate height and the middle elevation areas on high mountains have some cold to cool winter conditions and their climate is known as subtropical. The lowlands and lower mountain areas and the low hills have no frosts or distinctly cool winter conditions and support tropical types of vegetation. These effects of temperature have most affect upon the species composition of the forests. The tropical species are distinct from the temperate species and the two types are not adjacent. The subtropical types have many species common to both temperate and tropical types. Subtropical forests occur in northern regions over relatively low mountain regions and high valleys. In all three major types of vegetation, the Tropical, Subtropical, and Temperate, the forests are composed mostly of species of Dicotyledon trees that are known as hardwoods. There are also conifer forests, of pines especially. Some of the pine forests are natural and some are probably due to fire that has been used in the practice of shifting cultivation by many people. The fir and spruce forests of the high mountains are a temperate climatic type. Pine, fir and spruce forests compose the conifer types.

The following classification of the major types and minor types or subtypes of the forests and other woody vegetation is based on the conditions of the habitat, outlined above, on the tree species frequently present, and on the evergreen or deciduous leaf habit of the trees. The classification is not complete because the bamboo and cane vegetation is not stressed. Some of the subtypes of hardwood forests and scrub forests that are recognized by other writers are not described.

CLASSIFICATION OF TYPES OF FORESTS AND OTHER WOODY VEGETATION

I. TROPICAL

- A. Evergreen Hardwood Forests
 - 1. Rain Forests
 - 2. Coastal Mangrove Swamps
 - 3. Inland Swamp Forests

- B. Mixed Evergreen and Deciduous Hardwood Forests
 - 1. Lowland Forests
 - 2. Upland Forests

C. Dry Deciduous Hardwood Forests, Scrub Forests, and Scrub

- 1. Indaing (*Dipterocarp*) Forests and Scrub Forests
- 2. Dry Upland Hardwood Forests and Scrub Forests
- 3. Dry Scrub Forests and Semi-desert Scrub
 - a. Than-Dahat Scrub Forests
 - b. Sha (*Acacia*) Thorn Scrub Forests
 - c. Te (*Diospyros*) Scrub Forests
 - d. Semi-desert *Euphorbia* Scrub

II. SUBTROPICAL

- A. Hardwood Rain Forests
- B. Mountain Forests and Scrub Forests
 - 1. Moist Hardwood Forests
 - 2. Dry Hardwood Forests and Scrub Forests
 - 3. Pine Forests

III. TEMPERATE

- A. High Mountain Hardwood Forests
 - 1. Wet Hardwood Forests
 - 2. Moist Hardwood Forests and Scrub Forests
- B. High Mountain Conifer Forests
- C. High Mountain Subalpine Scrub

There are other more detailed and elaborate classifications and descriptions of the forests, of which those by Kurz (1875), Troup (1921), Stamp (1925), Champion (1936), Edwards (1950) and Richards (1957) were used in preparing this description. The Report of the 1953 Conference of Conservators of Forests, Union of Burma, the writings of the botanical explorer Kingdon Ward about northern Burma, and his forest classification (1944-1945), and the pamphlet by Morehead (1956) were also used. The 1956 publication "Forest Types of Burma" by the Chief Conservator of Forest is the latest classification. All of these are recommended to the readers who wish to increase their information.

THE TYPES

Forests are vegetation dominated by tall trees that form a closed canopy or nearly closed canopy, which canopy is usually over 60 per cent cover. Most of them have a layered or stratified structure of woody plants of different heights. The density of the plant population is greatest in the Tropical Evergreen Rain Forest where lianas, epiphytes, and palms grow in abundance with the hardwood trees. The Subtropical Lowland Hardwood Rain Forest and the Temperate High Mountain Hardwood Forests are also dense assemblages of many species of many forms of growth. The other forests are usually of less dense growth, have fewer species, and have fewer forms of growth of the plants. The classification of mixed evergreen and deciduous, and of deciduous types of forests is based on the characteristics of leaf fall of the common trees. Most of these forests are less dense than the evergreen types. The dry climate deciduous types have leaf fall during the dry months and generally have an open canopy that is less than 50 per cent cover. Some of these are so open that they are a woodland or savanna type vegetation. The pine forests and the other conifer forests of mountain regions are evergreen. Many of the pine types are open stands that are woodland or savanna types. The High Mountain conifer forests of spruce and fir are usually dense stands.

Scrub forests are vegetation of lower stature trees than in the true forests, and usually the trees are widely spaced. There are numerous subtypes recognized on the basis of a few species, such as *Dipterocarpus* (indaing) subtype scrub forest and the *Diospyros* (te) subtype. Some subtypes are thorny xerophytic trees and shrubs, such as *Acacia*, growing in seasonally dry areas on soils that retain very little water. There are five subtypes of tropical scrub forest and one subtropical type. The lack of rainfall, high summer temperatures, and dry soils usually cause their development.

The scrub types and subtypes are the lowest stature form of woody vegetation. Woody plants are only a part of these communities because there are often fibrous and succulent or cactus-form plants, such as the very prevalent species of *Euphorbia*. Thorn trees and shrubs are common, and some of the hard, bunch grasses are locally abundant. Scrub types have replaced many of the scrub forests on disturbed and burned areas. Also scrub forests have replaced some dense canopy forests on areas altered by man. Much clearing and other alteration of the forests is due to the system of *taungya*, or hill cultivation under which forest areas are cleared and burned, especially in the mountain areas. Both of these forms of woody vegetation are increasing rapidly. The other form of vegetation increasing in area is the bamboo thickets. All of these secondary types are relatively less useful and valuable than the primary vegetation they replaced. Conservation over a long period would attempt to retard this change, and in some areas there could be a redevelopment of the original forest type.

The three main tropical types, Evergreen, Mixed Evergreen and Deciduous, and Dry Deciduous are all composed mostly of the hardwood (Dicotyledon) trees and shrubs of genera and species common in tropical areas of Asia. The Evergreen type is not as extensive as the Mixed Evergreen and Deciduous type because regions of rainfall over 80 inches a year and without long dry periods cover less area than regions of less rainfall and longer dry periods. The Tropical subtypes of Mangrove Swamp and Inland Swamps are not climatic. They depend upon the depth, duration and salinity or lack of salinity of surface water for their development. Rainfall, except as it furnishes flood water, does not greatly influence them. In contrast, the Rain Forest type is notably a climatic climax. It is very typical of the wet lowlands or low mountain regions of the world. However, only scattered original or natural areas of this type occur in Burma because most of them have been much altered by timber extraction.

The forests of the medium rainfall areas are the Mixed Evergreen and Deciduous type, of either the Lowland or Upland subtypes.

Some of the upland forests have over 90 inches of rainfall but drainage of water off the areas and the shallow soils cause dry habitat conditions. Both

the Upland and Lowland subtypes are noted for the abundance of teak or kyun (*Tectona grandis*) and several of the other important timber trees. For this reason large areas of this type have been thinned and partly deforested. However, large areas are now under good forest management, which will insure their continuance. Consequently, these forests will probably remain as the most widespread and useful in Burma.

The third tropical type is composed of forests, scrub forests, and scrub vegetation of dry habitats. Extensive areas of the subtypes that compose this general type occur in all regions on a great variety of sites at altitudes below the medium high uplands. Many of sites of these subtypes have dry soils, excessive water drainage, and a long dry season. This general type and its subtypes are both climatic and edaphic. Hot dry conditions prevail for six months or longer. The forest subtype of tall trees occurs where sufficient water is retained in the soil to promote taller tree growth and a greater density of crown cover of the trees than in the scrub forest subtypes. The scrub forests and the scrub vegetation are on the sites of distinctly dry soils or in areas of very low rainfall, or both. Some scrub subtypes have succulent forms of shrubs and some shrubs that are evergreen.

The Subtropical types do not cover so large areas as the Tropical types because they are confined to the slopes and tops of mountains and some of the high valleys at altitudes where low temperatures occur during winter months and cause a distinct season of dormancy of tree growth. These areas covered by them are not large regions but usually elongated zones on the slopes of the mountains. In the northern regions in the high valleys of the Chindwin and Irrawaddy river systems there are forests of mixed composition of both tropical and temperate affinity trees that are the Rain Forest Subtropical type. Rainfall, clouds and fog create wet conditions.

The Subtropical Moist Hardwood or Dry Hardwood Forests and a few Dry Scrub Forests are generally on either well watered moist habitat sites or on dry habitat sites. Both are above altitudes from 3,000 feet in northern areas and 5,000 feet in southern areas. They extend up mountain areas to the altitudes where winter frosts are common and the Temperate forest types occur. The well watered sites are generally on windward slopes or in narrow valleys. The dry sites are often on the leeward slopes of mountain ridges and in the rainshadow of the monsoon rains, or they are on excessively drained and dry soil areas, especially on dry ridges.

The Subtropical Mountain Pine Forests occur over a wide range of altitude in the mountain regions and usually on seasonally dry sites. Many of these occur in the Shan States and Chin Hills over terrain that is similar to that supporting the Subtropical Mountain Hardwood Forests. The origin of these pine forests is a puzzle not yet solved. Some

forests may be due to many fires and other past alterations by man that gradually eliminated the species of hardwoods. But some of the forests show no evidence of this past history and may be natural vegetation. Once established the pine forests are not easily replaced by hardwood trees, even in areas where there are not repeated fires.

The Temperate High Mountain Forests, Scrub Forests, and Subalpine Scrub are distinctly confined to regions of winter cold and are composed of tree and shrub species common to high mountains and cool to cold temperate lowlands. There are numerous species of the genus *Rhododendron* and some fir, spruce, hemlock and other conifers. Oaks, chestnuts, maples, magnolias and other temperate genera abound. Some of the trees and shrubs are evergreen but many are winter deciduous. These forests extend up to elevations where tree form plants do not grow, which is usually known as the "timber line." Near this timber line on the highest elevations the temperate forest and scrub forest types give way to a scrub that is known as the Subalpine Scrub. Shrubs and herbs form this nearly alpine or arctic vegetation. Above this scrub and usually in or near the snow fields is the Alpine vegetation composed mainly of summer herbs.

The accompanying map shows the regions covered by the major or general types of forests, scrub forests and scrub. But areas of particular subtypes are not shown. The Central Dry Zone is shown as a region and not a type of vegetation. In it occur Dry Forests, Dry Scrub Forests and Semi-desert Scrub. The areas of Subtropical types are not clearly shown because many of them are small and widely scattered over mountain terrain in the Shan States, Chin Hills and other mountains. The subtropical and temperate forests and other vegetation in northern Burma are shown as nearly regular zones on the mountain ranges. The coastal mangrove swamps are only a narrow fringe along most of the coast and are not shown except in the Irrawaddy Delta region.

Cultivated areas cover many parts indicated as forest and other vegetation, but these areas are not shown because doing so would make the map too confused. The reader should refer to maps showing the large cultivated areas. Also the areas of the Reserved Forests are not shown, but can be obtained from the Union of Burma Conservator of Forests maps. Nearly 40,000 square miles have been set aside as reservations, and these are being extended. Reserved Forest areas occur in the regions of nearly every type shown on the map. In addition there are forest lands at the disposal of the Government which cover a total of nearly 115,000 square miles. Working plans have been made for nearly all these forest areas and most of them are being well managed. This means that the better types of forests and some scrub forests will be well managed in Burma. This will insure the preservation of representative areas of nearly all the types described here.

FVFRGRFFN TROPICAL FORTSI 5

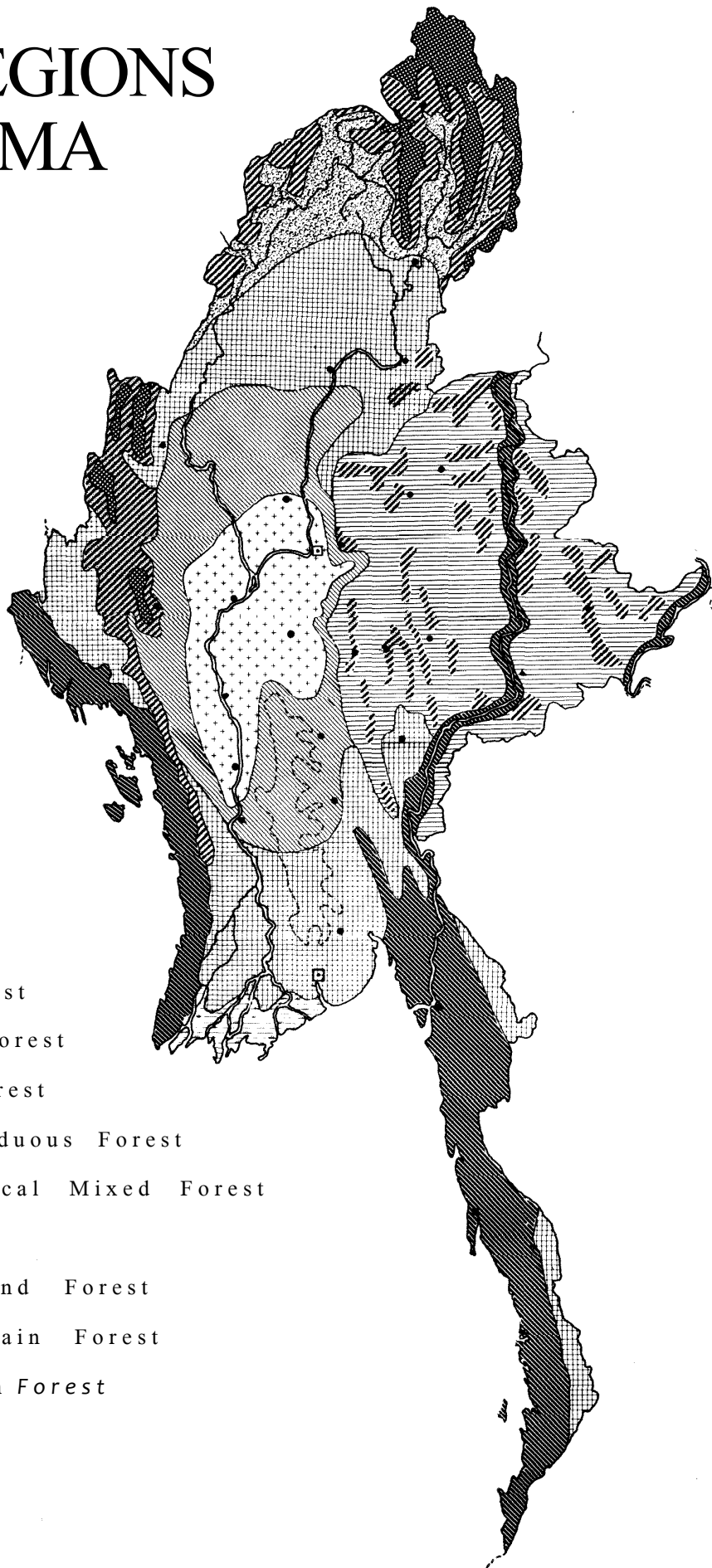
RAIN FOREST: Climax tropical forests of this type occur in three general regions of Burma: (1) the Tenasserim southern extension which projects south to about 10 degrees north of the equator, (2) in areas south and southwest of the central dry zone where annual rainfall is about 100 inches or more per year, and (3) in the warm areas north of the central dry zone where rainfall is about 90 inches

per year or more. The common species of trees in each of these three regions are not greatly different, and the forest structure and density of growth in each area is very similar. A great number of the tall, dominant trees of the canopy belong to the same genera or families in all three regions. However, there are some significant differences in species and these are given in Table I.

I ABLE 1

Botanical Name	Common Species of Trees and Bamboos in the Tropical		Rain Forest	
	Burmese vernacular	serim	Tenas-Southern name	Northern Region
Acrocarpus fraxinifolia	yedama			X
Anisoptera glabra	thingadu		X	
Artocarpus chaplasha	taungpeinne		X	
Artocarpus lakoocha	myauk-lok	X	X	X
Baccaurea sapida	kanazo	X	X	X
Calophyllum tomentosum	pon-nyet	X	X	
Caryota mitis	minbaw	X	X	
Caryota urens	kyauk minbaw		X	X
Castanopsis spp.	thite		X	X
Cedrela febrifuga	thitkado			X
Cinr.amomum inunctum	karawe	X		
Dipterocarpus alatus	kanyin-byu	X	X	X
Dipterocarpus griffithii	kadut	X		
Dipterocarpus macrocarpus	kanyin		X	X
Dipterocarpus turbinatus	kanyin-ni		X	X
Dysoxylum grande	thigatni		X	
Eleocarpus obtusus	thitpwe			X
Englehardtia spicata	thitswelwe	X	X	X
Eugenia grandis	thabye-gyi	X	X	
Ficus glomerata	thapan		X	X
Hopea odorata	thingan	X	X	
Melanorrhoea glabra	thitsi	X		
Melanorrhoea usitata	thitsi		X	X
Mesua ferrea	gan-gaw			X
Nipa fruticans	dani	X		
Parashorea stellata	thingadu	X	X	
Pentace burmanica	thitka	X	X	
Pentace griffithii	thitsho	X		
Quercus spp.	sagat or thite		X	X
Shorea assamica	kyi-lan		X	
Sterculia campanulata	sawbya		X	X
Swintonia floribunda	taung-thayet	X		
Terminalia myriocarpa	shila		X	
Tetramales nudiflora	baing	X		X
Bamboos				
Cephalostachyum pergracilis	tinwa		X	
Dendrocalamus brandisii	wa-bo	X		X
Dendrocalamus giganteus	wa-bo-gyi	X		
Dendrocalamus hamiltonii	wa-bo myetsangye		X	X
Gigantochloa macrostachya	wa-pyu	X		
Licuala peltata	salu			X
Oxytenanthera nigrociliata	waya			X

FOREST REGIONS OF BURMA



LEGEND

-  Tropical Rain Forest
-  Tropical Swamp Forest
-  Tropical Moist Forest
-  Tropical Dry Deciduous Forest
-  Shan States Tropical Mixed Forest
-  Central Dry Zone
-  Subtropical Lowland Forest
-  Subtropical Mountain Forest
-  Temperate Mountain Forest

EXPLANATION OF MAP

The nine types of forests and regions shown on the map and indicated by the Legend do not designate all of the types of woody vegetation that are considered in the following description because the map is too small to show all the details that would be needed to present every type. The following explanation is to supply information about the types not shown and the forests, scrub forests, and scrub types of the regions shown.

Tropical Rain Forest—These regions include not only areas of Tropical Rain Forest but also some Tropical Mixed Evergreen and Deciduous Forests on the areas having less than 90 inches rainfall. Also the Coastal Mangrove Swamps occur along many parts of the coast, and there are Inland Swamp Forests over river floodplains and other lowlands.

Tropical Swamp Forest—This is the Irrawaddy Delta region where the Coastal Mangrove Swamps are well developed and some Inland Swamp Forests are over interior lowlands. Both of these tropical swamp forests occur in many other areas along the coast and along the river valleys, but most of them are too small to be shown on this map.

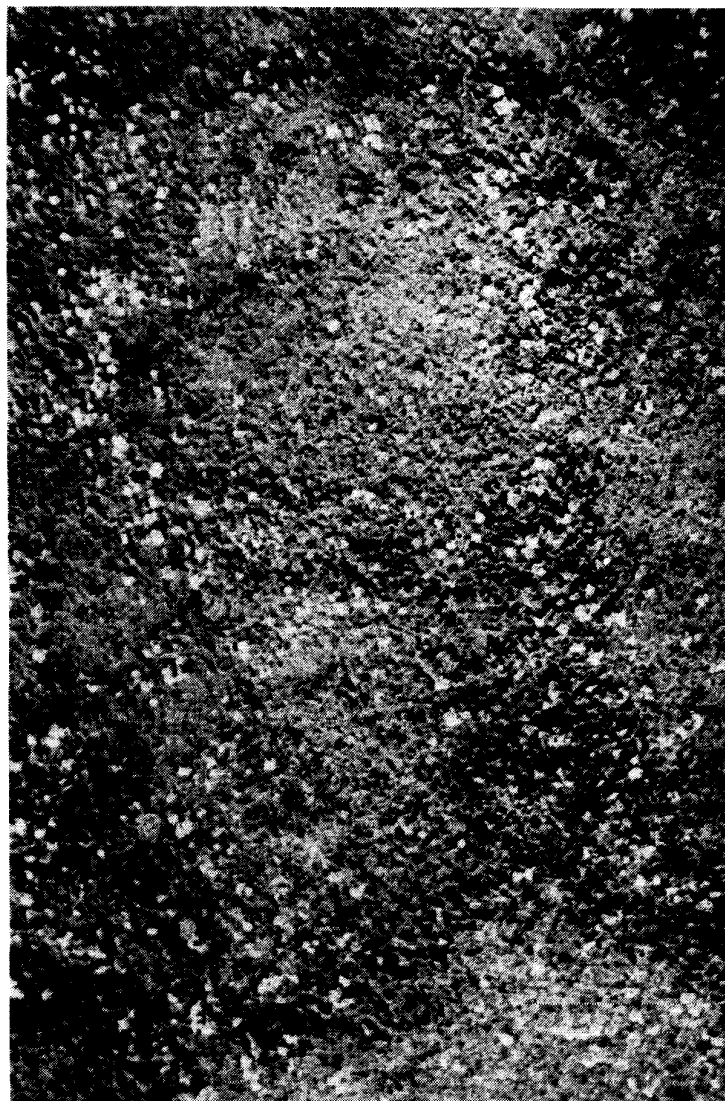
Tropical Moist Forest—These regions south and north of the Central Dry Zone include both the Lowland and Upland subtypes of the Tropical Mixed Evergreen and Deciduous Hardwood Forests. In the northern region some of the northern Tropical Rain Forests occur. Many small areas of both the Lowland and Upland subtypes of the Mixed Evergreen and Deciduous Forests also occur in the region shown as the Shan States Tropical Mixed Forest. Reference to topographic maps will aid in distinguishing between the areas of the Lowland and the Upland subtypes.

Tropical Dry Deciduous Forest—This region around the Central Dry Zone includes many of the subtypes of the Dry Deciduous Hardwood Forests and Scrub Forests, especially areas of the Indaing (*Dipterocarp*), Forests and Scrub Forests, and some of the Than-Dahat, Sha, and Te Scrub Forests subtypes. Some Dry Upland Forests and Scrub Forests are on upland areas, particularly over the northern part of the Pegu Yomas, which range of hills is shown by a broken line. Inland Swamp Forests occur near some parts of the rivers.

Shan States Tropical Mixed Forest—This is a general region of hills and mountains over which many tropical types occur at altitudes below 5,000 feet. The most widespread types are the Tropical Upland Mixed Evergreen and Deciduous Hardwood Forests on areas where rainfall is over 60 inches a year, and the Tropical Dry Upland Hardwood Forests and Scrub Forests where the rainfall is less. Areas of Indaing Forests and Scrub Forests, and some Than-Dahat Scrub Forests also occur. There are some Pine Forests of the low altitude type in which *Pinus merkusii* occurs. The valley of the Salween River divides this Shan States region and in it are Tropical Rain Forests and Inland Swamp Forests.

Central Dry Zone—This region with rainfall usually less than 40 inches a year includes all of the subtypes of Dry Scrub Forests and the Semi-desert Scrub. The Sha (*Acacia*) Thorn Scrub Forests and the Semi-desert *Euphorbia* Scrub are widespread. Some Swamp Forests are along the rivers, and a few

Air view of Tropical Rain Forest showing tall taung-thayet or shittle trees (*Swintonia floribunda*) that appears white due to being in flower. This is a common species of uplands near the coast. Courtesy of the Conservator of Forests.



hills have Dry Upland Hardwood Scrub Forests.

Subtropical Lowland Forest—This region of the Upper Chindwin and Upper Irrawaddy rivers is lowlands and lower slopes of the northern mountains and the rainfall is sufficient over some areas to supply enough water for a Subtropical Hardwood Rain Forest type. Many Subtropical Moist Hardwood Forests are on the low hills and lower mountain slopes.

Subtropical Mountain Forest—These are the subtropical zones on the mountains of northern regions and over much of the Chin Hills and south along the tops of the Arakan Yomas, and on the highest mountains of the Shan States. The Subtropical Mountain Hardwood Forests of both the Moist and Dry subtypes are common at elevations above 4,500 feet. There are also extensive Pine Forests where the *Pinus insularis* is the dominant tree. Dry Scrub Forests and open savanna forests occur in some areas. The whole complex of vegetation is related to topography and rainfall and the map does not show the areas accurately because many of the small areas are omitted.

Temperate Mountain Forest—These areas are only the highest mountain zone of northern Burma

and a few of the highest mountain tops of the Chin Hills. The woody vegetation of these areas is Temperate High Mountain Hardwood Forest of both the Wet and Moist subtypes, High Mountain Conifer Forests, High Mountain Scrub Forests, and the Subalpine Scrub at the elevations where tree vegetation can not survive the cold and snow.

EVERGREEN TROPICAL FORESTS (Continued)

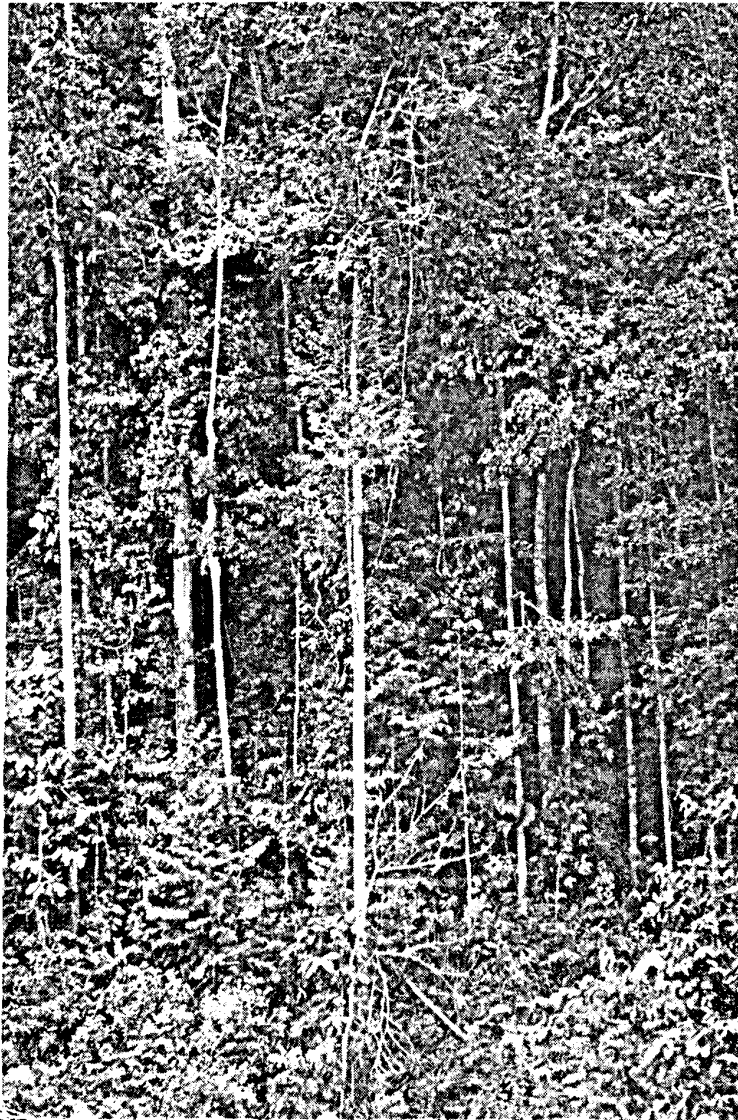
There are many more species in the Rain Forests of each region than are given in the table. Some of the species are not evergreen, such as *Terminalia myriocarpa*, *Sterculia colorata*, and some of the oaks (*Quercus*) and chestnuts (*Castanopsis*). In fact, the winter season condition of some trees becoming bare or nearly bare of leaves increases so much in the northern region that the forests are not as distinctly tropical as in the other regions. Also there are more species of temperate zone genera in the northern region. This region is, therefore, one of transition from Tropical to Subtropical Rain Forest. In parts of regions north of the dry zone there is also a going together of the Rain Forest and the Tropical type that is Moist Mixed Evergreen and Deciduous. These transitional forests occur in areas of rainfall of about 80 to 90 inches a year.

Similarly, in the regions south of the dry zone there are transitions between the Rain Forest of non-flooded areas and the Tropical Swamp Forest type of flooded areas, and also between the Rain Forest and the Lowland and Upland types of Mixed Forests that contain teak as an important species.

COASTAL MANGROVE SWAMPS: The two swamp types of Tropical Evergreen Forest are confined to coastal areas that are on or near the zones covered by tide waters or inland areas covered by river and other flood water. The coastal type is dominated by species of trees that are very tolerant to salt water and saline soil conditions. The trees are generally known throughout the world as mangroves.

In wide, low coastal areas, especially in the delta region of the Irrawaddy River, the Coastal Mangrove Swamps consist of three general zones that vary in form of growth and composition from the tide covered areas inland to areas not flooded by tide water. The outer, most flooded zone is the pioneer vegetation of young small trees that are usually widely spaced. This pioneer vegetation aids in the process of sedimentation which builds

Altered Tropical Rain Forest showing dense growth of small diameter tall trees, all evergreen species. In unaltered Rain Forest there would be larger trees more widely spaced and not so many small tall trees. This area had been cut-over.



up soils to higher levels. The middle zone is a mature forest of a few species of trees. These trees have the aerial prop roots, pneumatophore roots, and viviparous seedlings that are characteristic of mangroves. The inner zone is a transitional forest that contains some mangroves and some trees of the Inland Swamp Forests. The tidal waters and the soils of all the zones vary from very saline to nearly non-saline and the whole series of communities is a halophytic successional type of vegetation. This is a succession because the zones develop in sequence over areas where shores are building up and outward into relatively quiet waters. Such mangrove successions occur in many parts of the tropics along coasts and in estuaries, deltas, and similar low regions.

Some of the frequent and typical trees of the three zones are: Outer Pioneer Zone—*Avicennia officinalis*, *Ceriops rhoxburghiana*, *Sonneratia griffithii*, *Kandelia rheedii*, and *Bruguiera carophylloides*. Middle Mature Mangrove Zone—Some of the full grown trees of the species of the Pioneer Zone and also *Rhizophora mucronata*, *Rhizophora conjugata*, *Sonneratia apetala*, *Bruguiera parviflora*, *Xylocarpus granatum*, *Carapa moluccensis*, and the palm, *Nipa fruticans*. Inner Transition Zone—Some of the typical mangrove trees of the Middle Zone and *Heritiera fo-m.es* on areas only partially flooded, and *Excoecaria agallocha*, *Lagerstroemia speciosa*, *Hibiscus tiliaceus*, and the palm *Phoenix paludosa*.

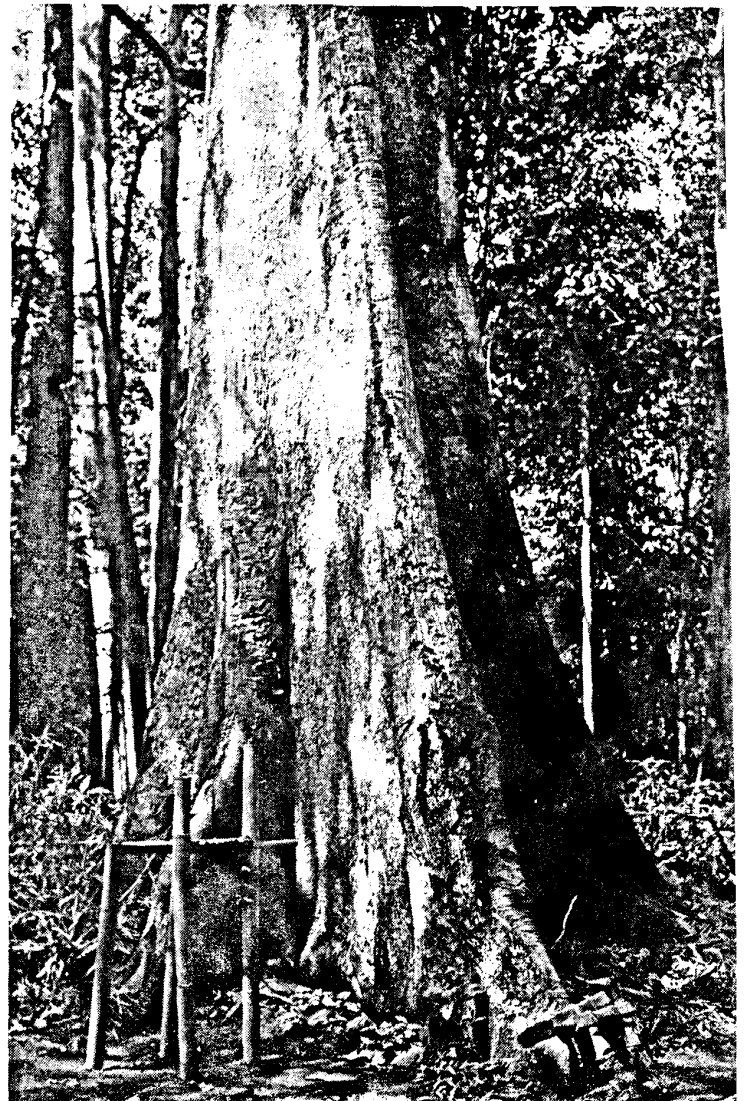
INLAND SWAMPS: There are a great variety of non-saline swamp forests over river valley depressions, bordering rivers and over other lowlands where seasonal or continuous flooding occurs. They are often of very mixed composition and vary from dense forests of tall trees to the open savanna-like types of vegetation. In contrast with the Rain Forest type, the *Dipterocarpaceae* are not frequent. The typical trees are *Lagerstroemia speciosa*, *Elaeocarpus hygrophilus*, *Amoora cucullata*, *Barringtonia acutangula*, *Albizia procera*, *Anogeissus acuminata*, *Fagraea jragrans*, and *Xylia dolabriformis*. The bamboo, (*Bambusa arundinacea*) is locally common. This swamp type is distinct from the edaphic Indaing or Dipterocarp forests that occur in some areas on sand and gravel soils near rivers or in basins.

MIXED EVERGREEN AND DECIDUOUS FORESTS

These are by far the most important forests in Burma because they cover the largest area and supply the best timbers and other forest products.

Leza (*Lagerstroemia tomentosa*) with characteristic buttressed base, in Minbyin Reserve forest near Pyinmana.

They have been the source of much of the teak or kyun (*Tectona grandis*) which is the characteristic species from the lowland plains up mountain slopes to about 3,500 feet altitude. This tree is deciduous during the dry season and a number of the other dominant trees are also deciduous. But there are also evergreen species and some that are semi-evergreen. Therefore, this is a mixed forest as concerns the conditions of leaf fall of abundant trees. In contrast the Tropical Evergreen Hardwood Forests have few deciduous trees, and they are generally denser and have a greater variety of species. This mixed deciduous and evergreen condition is due mainly to less rainfall and surface and soil water than in the Rain Forest and Swamp Forests. Most areas have about 60 to 80 inches rainfall a year and a distinct dry season during the winter months. For this reason they are described as moist or mesophytic rather than as rain or hygrophytic forests. The limited amount of water, especially in the soil, determines some of the species and growth characteristics. It is not as distinctly layered as most Rain Forests or is the canopy as dense. There are fewer epiphytes and palms, and in some areas there





Yon (*Anogeissus acuminata*) in Minbyin Reserve forest near Pyinmana.

This tree is common on alluvial soils in the Mixed Evergreen and Deciduous Hardwood Forests?

(*Cephalostachyum pergracile*) are locally common in southern areas and wabomyetsangye (*Dendrocalamus hamiltonii*) in northern areas. Species of *Dipterocarpus* are not frequent in either subtype, which is one feature that distinguishes them from the Rain Forest type. The following table (Table 2, page 11) is a list of important tree species of this general Mixed Evergreen and Deciduous Hardwood Forest type showing those most abundant on either the lowland or the upland sites and those common on both sites.

DRY DECIDUOUS HARDWOOD FORESTS

SCRUB FORESTS AND SCRUB

This third general type of tropical woody vegetation is more varied than either the Evergreen or the Mixed Evergreen and Deciduous types. The forests are not as dense and the species are fewer, trees, less tall, and almost all of them are deciduous during the dry season. But the greatest differences are the scrub forest and scrub subtypes which cover many of the rough topography and drier sites. They are open stands of low stature trees, and shrubs are plentiful. Bamboos are abundant in some areas, but the bamboo brakes are not described as they are not a woody vegetation. The Indaing or *Dipterocarp* subtype is the best forest of this dry type and occurs in many areas but almost always on gravel or sand soils. Therefore, it is an edaphic rather than a climatic type. It is not uniform in composition of density and size of the trees and numerous subtypes have been named. Most of the other types and subtypes of this general Dry Deciduous type are also characterized by the abundance of only a few species, and some of them bear the name of the abundant plants, such are the *Acacia* or Sha Thorn scrub, the *Diospyros* or Te Scrub Forest and the *Euphorbia* Scrub. Many other dry subtypes have been recognized and described in Burma, and all of these and the ones given are typical of dry regions of the tropics in Asia. They are the xerophytic types of vegetation which grow where the water supply is limited. The plants of nearly all show some adaptation in form or habit to the seasonal dryness following the monsoon rains, of which the deciduous habit of leaf fall is the most obvious.

DIPTEROCARP (INDAING) FOREST AND SCRUB FOREST: Forests and scrub forest in which species of *Dipterocarpus* are important and where many of the trees are deciduous occur in many regions of Burma. The sites of most of these

are more bamboos. However, it is denser, has larger trees, and less of them are deciduous than in the third main tropical type the Dry Hardwood Forests and Scrub Forests.

These mixed forests cover both upland and lowland areas and the two subtypes are the Lowland, and the Upland. Both of these occur north and south of the central dry zone and over lower parts of the Shan hills and the hills of the Arakan Yomas and Chin hills, and over much of the Pegu Yomas. The hill or Upland forests are different from the Lowland forests of the valleys and plains in respect to their trees, but many species occur in both. The best Lowland forests are denser and have more species than most Upland forests. Some of the Lowland forests have the best stands of tall large trees in Burma, especially on the river floodplains. The highest percentage of teak occur in these lowland situations, especially in areas north of the central dry zone, as in the Mohnyin Reserve of the Myitkyina Division. Bamboos are more common in the Upland subtype than in the Lowland subtype of which kythaung (*Bambusa polymorpha*) and tin

TABLE 2

Common Trees of the Mixed Evergreen and Deciduous Hardwood Forests

Botanical Name	Burmese Vernacular Name	Lower	Upper	Both
<i>Adina cordifolia</i>.....	.hnaw		x	
<i>Albizzia procera</i>.....	.sit	x		
<i>Anogeissus acuminata</i> .....	.yon	x		
<i>Dillenia pentagyna</i> .....	.zinbyun	x		
<i>Gmelina arborea</i> .....	.yemane			x
<i>Homolium tomentosum</i> .....	.myaukchaw			x
<i>Hopea odorata</i> .....	.thingan.....	x		
<i>Lagerstroemia parviflora</i>.....	.zaungbale	x		
<i>Lagerstroemia tomentosa</i> .....	.leza	x		
<i>Lagerstroemia speciosa</i> .....	.pyinma.....	x		
<i>Lanea grandis</i> .....	.nabe		x	
<i>Mesua ierrea</i> .....	.gangaw			x
<i>Millettia pendula</i> .....	.thinwin		x	
<i>Mitragyna diversifolia</i> .....	.binga		x	
<i>Pterocarpus macrocarpus</i> .....	.padauk.....		x	
<i>Salmalia insignis</i> .....	.didu		x	
<i>Salmalia malabarica</i> .....	.letpan	x		
<i>Spondias mangifera</i> .....	.gwe		x	
<i>Stercuiia campanulata</i> .....	.sawbya.....		x	
<i>Tectona grandis</i> .....	.kyun			x
<i>Terminalia chebula</i> .....	.panga		x	
<i>Terminalia pyrifolia</i> .....	.lein			x
<i>Terminalia tomentosa</i>.....	.taukkyan			x
<i>Tetramales ၈၈၀iflora</i> .....	. , baing	x		
<i>Xylia dolobriformis</i> .....	.pyinkado			x

Upland Tropical
Mixed Evergreen
and Deciduous
Hardwood Forest
in which teak
or kyun (*Tectona
grandis*) is
abundant.
Gokteik Canyon
area of Northern
Shan State.





Deciduous condition during dry season of kyun or teak (*Tectona grandis*) in an upland region of Tropical Mixed Evergreen and Deciduous Forest. Courtesy of the Conservator of Forests.

Teak (*Tectona grandis*) is locally abundant in northern areas, and there are some species of *Quercus* in the understory. Other trees that are common are pyinkado (*Xylia dolabriformis*), *Pentacme siamensis*, *Shorea oblongifolia*, *Melanorrhoea usitata*, *Lagerstroemia macrocarpa*, *Embllica officinalis*, *Wendlandia paniculata*, *Terminalia tomentosa*, *Diospyros burmanica* and *Lannea grandis*. Bamboos are not common or characteristic, but *Dendrocalamus strictus* is locally abundant.

Indaing forests on the drier sites of ridges and areas of more drainage than the alluvial soil sites have shorter trees and the forest are not as dense. These have been termed Semi-indaing Forests. They are often a transition subtype between Indaing and Dry Upland Hardwood Forests in which teak is common. Ingyin (*Pentacme siamensis*), in (*Dipterocarpus tuberculatus*) teak, pyinkado, and nabe (*Embllica officinalis*) are frequent species. An undergrowth of grass is common in some areas where the forests are open.

This drier forest grades into an Indaing Scrub Forest which occurs where rainfall is as little as 30 inches a year, and the soils are often laterites. The trees are seldom over 30 feet tall and of inferior growth form. Many are the same species as in the forest type. Shrubs are common, among which *Strychnos nux-blanda*, *Randia dumetorum*, and the low palm *Phoenix acaulis* are frequent. There are brakes of the bamboo myin-wa (*Dendrocalamus*

are on sand, gravel, laterite and other soils which become dry, even though some of them are in river floodplains. Therefore, these are considered edaphic forests and scrub forests. A great number of subtypes have been recognized by foresters among which "Indaing High Forest" "Semi-indaing Forest," and "Indaing Scrub Forest" have been distinguished by the Conference of Conservators of Forests.

The Indaing Forest type growing on the best sites, particularly north of the central dry zone on alluvium in river valleys, is one of the best forests in Burma. The characteristic species in northern areas is *Dipterocarpus tuberculatus* (in) which in places reaches a height of 150 feet. The forests are dense and many other hardwoods are present, but in nearly all areas this species or another species of *Dipterocarpus* is dominant and abundant. The inbo (*Dipterocarpus obtusifolius*) is locally dominant and abundant in southern areas, and *Dipterocarpus turbinatus* and *Dipterocarpus alatus* are most abundant on sites of the wettest soils. The best areas of the tall forests are in the Yinke, Shwegu, and East Katha Forest Divisions.

DRY UPLAND HARDWOOD FORESTS AND SCRUB FORESTS: Many of the dry slopes, ridges and shoulders of the mountains, and numerous areas of uplands that have been disturbed and altered by human activities have deciduous hardwood forests and hardwood scrub vegetation. The rainfall is generally only about 40 to 50 inches a year. But these forest and the scrub types also occur where rainfall is more. They are edaphic on areas of thin, dry soils and where erosion and fire have been intense. There is no distinct difference between the forest subtype and the scrub subtype in respect to most of the tree species present. But the growth of the trees in the scrub type is of lower stature, more shrub forms are present, and the woody plants are more widely spaced. Bamboo brakes, which are thickets of bamboo, are common in the areas of great disturbance by man, and the prevalent bamboo is *Dendrocalamus strictus*. Other bamboos locally abundant are *Bambusa polymorpha*, *Bambusa tulda*, and *Thyrostachys oliveri*.

The best of these dry forests have teak trees, but the trees are smaller than in the other more mesophytic types of Mixed Hardwood Forests. There

are also some other useful trees, among which the pyinkado (*Xylia dolobrijformis*), padauk (*Pterocarpus*), ingyin (*Pentacme siamensis*), hnaw (*Adina cordifolia*) and thitya (*Shorea oblongifolia*) are locally abundant. A few of the other common species are *Tectona hamiltoniana*, *Cassia fistula*, *Pentacme suavis*, *Spondias pinnata*, *Terminalia tomentosa*, *Terminalia chebula*, *Vitex* spp., and *Lannea grandis*. *Acacia catechu*, the common sha tree, is locally abundant on the driest sites.

DRY SCRUB FORESTS AND SEMI-DESERT SCRUB

These types of xerophytic vegetation occur in the driest areas, which are most extensive in the central dry zone. Each subtype has numerous low trees and shrubs adapted to dry soil and dry climate conditions, and most of them that have leaves are deciduous during the dry season. But some do not have leaves and are stem succulent plants, such as the arborescent species of *Euphorbia*, and some of them have very small leaves. A few have evergreen leaves. Spiny plants are common especially of the genus *Acacia*. Fibrous leaved plants, such as *Agave* were introduced and have become common.

The least xerophytic subtypes are the Than-Dahat Scrub Forest, that occurs in areas of rainfall of about 40 inches, and the Te Scrub Forest, that occur in areas of about 50 inches rainfall that are mainly north of the central dry zone.

THAN-DAHAT FORESTS: The than is *Terminalia oliveri*, and the dahat is *Tectona hamiltoniana*. They occur in forest around the margin of the central dry zone and on the foothills or low mountains on thin and heavy clay soils, particularly in the Shan Hills. These sites become very dry. The than is used for fuel and implements and the dahat for cart shafts and yokes, so much so that these forest have been severely cut-over. These and the other species of trees are low, rarely over 40 feet tall, and have wide spreading branches. The forest is an open stand with many shrubby bushes and a ground cover of grasses. The most open stands are very similar to the savanna type of vegetation. Besides the than and dehat some of the other frequent trees are *Dalbergia paniculata*, *Bauhinia racemosa*, *Osyris arborea*, *Boscia variabilis*, and *Limonia acidissima*. The common bamboo is *Dendrocalamus strictus*, but bamboos are not typical of this forest.

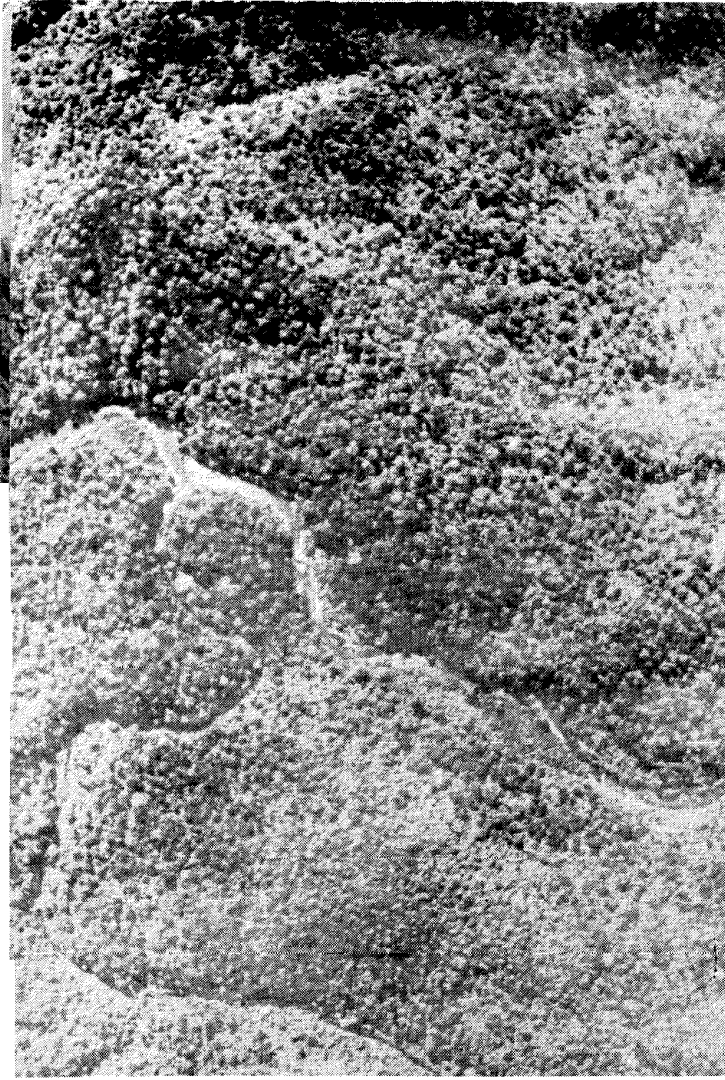
DIOSPYROS (TE) SCRUB FORESTS: These are edaphic scrub forests on red and ferruginous sandy soils. They are most prevalent mainly to areas in the northern part and north of the central

dry zone where rainfall is about 50 inches a year. The subtype has an open canopy and the trees are short and stunted, and where grasses are common between them it is a savanna type vegetation. The te is *Diospyros burmanica*. It is common and characteristic. Some of the other woody plants are the dahat, (*Tectona hamiltoniana*), *Pentacme siamensis*, *Terminalia tomentosa*, *Dalbergia paniculata*, *Dalbergia cultrata*, *Acacia catechu*, *Pterospermum semi-sagittatum*, *Miliusa velutina*, *Limonia acidissima*, and, *Zizyphus jujuba*. The bamboo *Dendrocalamus strictus* is locally abundant.

ACACIA (SHA) THORN SCRUB FORESTS: Three to five species of *Acacia* and other trees and shrubs with thorns and spines are prevalent in this very xerophytic type of scrub forest. Usually the trees and shrubs are widely spaced and, if grasses are present, the vegetation is of the savanna type. This subtype covers large areas in the southern part of the central dry zone on both sandy and dry clay soils, and it occurs in some dry soil areas outside this dry zone. It is generally known as the sha type of open forest because of the prevalence of *Acacia catechu*. The tanaung (*Acacia leucophloea*) is also frequent and some of the other common species are *Tectona hamiltoniana*, *Acacia arabica*, *Aca-*



Air view of area where temporary cultivation (ponzo) is evident. Cleared areas in forest develop a bamboo regrowth instead of a forest growth. Area in Tavoy valley. Courtesy of the Conservator of Forests.



Air view of Tropical Evergreen Dipterocarp (Kanyin) forest in Theinkun River valley. Bamboos grow under the taller species of *Dipterocarpus*. Courtesy Burma Conservator of Forests.

Some of the most frequent plants, besides the *Euphorbia* and *Agave*, are *Acacia catechu*, *Acacia leucophlaea*, *Acacia arabica*, *Acacia pennata*, *Limonia acidissima*, *Carissa sepinria*, *C. spinarum*, *C. horrida*, *Zizyphus jujuba*, *Jatropha gossypifolia*, *Azima sarmentosa*, *Capparis spinarum*, *C. hastigera*, *Tectona hamiltoniana*, *Phyllanthus reticulatus*, *Vitex negundo*, *Boerhaavia*, *Combretum apetalum*, and *Vallis solanacea*. Three common grasses are *Erenopogon joveolatus*, *Tragus biflorus*, and *Digitaria pruriens*. Two introduced cacti are *Cereus* and *Opuntia dillenii*.

SUBTROPICAL FORESTS

Burma has conditions favorable for plants of both the tropical zone and temperate zone because of its mountains and the presence of lowland areas north of the Tropic of Cancer. The forests and other vegetation on the mountains and in some of the high valleys of the northern regions are of mixed composition of species common in both tropical regions and temperate regions and are therefore a subtropical type. The zone on the mountains in which most of these occur is usually above 3,500 feet elevation and below 7,500 feet. But these elevations are not the same in all regions, the zone being higher in the southern regions than in the northern regions. The map shows the location of some of the areas of subtropical vegetation in three mountain parts of Burma. The most distinct zone is on the mountains of the Kachin State. There are mountain areas in the Shan States that have cool winters and support a subtropical vegetation. And also there are slopes and mountain tops in the Chin Hills, and even a few high mountain areas in the Arakan Yomas with subtropical types.

The types are mainly two: (1) those composed of numerous species of hardwood trees, and (2) the conifer pine forest above 4,000 feet elevation. The three hardwood type forests are distinct because of differences in their tree species and in the rainfall and other water conditions. There is a Kain Forest type in areas of abundant rainfall, usually above 80 inches a year. There is a Moist Forest type in areas of moderate amounts of rain and other water. And there is a Dry Forest and Scrub Forest type.

Most of the trees of the dry habitat type are deciduous because of the lack of water during the dry season. But most of the deciduous habit of the trees in the moist and rain habitats is related to low winter temperatures. Some of the woody vegetation of both the driest areas and the sites exposed to wind is of the scrub forest type. These scrub forests are common over dry parts of the Chin Hills where

cia jarnesiana, *Randia dumetorum*, *Limonia acidissima*, *Boscia variabilis*, *Zizyphus jujuba* and the shrub *Capparis* spp. *Limonia acidissima*, is known as thanaka, and is common. Its bark is extensively used by Burmese ladies and children as a cosmetic. Some trees in the regions of this scrub forest are *Melia azadirachia*, *Entolobium seman*, and *Cassia fistula*, which are often along roadsides and in groves of the villages and towns.

SEMI-DESERT EUPHORBIA SCRUB: This is the most xerophytic vegetation of Burma. It is scattered over many parts of the Central Dry Zone and occurs near and in the *Acacia* Thorn Scrub Forest areas. The favorable sites are well drained, eroded uplands of dry clay soil and on rockland areas. The arborescent and succulent *Euphorbia antiquorum* is very frequent and characteristic. Desert plants from other continents have become established, especially species of *Agave* from the Americas. The *Acacias* and other plants of the sha subtype are common. The ground is bare or has low grasses and other herbs between the widely spaced low trees and shrubs. The browsing of goats has modified the form of many of these low trees and shrubs.

oaks and chestnuts are associated with the *Pinus insularis* to form a mixed hardwood and pine scrub forest.

The maximum development of Subtropical Forests is the Rain Forest type. It is similar to the Tropical Rain Forest because of its layered structure and the presence of palms, epiphytes and liana vines in abundance. But It is dissimilar because there are species of temperate zone genera as well as those of tropical genera. Some of the tropical species of Dipterocarpaceae are present, but the oaks (*Quercus*) and chestnuts (*Castanopsis*) are also abundant. And there are some species of the distinctly temperate zone genera of *Acer*, *Betula*, *Celtis*, *Carpinus*, *Fraxinus* and *Magnolia*. These temperate trees are not abundant, except locally. The flora of the subtropical zone is a mixture of tropical species from as far south as Malaya with temperate species from India, Indochina, and China. The Subtropical Rain Forest has the greatest number of tropical climate trees and the Subtropical Moist Hardwood Forests have the greatest number of temperate climate species.

HARDWOOD RAIN FORESTS

These rain forests are in regions of abundant rainfall and moist conditions of fog, clouds, and moist soils of the upper valleys and lower mountain slopes in the Kachin State and similar areas in the Naga Hills and upper Chindwin River valley. The forest canopy has both evergreen and deciduous trees and the forests are distinctly layered. There are fewer evergreen species than in the similar Tropical Rain Forests adjacent to them in the warmer parts of northern Burma, and there are more temperate climate species of trees. But it is almost im-

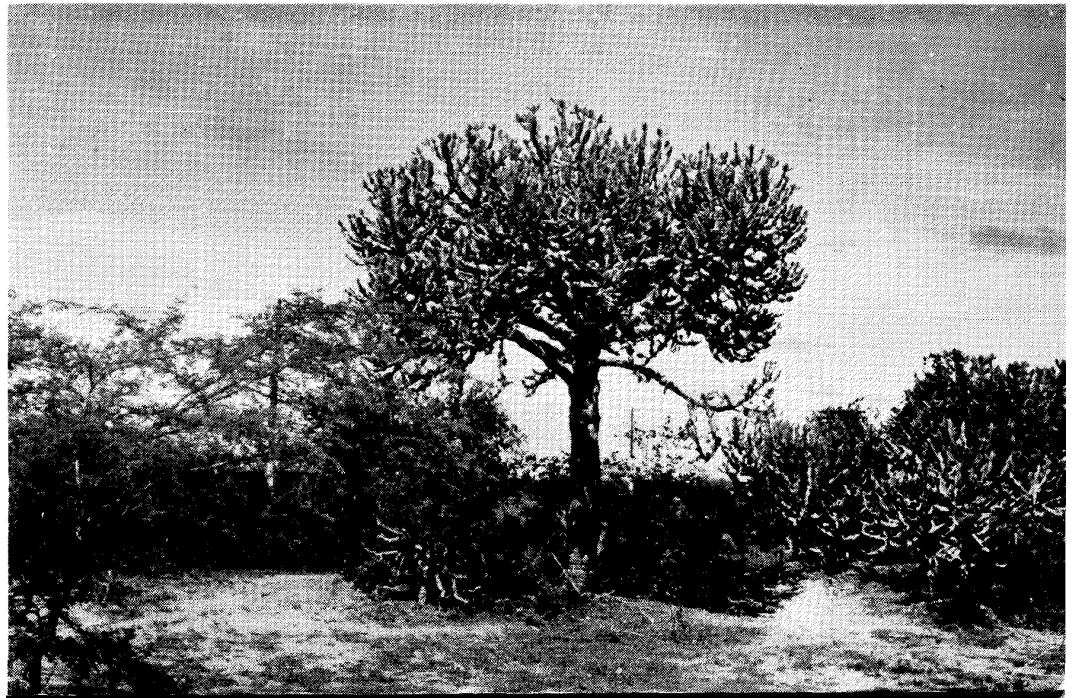
possible to distinguish between this Subtropical type and the Tropical type from their general appearance. The distinction is based on more temperate species in the Subtropical type.

Species of the temperate genera *Quercus*, *Castanopsis*, *Magnolia*, *Michelia*, *Fraxinus*, and *Celtis* are associated with tropical species of *Dipterocarpus*, *Terminalia*, *Engelhardtia*, *Sterculia*, and the palm genus *Caryota*. The genus *Ficus* is represented and species of the *Lauraceae* and *Magnoliaceae* are more common than in the Tropical Rain Forests. A few of the common trees are: *Dipterocarpus alatus*, *Engelhardtia spicata*, *Ficus benjamina*, *F. fistulosa*, *Heliocia erratica*, *Kydia calycina*, *Michelia baillonii*, *Sideroxylon hookerii*, *Stereospermum chelonoides*, *Sterculia coccinea*; and the shrub *Clerodendron nutans*. But the composition of these forest communities is so varied from place to place that it is difficult to give a list of trees that are typical. The main feature is that this Rain Forest type is intermediate between the Tropical Rain Forest and the Mountain Subtropical Hardwood type of moist habitats, which is the most distinctive Subtropical type in Burma.

SUBTROPICAL MOUNTAIN FORESTS AND SCRUB FORESTS

The climatic zone of subtropical conditions of temperature varies a great deal in amount of rainfall, clouds, mists and fogs, soil water, and drainage. Also there are great differences in exposure to wind, in the kind of soil and of rocks, and in some places the rate and amount of erosion on steep slopes. All of these factors cause great differences in sites. A

Semi-desert
Scrub showing
large *Euphorbia antiquorum*
(tazaung-gyi)
and the open
areas between
the shrubs with
bare ground and
scattered low
herbs.



variety of subtypes of woody vegetation could be distinguished, but, in general, the three main types are: (1) Moist Hardwood Forests, (2) Dry Hardwood Forests and Scrub Forests, and (3) Pine Forests. In some areas, as on parts of the upper Chin Hills there are combinations of hardwoods with pine. The two Hardwood Forest types are based on water relations: (1) the Moist subtype of habitats where there is not a long and distinct dry season, (2) the Dry subtype of habitats that stay dry all year or have a long dry season. The Moist subtype is mostly forest stands of large to medium large trees. The Dry subtype is mostly open forests of low stature trees, widely spaced and some open stands are like savanna vegetation. The Scrub Forests are common on the driest sites. The Moist Hardwood Forests have both evergreen and deciduous species, but the Dry Hardwood Forests and Scrub Forests have mostly deciduous species of trees and shrubs. The species of *Rhododendron* are mostly evergreen and are numerous at the higher elevations. The deciduous habit is generally due to winter cold in the Moist Forests and due to both cold and dryness in the Dry Forests and Dry Scrub Forests.

MOIST HARDWOOD FORESTS: Subtropical Forests of this type occur in zones on slopes and on top of some mountain parts of the Shan State, Chin Hills, Kachin State, and Naga Hills. They have developed where winter temperatures are cold enough to prevent the growth of distinctly tropical species of trees. The rainfall and other moisture conditions are not as wet as in the Rain Forest type but they are sufficient to support a dense to medium dense forest.

The Scrub Forests subtype occurs in the same general region as forests but on the sites of less rainfall and less soil moisture. Also the Subtropical Pine Forests are usually on dry sites in the same region.

In the forest type many trees are evergreen or semi-evergreen, but some are deciduous due to the cold of winter months. The canopy is often dense, but is usually less dense than that of the Rain Forest type. The forests are layered and there are numerous epiphytes, vine lianas, and in some areas tree ferns. In many features they are very similar to the Tropical Upland Moist Hardwood Forests of lower mountain zones, except for the presence of common temperate species of trees.

Oaks and chestnuts and species of the *Magnoliaceae* and *Lauraceae* are common. The genus *Ficus* is represented by a number of species. There are some species of *Rhododendron* but not as many as in the Temperate Forests of higher elevations. There are also some conifer species besides the pines. The tree and other flora is not well known because many areas of subtropical conditions have not been thoroughly studied. Therefore, the following is only a partial list of some of the frequent tree species. The trees of temperate affinities are listed first. A few palms and tree ferns are present. The

following are mainly from Kingdon Ward.

Temperate species—*Quercus spicata*, *Quercus serrata*, *Castanopsis argyrophylla*, *Castanopsis diversifolia*, *Castanopsis argentea*, *Castanopsis burmanica*, *Magnolia campbellii*, *Magnolia pterocarpa*, *Acer niveum*, *Acer thompsonii*, *Acer oblongum*, *Alnus nepalensis*, *Prunus cerasoides*, *Pyrus harroviana*, *Carpinus londoniana*, *Carpinus viminea*, *Aesculus punduana*, *Ulmus lancifolia*, *Betula alnoides*, *Salix tetrosperma*, *Nyssa sessifolia*, *Ilex* spp., *Fraxinus jloribunda*, *Rhododendron arboreum*, *Rhododendron simsii*, *Alseodaphne petiolaris*, *Alsophila* spp. (tree ferns.) Tropical species—*Bauhinia* spp., *Bucklandia populnea*, *Cinnamomum* spp., *Dipterocarpus alatus*, *Duabanga sinneratoides*, *Eugenia* spp., *Echinocarpus assamicus*, *Eleocarpus obtusus*, *Englehardtia spicata*, *Ficus clavata*, *Ficus cuneata*, *Ficus glomerata*, *Ficus hirta*, *Ficus obscura*, *Kydia calycina*, *Lagerstroemia macrocarpa*, *Litsaea chinensis*, *Manglietia caveana*, *Michelia* spp., *Parashorea* sp., *Shorea* sp., *Sterculia colorata*, *Stereospermum chelonoides*, *Sarcocephalus cordatus*, *Schima wallichiana*, *Tetrameles nudiflora*, *Ternstroemia japonica*, *Terminalia myriocarpa*, and *Wendlandia tinctoria*.

DRY HARDWOOD FORESTS AND SCRUB FORESTS: These occur on dry slopes and ridges, and where clearing and fire have been common and soil erosion is intense. Many of the trees and shrubs are deciduous and the forests are open stands of low stature trees and shrubs. Thorn shrubs and trees are common and other features are similar to the Tropical Dry Deciduous Forests, Scrub Forests, and Scrub. But there are not as many subtypes of this subtropical type. There is no good development of a subtropical semi-desert subtype or of a sha (*Acacia*) thorn scrub forest in the subtropical mountain zone.

Many of these forests and scrub forests are open stands of oaks, chestnuts and other hardwoods. Locally common evergreen trees are *laukya* (*Schima wallichii*) and *Quercus incana* and in some regions the *Rhododendron arboreum* (zalatni) is frequent. Also some stands contain scattered *Pinus insularis*. The most open stands are a savanna-like vegetation, especially where the bracken fern (*Pteridium aquilinum*) is abundant. Fires are frequent in some of the areas and may have promoted the development of some of these dry forests, especially the scrub subtype.

Some hill forests of this Dry Subtropical type are composed mostly of oaks, chestnuts, *Schima*, *Kydia*, and *Primus*. In fact, there are so many different subtypes of these dry forests and scrub forests that no short description applies to all of them.

MOUNTAIN PINE FORESTS

Most of the species of pines in Burma occur in mountain areas and usually in the subtropical and temperate altitude zones. The khasi pine (*Pinus insularis*) is most prevalent and grows in pure stands or nearly pure stands to form open forests, especially in the Shan States, Chin Hills, and a few

in the Arakan Yomas. The three other species of pines do not form as distinct or large forests. One of the pines is the tropical *Pinus merkusii* which grows at low altitudes on hills and in some valleys. It is common in some of the Dipterocarp or indaing forests of the Salween and Thaungyin drainages at altitudes between 500 and 2,500 feet. The two other pines are species of temperate climate conditions and occur at high altitudes. The blue pine, (*Pinus wallichiana*) is in the Kachin State and Naga Hills associated with spruce (*Picea*) and hemlock (*Tsuga*) in temperate conifer forests, described later. The chir pine (*Pinus roxburghii*) is not common and no record was found of it forming distinct forests.

The Subtropical Pine Forest type is open stands of *Pinus insularis* usually in the zone between 4,500 and 8,000 feet altitude in the same general regions of Subtropical Mountain Hardwood Forests and Scrub Forests. It is distinct from them in most areas because the stand is usually almost completely dominated by this khasi pine. Oaks and chestnuts and a few other hardwoods occur with the pines, as in parts of the Chin Hills, to form a mixed open forest, and in some areas the *Rhododendron maximum* and maibau (*Alnus nepalensis*) are locally abundant. Three frequent oaks on dry sites are *Quercus griffithii*, *Q. incana* and *Q. serrata*. However, in most areas the hardwoods are absent or restricted to a few low stature trees. Grasses and the bracken fern (*Pteridium aquilinum*) are common as ground cover in some areas, and such areas are like savanna vegetation.

The lack of hardwoods in the pine forests is probably due to the difficulty of sprouting of hardwood seeds on the forest floor because of the abundance of a litter of pine needle leaves that do not rot

quickly. The frequent burning of these forests may also have some effect if the fires burn out the young hardwoods more than the pines. But this selective action of fire has not yet been confirmed by long term observations and may not be important. There are some natural areas of pine forests, natural meaning that they were probably not the result of either burning out of the hardwoods or the second growth of pines after clearing and fire used by man.

This khasi pine forest type is the only extensive conifer forest in Burma and it may prove very useful in the future if the type can be extended and the products of the forest better used. Sites favorable for pine forests could be changed from hardwood to pine with systematic planting of the pine and other controls and management. In fact, it may be possible to introduce more suitable species of pine and promote exotic pine forests, as has been done on a large scale in New Zealand.

HIGH MOUNTAIN TEMPERATE FORESTS, AND SUBALPINE TYPES

The forest and other vegetation of the high mountains of northern Burma and on a few high peaks in the Chin Hills are the southern extension of temperate types from the mountain regions north and northwest of Burma into Burma. These are the wet temperate forests of the Assam, Burma and Yunnan China regions that are mainly a hardwood type. Both evergreen and deciduous species are common. There is also a less wet or moist temperate type in which there are some conifer trees, especially the hemlock (*Tsuga dumosa*). And there are conifer forests in this temperate zone. Some of the khasi pines forests (*Pinus insularis*) occur at 7,000 feet elevation and two other pines are locally abundant, *Pinus wallichiana* and *Pinus roxburghii*. But

Low elevation mixed forest of pine (*Pinus merkusii*) and teak or kyun (*Tectona grandis*) in Sittang River valley.



the most typical temperate conifer forest is the fir forest composed mainly of the silver fir (*Abies fargesii*) at altitudes usually above 9,000 feet. The spruce, (*Picea spinulosa*) is present but not as abundant as the fir.

But these hardwood or conifer forests are not on the highest altitudes where woody vegetation on the mountains occurs because a number of distinct types of subalpine scrub forests and scrub are present. The high tops of the mountains of the north Kachin State have snow fields and cold winters and this subalpine woody vegetation is at the "timber line" altitudes just below the snow fields. This zone of long winter conditions of cold and abundant dampness is the reason for naming it subalpine. Many of the small trees and shrubs are species of the genus *Rhododendron*, about which Kingdon Ward wrote many descriptions and made numerous collections.

Ward in his "Sketch of the botany and geography of North Burma" gave the altitude zone on the mountains in which tropical, subtropical, and temperate forests and scrub occurred. He considered temperate types above 6,000 feet altitudes as follows: Temperate Rain Forest and Temperate Pine Forests 6,000-8,000 feet; Mixed Temperate Forest 8,000-9,000 feet; Silver Fir Forest 9,000-12,000 feet; Scrub, 12,000-13,000 feet, and Alpine 13,000-15,000 feet. Throughout all of these forests and in all these zones are Rhododendrons, but the zone of most prevalence and greatest number of species of *Rhododendron* is from 7,000 to 12,000 feet altitude. This is the Subalpine Scrub of this description.

Other genera of typical temperate and even arctic climate plants, such as *Betula*, *Juniperus*, *Viburnum*, *Sorbus*, and *Salix*, are present. From areas of this highest mountain type to the Tropical Rain Forest of northern Burma is only a few miles in the steep mountain region of the upper Chinwin River and Kachin State, and in this short distance are probably as many different types of woody vegetation as in any other region of Asia. Due to the rough topography forests are not well known or described, especially those of the high mountains, and the following is only a brief and probably somewhat inaccurate description.

HIGH MOUNTAIN HARDWOOD FORESTS

The most distinct of these temperate type forests are above 6,000 feet altitude in northern regions of Burma and Assam and Yunnan. At the intermediate altitudes from about 5,000 to 7,000 feet they intergrade with and have elements of the subtropical forests. In the areas of most rainfall, clouds and fogs the forests are a wet subtype. Some evergreen trees occur with the winter deciduous species. Epiphytes are particularly abundant and the canopy is dense. There are stretches of grasslands occurring as glades between the forests. The densest communities are

in the steep sided valleys. The ridges usually have many species of *Rhododendron* present. At higher elevations and on drier slopes and ridges is a less wet subtype known as Moist Hardwood Forests and Scrub forest. These are usually transitional between hardwood or pine types and the high altitude conifer forests, some of *Tsuga* and some of *Abies*. The upper part is usually a scrub form vegetation in which *Rhododendron* species are very common.

WET HIGH MOUNTAIN HARDWOOD FORESTS: Oaks, especially the evergreen species, such as *Quercus lamellosa* and *Quercus lineata*, are common in the warmer, lower elevation areas. Other species of *Quercus* and species of chestnuts (*Castanopsis*) and some *Ficus* are also present. At the higher elevations the common trees are *Acer wardii*, *A. flabellatum*, *Magnolia rostrata*, *Prunus* spp., *Ilex* spp., *Betula alnoides*, *Sorbus insignis*, *Manglietia caveana*, *Tsuga dumosa* and species of *Rhododendron*, especially *Rhododendron sinogrande*, *R. arizelum*, *R. tanastylum*, and *R. macabeanum* are frequent. In the lower parts, in addition to oaks and chestnuts, are species of *Schima*, *Bucklandia*, *Calophyllum*, and *Alnus nepalensis*. The rare conifer *Taiwana cryptomerioides*, known as the coffin wood in Yunnan, occurs in the Kachin State mountains and the larch *Larix griffithiana* is also present. There are many species of *Quercus*, *Castanopsis*, *Acer* and *Magnolia* because here are many from China and other adjacent regions. *Viburnum* and *Lyonia* species are locally abundant. These and low tree or shrub species of *Betula*, *Sorbus*, *Ilex*, and *Rhododendron* increase with elevation. The whole forest and scrub forest zone is a temperate transition from lowland subtropical to high mountain subalpine scrub.

MOIST HIGH MOUNTAIN HARDWOOD FOREST AND SCRUB FORESTS: These occur on the drier slopes and exposed slopes and ridges at altitudes usually above 8,000 feet. The forest subtype is not as dense as the Wet Temperate Hardwood Forest just described and the Scrub Forest subtype is almost a subalpine form of vegetation. Many species of *Rhododendron* are present, of which there are probably 25 in this forest subtype and in the subalpine scrub. Some of these are epiphytic Rhododendrons. Locally common hardwood trees are species of *Quercus*, *Schima*, *Magnolia*, *Cornus*, *Ilex*, *Acer campbelli* and *Michelia doltsopa*, and some of the other trees common in the upper parts of the Wet subtype. But in this subtype the conifers are usually more numerous, especially the hemlock, *Tsuga dumosa*. This subtype grades upward into the High Mountain Conifer Forest. It also grades upward into the High Mountain Subalpine Scrub. The conifer forests develop on high slopes and in high valleys above which usually rise even higher slopes and peaks. In these hardwood forests and scrub forests and in the conifer forest are many areas occupied by the dwarf bamboo (*Arundinaria* spp.), that occurs in thickets in the open and as an understory

in the forests. The thicket communities check the reproduction of the hardwoods and conifers. All these kinds of forests and scrub forests are at or near what is known as the "timber line" or upper limits of growth of tree form plants. The Subalpine Scrub is above this tree line. And the Alpine vegetation is at even higher altitudes in and among the snow fields. It is not a woody type of vegetation because many of the plants are herbs and the woody plants are very small.

HIGH MOUNTAIN CONIFER FOREST

North Burma fir forests, composed mainly of the silver fir (*Abies fargesai*), are limited mainly to a few high mountain slopes and ridges above 9,000 feet elevation on mountains that usually are over 12,000 feet high. The spruce (*Picea spinulosa*) is associated with this fir but is not always present or abundant. Hemlocks (*Tsuga dumosa*) and the upper mountain hardwoods are near and in some fir forests. But in most areas the fir forms a nearly closed canopy. However, there are openings in the forests and hardwoods grow and some grassy areas occur. Also some species of hardwoods are below the canopy of conifers. Species of *Acer*, *Betula*, *Magnolia*, *Sorbus*, *Viburnum*, *Clethra*, and species of *Rhododendron* are frequent, especially *Rhododendron nerijolium*, *R. sinogrande*, and *R. sidereum*. These Dicotyledons are so subordinate to the tall fir trees that the forest is not a mixed hardwood and conifer type.

Near the upper limits of tree size growth the firs become low stature and many are of wind-blown form. The Sub-alpine Scrub begins at the upper edge on some mountains and in it are low form junipers (*Juniperus*), that are also conifers. In some parts of this fir forest are species of *Arundinaria* that form dense dwarf bamboo thickets that check the spread of the forest.

HIGHEST MOUNTAIN SUBALPINE SCRUB

The exposed upper slopes and mountain tops above 11,000 feet elevation are areas of intense cold and winds and snow. The woody vegetation is reduced to a scrub type of only a very few tree spe-

cies, and these are beaten down to small and gnarled forms. Low shrubs are common. Tussocks and cushions of grasses and sedges, and groups of other herbs are in the openings between the shrubs and shrub-form trees. Gentians and lilies are locally common. In general, there is a gradation from communities of scrub forests of tree species near the lower parts of this subalpine zone upward to the very open and almost entirely herbaceous vegetation at the highest elevations just below the permanent snow fields. There is no sharp division between scrub forests and scrub and for convenience all this type is considered Subalpine Scrub.

In the lower warmer parts where there is also less exposure to wind, the Scrub Forest subtype has low stature, oaks, chestnuts, birches (*Betula*) maples (*Acer*) *Magnolia rostrata*, *Clethra* spp., *Sorbus* spp., *Viburnum* spp., *Juniperus* spp., *Berberis* spp., and *Rosa* spp., as well as numerous species of *Rhododendron*, of which probably the most frequent are *Rhododendron arizelum*, *R. beesianum*, *R. tephropetalum*, *R. euchaetes*, *R. triflorum*, *R. crassum*, *R. bullatum* and *R. electeum*. Some ridges have nearly pure stands of these *Rhododendrons* that form thickets. Some of the species are epiphytes and many are dwarf and prostrate shrubs.

Over the intensely wind-swept mountain tops and the upper ridges and slopes the highest Sub-alpine Scrub type has developed. In it are many *Rhododendrons*, low junipers and other low stature woody plants. Among these are *Sorbus reducta*, *Sorbus insignis*, *Viburnum cordifoliurn*, *Enkianthus himalaicus*, *Vaccinium glauco-album*, and species of *Betula*, *Clethra* and *Salix*. The writings of Kingdon Ward list over 20 species of *Rhododendron*, of which the following are frequent: *Rhododendron arizelum*, *R. tephropetalum*, *R. glaucum*, *R. triflorum*, *R. myrtiloides*, *R. repens*, *R. sanguineum*, and *R. pnmiflorum*.

Tussocks and cushions of *Diapensia himalayana*, and grasses and sedges are common at the upper borders with the herbaceous alpine areas. Gentians and lilies occur and there are species of *Luzula*, *Carex*, *Smilicina*, and *Rubus*.

The alpine turf and scree areas have a vegetation that is seasonal with flowering and growth after the snows begin melting. Some common plants are species of *Fritillaria*, *Potentilla*, *Diapensia*, *Gentiana* and *Salix*.

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