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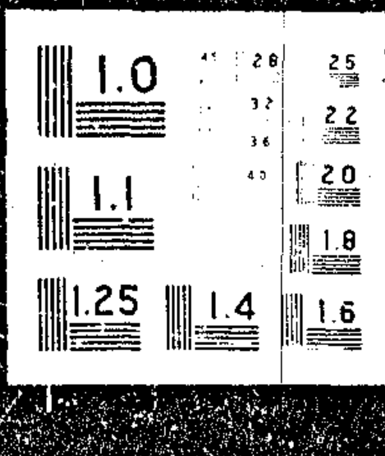

VEGETATION
OF
SOUTHEAST ASIA
STUDIES OF FOREST TYPES
1963 - 1965

Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE
Under ARPA Order No. 424
Advanced Research Projects Agency
Department of Defense

Vegetation of Southeast Asia Studies of Forest Types 1963–1965

Compiled By
LLEWELYN WILLIAMS
Crops Research Division

CR 49-65

Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE
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F O R E W O R D

This Report on 'The Vegetation of Southeast Asia' is submitted in accordance with ARPA Order No. 424, Program Code No. 3860, dated January 30, 1963 to the Agricultural Research Service, U. S. Department of Agriculture from the Advanced Research Projects Agency, Department of Defense.

As stipulated, in part, the Order directed the Agricultural Research Service to obtain, evaluate, and/or categorize botanical information on the specific composition and physiognomy of forest associations of Southeast Asia, essential for the effective interpretation of the reaction of tropical and subtropical plants to defoliants.

To accomplish this, two field missions were undertaken by the writer to Thailand during November 1963 to January 1964, and from December 1964 to February 1965. Considerable data were gathered during these field assignments, supplemented by a large series of photographs, many of which are reproduced in Part II of this Report.

To augment the field investigations, an extensive review was made of published information on the forests, forest and agricultural products, and other features of the Mekong basin countries.

This Report completes the phase of ARPA Order No. 424 pertaining to botanical investigations on vegetation in Southeast Asia.

Crops Research Division

A C K N O W L E D G M E N T S

The task of studying the vegetation of Southeast Asia, and the preparation of the accumulated data into a final Report would not have been possible without the cooperation of many kind friends. It is impossible to acknowledge individually all who have assisted in one form or another in this Project. But a word of gratitude is due to Mr. T.W. Brundage, director, Lieut. Col. W. R. Scheible, Captain John Kelly, Jr., and other staff members of the Bangkok office of Advanced Research Projects Agency, who arranged travel and other facilities during the two field missions carried out in 1963-64 and 1964-65.

Acknowledgment is made of the fine cooperation given by Mr. Dusit Banijbhatana, Director-General of the Royal Forest Department of Thailand; Mr. Tem Smitinand, taxonomist in the Forest Department; and the Divisional, Provincial and other forest officers contacted in the interior in the course of the field investigations. To Professor Thiem Komkris, Dean of the School of Forestry at Kasetsart University, I owe gratitude for permitting Professor Preecha Chárenmayou to accompany me, as interpreter and assistant, on most of the field trips conducted during December 1964 to February 1965. Mr. Preecha's familiarity with the vegetation of Thailand and his many personal contacts in the interior were of invaluable aid in the pursuit of the field studies.

I am also indebted to the National Agricultural Library of the Department of Agriculture, particularly the Beltsville Branch, in making available the large number of references reviewed; and to the Photo Laboratory at the Plant Industry Station, Beltsville, for preparing the series of photographic prints reproduced.

And finally, I am grateful to the staff members of the Crops Research Division for their cooperation, and particularly to those who have persevered to prepare this and other, progress, reports related to the Project.

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Summary

This Report treats with the vegetation and other natural features of Cambodia, Laos, North and South Vietnam, and particularly those of Thailand. The vegetation of Thailand, in general, is representative of the countries drained by the Mekong river and its tributaries.

Part I contains a discussion of the systems, proposed by various ecologists or phytogeographers, to classify tropical vegetation. The principal forest types of Thailand, and applicable to Southeast Asia in general, are described.

The entire region lies between the Equator and the Tropic of Cancer. Although politically independent, and divided economically, the countries of Southeast Asia, under consideration, exhibit considerable analogies from the standpoint of physiography, climate, soils and especially the vegetation.

The five countries combined have a total area of approximately 505,000 square miles, almost equivalent to twice the size of Texas, or 146 times the size of Puerto Rico. With an estimated total population of 56,500,000, the average density is about 112 inhabitants per square mile.

From the earliest times the Indo-China Peninsula, so called because of its position between India and China, has been peculiarly subject to foreign intrusion. Successive waves of Mongols have broken over it from the north; Dravidians from India colonized it; Buddhist missions from Ceylon have penetrated it; and it has been invaded by buccaneers from the islands to the south. Race fought against race, and tribe against tribe. Dominant powers rose and declined. Civilizations developed, flourished and faded. Out of many races and diverse elements - Thais, Lao, Khmer, Mon, Annamese, Malayans, Chinese - a series of nations evolved. They are fundamentally alike, but differ in many essentials. They have striven during centuries for mastery over each other, as well as over the many minor tribes and clans who lead a precarious, sometimes nomadic, existence in their midst.

Unlike its neighboring countries, Thailand, throughout modern history, has been an independent nation, a kingdom with no colonial ties. For this reason the Thais proudly refer to their country as the 'land of free men'.

Formerly, Vietnam, Laos and Cambodia collectively formed the French Union of Indochina, as it was known in official documents, or simply Indochina. This large area occupies the eastern portion of the Indochina Peninsula in Southeast Asia, situated between parallel 8° 30′ and almost 20° N, and meridians 100° to 109° 30′ E.

Indochina was established by France as a single political entity towards the end of the 19th Century. Up to that time this large territory was not united by any political or administrative ties, but represented an assemblage of different states and geographically diverse areas.

Under French rule, Indochina consisted of 5 territories or protectorates: Tonkin, currently a part of North Vietnam; Annam, in central Vietnam, divided between North and South Vietnam; Cochin-China, now forming a part of South Vietnam; Cambodia; and Laos.

When Indochina lost its cohesion, in 1946, it was divided along geographical and ethnical lines into the independent states: Laos, in the northwest, with an area of approximately 89,000 square miles; Cambodia, in the southwest, covering an area of about 70,000 square miles; and Vietnam, in the east, with a total area of approximately 126,000 square miles. In 1954, at the Geneva Conference, Vietnam was separated into the Republic of South Vietnam, the region south of the 17th parallel, as distinguished from the Communist-dominated State of North Vietnam, north of the parallel.

The great majority of the inhabitants of Southeast Asia are farmers and peasants. It is estimated that up to 85 or 90 percent of the national income of each of the five countries is derived from agricultural crops and forest products. Approximately 85 percent of the land, under permanent cultivation, is used for the production of rice. Other natural products or crops of importance include: timbers, especially teak from northern Thailand, bamboos, rattans, Pará rubber (Hevea brasiliensis) from plantations, lac and cassava (Manihot), for domestic use and for export, and corn, beans, peanuts, cotton and kenaf fiber, tobacco, vegetables, fruits and other produce.

As in most Asiatic countries the diet consists principally of plant foods, especially rice. [illegible] also figures prominently in the diet of all classes.

The general physiography of Southeast Asia is that of mountain ranges, with peaks upwards of 6,500 ft. (2,000 m.) in altitude, interspersed with mountain gorges, plateaus and great plains.

The region is drained by numerous rivers, most of which flow in a southerly or southeasterly direction, and their estuaries form extensive deltas. The largest of these, and the longest in Southeast Asia, is the Mekong, flowing through plateaus and plains of western

Laos. It enters Cambodia before it reaches the Mekong delta of South Vietnam. Through North Vietnam flows the Red river, so called from the red color of the silt carried by its waters from the mountains of Tibet, and forms the Tonkin delta. In Thailand, the Chao Phraya river and its tributaries drain the great central plain, to form the Menam or Chao Phraya delta, south of Bangkok on the Gulf of Thailand.

Although the Indochina Peninsula projects far down into the tropical oceanic zone, the climate of Southeast Asia is influenced to a large degree by its position as a part of the great continental mass of Asia. This is indicated by the prevailing winds, with accompanying changes in humidity and aridity. Proximity to the sea and regional relief also cause variations and modifications in the climate.

The monsoon is the dominating climatic factor. Monsoons are essentially seasonal winds blowing from one direction during part of the year, and from another direction during the remaining months. Throughout the region these winds result from the interaction of two maritime air masses - the southern tropical, moving toward the Equator in the Southern Hemisphere, and the northern tropical, moving towards the Equator in the Northern Hemisphere. In brief, the monsoon is largely the result of the differential heating of land and water, producing alternating dry and rainy seasons.

Based on a series of analogies, the countries of Southeast Asia may be considered a unit. The presence of mountain ranges, which intercept moisture-laden winds, results in a wide pattern of annual rainfall, with the dominance almost throughout of alternating rainy southwest monsoon, and dry northern or northeastern monsoon. Except in mountainous areas, the temperatures are fairly high throughout, with no frost at lower elevations. The varying distribution of rainfall during the year is highly significant, being particularly noticeable in North Vietnam, Laos and Thailand.

Covered mostly by tropical vegetation, Southeast Asia is separated from India and Burma by mountain ranges; from China and the Himalayas, on the north, with their essentially temperate flora; while the vegetation of the southern Peninsula of Thailand, with almost year-round precipitation, closely resembles the vegetation of sections of Malaysia. While the five countries show appreciable diversity in the vegetation cover, the principal analogy and unifying factor is the widespread occurrence of certain tree species, particularly those of the wood-oil family (Dipterocarpaceae). In addition to Malaysia, Southeast Asia is apparently the major natural range of this large and important family, represented by several genera and numerous species.

The forests of Southeast Asia may be segregated into 2 broad classes: Evergreen and Deciduous forests. In Thailand these may be divided into 12 principal forest types, most or all of which are also represented in each of the adjoining Mekong basin countries. These are: (a) Evergreen - separated into Rain, Moist, Dry Evergreen, Montane, Coniferous and Swamp, including Mangrove; (b) Deciduous - classified as Mixed, Dipterocarp, Beach, Thorn, Bamboo and Savanna.

Observations made on the ground and from the air, on the effect of chemical defoliants on vegetation, conducted near Pranburi, upper peninsular Thailand, under the direction of the Biological Laboratory at Fort Detrick, Maryland, are discussed briefly.

Attention is drawn to some of the most prevalent plants in Thailand, with wide distribution in Southeast Asia, and which are considered hazardous, providing ideal sites for ambush along roadsides and in forest clearings.

Stress is placed on the use of aerial surveys and photo sampling, as a tool to supplement ground investigation or to expedite the evaluation of the type of vegetation prevailing in a given area.

There is a review of field studies which have been in progress throughout Thailand during the last 2 years by a Thai field team to prepare profiles of tree stands, in order to determine the structure and species composition of various forest associations, ranging from the canopy to the ground cover. At the same time, soil samples are gathered at different horizons for analysis.

A comparison is made between the major aspects of the topography, climate and vegetation of Southeast Asia, Puerto Rico and Texas.

A series of maps illustrates the various forest zones investigated, and the distribution of Evergreen and Deciduous forests occurring in Thailand. One map indicates the range of the principal forest types in North and South Vietnam, Cambodia and Laos.

Part II contains a series of 125 ground and aerial photographs, most of which were taken by the author during the recent field assignments. These illustrate the principal forest types in Thailand, which are representative of similar formations in the adjoining Mekong basin countries; some of the most frequent weed plants in Southeast Asia, providing sites for ambush in clearings and along highways; aerial photographs of some of the major forest types in Thailand, taken immediately following ground studies; and views of the effect of chemical defoliants on vegetation near Pranburi, upper Peninsular Thailand. A limited number of forest types occurring in South Vietnam, Laos and Cambodia are also illustrated.

Part III contains an annotated Bibliography, of almost 800 titles, referring to forests, forest products, agricultural crops, and other resources of Southeast Asia, with emphasis on Thailand.

THAILAND

Field Investigations

During a period of five and a half months, from November 6, 1963 to January 17, 1964 and from December 17, 1964 to February 27, 1965, the author made a total of 28 trips overland and 9 aerial surveys throughout Thailand (see Fig. 6), from the border of Burma, on the west and northwest, to the Mekong river in the east and northeast; in the Chantaburi-Khlung-Trat region in the southeast; and from the southernmost section of the Peninsula, along the Malaysian border in the southwestern section and the Kra Isthmus as far north and northwest as Nan, Phyao, Chiengdao, and Mae Hongson, near the border of upper Laos, Shan States and Burma, respectively.

Briefly, the regions and forest types investigated were:

GROUND STUDIES:

Central Region

The vegetation along the Paholyothin-Friendship Highway, from Bangkok to Saraburi, Nakhon Ratchasima, Konkaen, Udon and Nongkhai on the upper Mekong river, in the northeast.

In the Khao Yai National Forest, on the Korat Plateau - forest types, varying according to altitude, from Lowland and Mixed Deciduous, Hill Evergreen, to Lower-Montane forest.

Dominant vegetation, such as fruit trees and palms, - in rice paddies, between Saraburi and Ayuthia, in the central plain.

Eastern Region

The areas around Saraburi, Nakhon Nayok, Chachensao, Prachinburi, Kabinburi, Aranyaprathet, eastward to the border of Cambodia - where Dry Dipterocarp forest predominates.

The region around Surin, Ubon, Phibun Mangsahan, toward the border of southern Laos - also mostly a Dry Dipterocarp forest.

Southeastern Region

From Prakan and the delta of Chao Phraya river, south of Bangkok, eastward to Rayong, Chantaburi, Khlung, Trat, to the border of southwestern Cambodia - to study Mangrove forest, stands of Nipa palm, and Beach forest.

Slopes on Khao Sa Bap, northeast of Chantaburi - Upper Moist Evergreen forest.

Northeastern Region

The Korat Plateau from Nakhon Ratchasima to Konkaen, Udon and Nongkhai, on the upper Mekong river - Mixed Deciduous and Dry Dipterocarp forests.

The region of Konkaen, Udon, Kalasin, Borabue, Phuphan Mountain, Sakhon Nakhon to Mukdahan and Nakhon Phanom on the Mekong river - Dry Dipterocarp, Mixed Deciduous, Hill Evergreen and Thorn forests.

Northwestern Region

Region of Nakhon Pathom, Banpong, Kanchanaburi, and along the Khwae Noi river to Thakanom, on the border of Burma - stands of Borassus palm, Thorn forest, Bamboo brakes and Mixed Deciduous forest.

Area around Saraburi, Lopburi, Nakhon Sawan, Tak, Thoern - Bamboo brakes, Mixed Deciduous forest, with Teak being dominant, and Dipterocarp forest.

Northern Region

From Thoern to Lampang, Ngao, Phyao, Prae, Nan, Lampun, Chiengmai and Chiengdao - Mixed Dry and Moist Deciduous, mostly Teak, forests.

Mountains Doi Sutep, Doi Puy, and Doi Chiengdao - study of Hill Evergreen forest on slopes and Pine forest on summit.

Peninsular Region

Northern:

From Ratburi, Phetb... to Hua Hin - stands of Borassus palm, Deciduous forest, Thorn forest, Bamboo brakes and other secondary growth.

Pranburi - Test site area to observe effect of defoliants on vegetation.

Central:

From Prachuap Khirikhan to Chumphon - study of Beach and Mixed Deciduous forests.

Region of Kra Isthmus to Ranong - Mangrove forest, stands of Nipa palm, Savanna and Rain forest.

Peninsular Region - continued:

Southwest:

Region of Ranong, Chaklee and Takuapa - Rain forest, Mangrove forest and Savanna.

Region of Krabi and the island of Phuket - Moist Evergreen and Mangrove forests.

South:

From Trang, Kachawng, Patalung to Haadyai - Rain and Moist Evergreen forests.

Area around Songkhla - Mixed Deciduous and Littoral forest.

AERIAL SURVEYS:

Central Region

Knao Yai National Forest, Korat Plateau, in central Thailand - Lowland Deciduous, Hill Moist Evergreen and Lower-Montane forests.

Eastern Region

Mountain range between east-central Thailand and western Cambodia - Upland Rain or Moist Evergreen forest.

Between Aranyaprathet and Ubon, in eastern Thailand - mostly Dry Dipterocarp forest.

Southeastern Region

Following the southeast coast from Bangkok to the southwestern border of Cambodia - aerial observations of Mangrove forest, especially in the region of Khlung and Trat.

Northeastern Region

From Bangkok to Nakhon Ratchasima, Sakhon Nakhon and Nakhon Phanom, as far as the middle Mekong basin - mostly Dry Dipterocarp forest in the northeast.

From Konkaen to Udon and Nongkhai, following the course of the upper Mekong river to Chiangkhan, southward to Loei and southeastward to Konkaen - aerial survey of Dry Dipterocarp, stands of Pine on the tablelands around Loei, and Dry Dipterocarp forest.

Konkaen northwestward to Loei - over Dry Dipterocarp, Mixed Deciduous, Teak and Pine forests, thence southward by way of Phetchabun to Bangkok.

North and Northwest

From Bangkok northward, following the central plain to Nakhon Sawan, Phitsanulok and Uttaradit; thence over Teak forest to Lampang and Prae; northwestward over Hill Evergreen, Dry and Moist Deciduous forests, and stands of Pine to Mae Hongson; northeastward over Dipterocarp forest to Chiengmai; southwestward over Dipterocarp and Teak forests to Mae Sariang and Mae Sot; and along the basin of the Khwae Yai river to Nakhon Pathom and Bangkok.

Peninsular Region

From Songkhla, in the southern Peninsula, westward over Moist Evergreen forest of Kechawng; Mangrove forest along the coast of Krabi, around Phuket and other islands in the southwest, and the Kra Isthmus, farther north; Rain forest in the Takuapa - Chaklee - Ranong area; and Mixed Deciduous and Hill Evergreen forests along the eastern slope of the Tenasserim Range.

Over the test site at Pranburi - to evaluate the effects of chemical defoliants on vegetation.

CLASSIFICATION OF TROPICAL FOREST TYPES

With Special Reference to

SOUTHEAST ASIA

The classification of vegetation has long been a fertile ground for discussion and speculation. This is because plant-cover, even in its simplest manifestation, is a complex variable owing to the many interrelated factors that control its distribution.

The flora and vegetation of much of the world, especially of temperate regions, are well known. Considerable information is available on the operation and effect of the environment on the vegetation of many of those areas, and which makes classification possible. But in many tropical forest regions the technical problems of descriptions and identification are great. Usually there is little information available on the influence of the climate, soil and other factors on the vegetation. So that much data still remain to be assembled before a standard system of classification of tropical forest types can be established, which would be applicable to widely separated area, such as Southeast Asia, Tropical America or Central Africa.

Several systems have been suggested or adapted for the classification of vegetation. Such plant geographers as Drude (1890), Gaussen (1933), Cain (1944), and Good (1947) are concerned mainly with the distribution of individual species and the relative coincidence of members of the same flora in certain areas.

The need for a physiognomic as opposed to taxonomic description of vegetation was recognized by Schimper (1903), the renowned plant physiologist and geographer, and later by Warming (1909), who desscribed equivalent formations based on similarity in appearance and function of botanically unrelated dominant or characteristic species. These criteria represent an appreciation of the vegetation in general and not of flora. The system advanced by Rübel (1930) covers the most important types of plant associations, and makes possible their subdivision into many facies, but it does not depend upon botanical classification of dynamic status. The main criteria he considers are woodiness, leaf-shape, type and deciduousness.

A radical departure from toxonomic thinking in descriptive ecology was also made by Raunkiaer (1934), to whom the concept of life-forms must be credited. Several authors have modified somwhat the system proposed by Raunkiaer, but on the whole the original framework has been retained. Its object is to provide a small number of categories into which all plants can be fitted according to their apparent morphological-physiological response to the unfavorable season.

According to Raunkiaer, leaves can be classified according to size, shape, venation, mode of development and other criteria.

Burtt Davy (1938), confronted with the difficult problem of establishing a preliminary classification of tropical vegetation, where detailed surveys and complete floristic inventories are unavailable, revised Schimper's and Warming's physiognomic systems, the method proposed by Tansley and Chipp (1926), and that adopted by Champion (1936) for India. Burtt Davy's system on the 'Classification of Tropical Woody Vegetation Types' was later modified and simplified by Richards, Tansley and Watt (1939).

Beard (1941), in his treatment of 'The Natural Vegetation of the Windward and Leeward Islands', deals with the classification of plant communities on a regional basis, and considers the natural distribution of plant communities, regionally constant characters of physiognomy and composition and life-forms as important criteria.

Barbour (1942) discusses the primary forest types of Tropical America, in an attempt to clarify their nomenclature, and to indicate their distribution and economic importance.

Kuchler (1947, 1949), inspired by climatological classifications, especially Koppen's (1923), was led to formulate a system, in which he uses a series of symbols which could be combined to show the most important features of any vegetation type. The symbolism proposed is essentially aimed at small-scale mapping. Therefore, it applies to an overall description of regional vegetation rather than to a detailed characterization of individual plant communities.

Holdridge (1947) constructed a chart which differentiates the vegetation of dry land areas of the world into 100 closely equivalent formations separated by temperature, precipitation and evaporation lines of equal value. The chart is designed to make broad divisions and to show actual relations between climatic vegetation formations.

The comprehensive treatment of the 'Tropical Rain Forest' by Richards (1952) contains a detailed discussion of associations and consociations and other phases of the climax Rain forest and other forest types.

Dansereau (1953) maintains that quantitative representation is the important criterion in the description of vegetation, and that a long list of species, and a complete enumeration of the flora, are of little value. Instead, the dominant and other characteristic species must be recognized, because of their physiognomic prominence and their indicator value. A knowledge of the flora provides a classification of species into floristic elements of common origin. Information on the vegetation, on the other hand, permits an entirely different classification based on ecological requirements and the usual role of the plants in the landscape. Dansereau proposed a system based predominantly on structure, rather than a knowledge of the taxonomic identity of the plants composing the respective communities. No casual factors need be considered, such as particular edaphic or climatic conditions. The principal objective is to devise a means of recording and plotting vegetation.

Criteria For Classification

In the United States the prevailing practice is to separate forest types by factors of composition, whereas European ecologists and foresters rely more upon climatic and edaphic factors In the United States a 'forest type' has been defined as a descriptive term used to group stands of similar characters as regards composition and development, owing to given physical and biological factors, by which they may be differentiated from other groups or stands. The term suggests a repetition of the same characters under similar conditions.

In order to establish a broad classification of tropical vegetation, applicable to the vegetation of Thailand or to Southeast Asia in general, important criteria for consideration are:

Habitat: This involves the primary factors of the environment, namely climatic, physiographic, edaphic (soil and subsoil) and biotic (felling, clearing, grazing, or burning).

The origin of the vegetation of any given habitat is very complicated. This is well illustrated by the range of plant associations occurring in Thailand, Vietnam or Puerto Rico. The presence or absence of a plant species is determined not by a single environmental factor, but a series of combinations is usually involved. Some of these are favorable for the plant, others may be unfavorable. A plant rarely, if ever, grows in an environment where all conditions are favorable for its optimum development. A number of local or environmental combinations exist, such as local variations in rainfall, atmospheric and soil moisture, range of daily or seasonal temperatures, velocity of wind, character of soils and intensity of light. In addition, erosion and rock decomposition. and the destruction or changing of old habitats may change the environment of the plant.

The primary cause for the presence of a plant association may depend on factors which are active now or have been operative in the past. This is well illustrated in Thailand, as elsewhere in Southeast Asia, where changes have taken place in the distribution of plant life. The destruction of the original growth over large areas, as a result of man's activities during a period of many centuries, has resulted in the modification of the original plant associations, and the development, for example, of bamboo brakes and other secondary growth.

Each plant species requires a more or less definite combination of conditions favorable for the germination of its seeds and the eventual development of the seedlings. These conditions are precipitation, atmospheric and soil moisture, temperature, soil, light, air movement, and very often association with certain other organisms. If the variation of any one or more of these factors exceeds the tolerance of the plant, its seeds fail to germinate or the seedlings may not attain maturity. Therefore, each combination of environmental characters makes possible the growth of certain species and the exclusion of others.

Each habitat has certain environmental factors which the vegetation itself cannot change materially. Such factors are temperature regulated by broad climatic conditions; rainfall influenced by climatic and physical agencies; and wind regulated by location and topography. However, these factors are but a part of the environment. This is subject also to modifications brought about by the growing plants themselves. Large plants intercept and reduce the amount of light so necessary for the development of their own seedlings and other small plants in the ground cover. They may also modify the wind currents, increase the atmospheric moisture and thereby reduce temperature. They modify the soil both physically and chemically by means of their roots and by the accumulation of decaying material. Thus, plants not only alter the environment but become a part of it.

That the physical and vegetation features of the environment are interrelated in the development of plant life in any region is clearly indicated when a habitat is disturbed. The destruction of the original vegetation, whether by the action of man or by forces of nature, is usally followed by the development of a new formation of plant life. Sites in a primary forest when felled are soon populated by fast growing plants, usually entirely different from the original growth. A teak forest in northern Thailand, when cutover, is soon invaded by certain species of bamboo, and which later are difficult to eradicate. However, the Mangrove woodland of Southeast Asia, and of other tropical regions, is an exception to this rule, in that it is an edaphic community, immersed at high tide and regenerates itself soon after cutting.

Physiognomy: By this is meant all the characters which contribute to the appearance and structure of a plant community. The physiognomy of a forest depends upon the stature, spread, and life-form of the species composing it. In a tropical forest, physiognomy includes such features as the number of stories and the height of the respective story in a particular forest type. We may distinguish horizontal structure, or spacing, and vertical structure, which corresponds to stratification. The canopy of the forest may either be open or closed, and the constituent trees may stand at certain distances apart. The primary characteristic of all but the simplest communities is their stratification. The layering or stratification of a forest may be sharply or poorly defined. In the Rain or Moist Evergreen forest there are usually three stories, of tall trees to shrubs, in addition to a ground cover of grasses, herbaceous plants, cycads and ferns. In the Dry Dipterocarp forest of Southeast Asia, on the other hand, the trees are of uniform height, widely spaced, have little or no undergrowth, so that stratification is not well demarcated.

In addition to the stature and general habit of the trees, additional characters, considered as life-forms and often present in tropical forests, include: type of branching; plank buttresses; presence of stilt roots, pneumatophores or 'breathing roots', which may be erect or knee-shaped; thorns on trunks and/or branches; characteristics (color, thickness, scaliness) of the bark; exudations, if present; and succulent stems or leaves. Other special life-forms that may be present are: woody vines or lianes, palms, cycads, rattans, pandans and epiphytes.

Other salient features of a life-form are: whether a tree is Evergreen or Deciduous; and the thickness and especially the size of the leaf. The latter factor is indicative of habitat, and can be determined by assigning it to one of Raunkiaer's 'life-size classes' (see Bibliography).

Floristics: The floristic composition of a plant community is based on assembling and identifying as many as possible of the plant species present. It involves the accumulation of precise information on the species present in a community, and some quantitative estimate of basal area, cover and density. Generally, it is possible to evaluate the physiognomy of a forest type from its floristic composition, whereas the contrary is usually not possible.

Climate: Despite existing deficiencies in accurate and consistent classification of the major forest associations on a regional or world-wide basis, there is an unmistakable relationship between climate and vegetation. That climate has a decided influence on the type and distribution of vegetation has attracted the attention of ecologists and plant geographers for more than 50 years.

The distribution of natural vegetation types in the tropics is influenced in large measure by rainfall, its amount, distribution, timing and intensity. Schimper (1903) maintained that a broad climatic-vegetative community can be segregated, on the basis of precipitation, into a series of progressively drier formations in conformity with increasing latitude.

In general, precipitation, and particularly the rainfall pattern, are functions of latitude. The inner tropics are usually very wet, with little or no seasonal changes. The middle latitudes have less rainfall, usually in alternating wet and dry seasons which may occur twice annually. The outer tropics are still drier, most frequently with a single wet and dry season each year. The rainless period increases steadily in length and severity until forests finally give way to sterile deserts, which border almost every tropical belt.

Thus, according to Schimper, tropical vegetation may be classified around a central belt of wet, luxuriant Evergreen forest occurring within a few degrees north and south of the thermal Equator. This core is bordered on the north and south by increasingly drier forests, becoming more markedly deciduous and open in character as we move away from the Equator. Wet Evergreen forest gives way progressively to less mesophytic Semi-Evergreen, Moist Deciduous, Dry Deciduous, Open Woodland and Savanna, and finally culminating in Semi-arid Thorn and Scrub forests at the lower moisture limits for tree vegetation.

Although moisture appears to be the dominant factor controlling plant life in the tropics, temperature should not be discounted entirely. In the tropics the daily variation in temperature is frequently greater than the seasonal variation of the mean. This is of importance as it may affect the seasonal phenomena or rhythms in tropical plants. In the United States as in other temperate regions, leaf-production, leaf-fall, flowering, fruiting, and growth of plants are taken for granted, and we tend to regard these phenomena as depending upon seasonal changes of temperature and light. In the tropics many plants also show periodic rhythms, although some appear to be continuously active while others behave irregularly. Regular periodic behavior is also exhibited by plants in tropical regions where there is a sharply contrasted wet and dry season. This is more surprising in tropical climates where there is precipitation almost throughout the year, and with only a very limited range in seasonal variation of temperature. In such cases the native inhabitants may be scarcely conscious of seasonal change, but depend on the seasonal behavior of plants to provide them with a timetable for their agricultural operations.

Climax Formations and Types

The classification of the vegetation of Thailand, and of the adjoining countries, may be based on climatic Climaxes or Formations. By Climax is meant a plant community that appears to be stable in terms of historic time.

A sample plot of forest growth may be regarded as an Association, sometimes called a Stand, which is the fundamental floristic unit of vegetation. This may be dominated by two, several, or many species. When dominated by a single species it is termed a Consociation; by several species as an Association. A particular forest may be a typical example of a Consociation or an Association, or it may deviate from the more prevalent type. The criterion is the presence of certain dominants and a particular flora or the total flora present. The component species, especially the dominants of certain Consociations or Associations may agree in life-forms, although the species and even the genera may be totally different. This general agreement in life-form indicates similar habitat, and especially similarity of regional climate. Associations showing such similarity may be grouped in a larger unit, the Formation. In other words, a Formation is a group of Associations which resemble each other more closely, in general physiognomic and in climatic or edaphic habitat, than to any other group of Associations. A formation, or Forest Type, is a mature, integrated community, controlled by the prevailing conditions of climate and occasionally of soil.

Some plants, such as Mangrove species, are restricted to one type of Formation and environment. Other plants overlap and flourish in two or more forest types, as in the case of Teak (Tectona grandis) in northern Thailand, where it thrives both in Moist Deciduous and Dry Deciduous forests.

Dominants, in the ecological sense, are members of a plant community which exert a determining or controlling influence on the rest of the vegetation constituting it. In other words, it applies to layers of vegetation in their relationship to, and their effect upon, other layers. Trees forming the canopy of a closed forest are typical dominants of a community, because in their absence much of the subordinate vegetation, or the lower stories of the forest, would probably not exist. In the dense Rain or Moist Evergreen forests, for example, the tallest plants of the entire community are capable of modifying or reducing the amount of light that reaches the lower layers, and at the same time increase the humidity in the air. Likewise, the subordinate stories or layers have their dominants - low trees, tall shrubs or palms - which also have a similar influence on the vegetation below each corresponding layer.

The tallest plants of some complex communities, however, are not necessarily the controlling factors. For example, as in the open Dipterocarp forest, when trees are scattered, they do not effectively modify or reduce the amount of light reaching the lower layers. Thus, very often the main controlling layer of the forest community is the comparatively low stratum of trees whose crowns are 20 to 40 feet (6-12 m.) above the ground, rather than the much taller, but more scattered, trees reaching up to 100 (30 m.) or more feet.

Widely scattered trees in a savanna have little or no effect on the grasses and other plants that constitute the ground layer, and therefore they are not the true dominants of the savanna. It is the tall grasses, particularly, which actually exercise a controlling effect on any plants of lower stature growing in-between them. Nevertheless trees growing in a savanna are often spoken of as 'dominants', because they are usually the tallest and most conspicuous plants present. The term 'Physiognomic Dominant' is best applied to conspicuous trees which give character to the savanna. Since the tall grasses share in this characteristic feature they are physiognomic dominants as well as true dominants of the ground layer.

In the silvicultural sense Dominant trees of a forest canopy are those whose crowns are more than half exposed to full illumination, while the crowns of Sub-dominant trees are less than half exposed to full light. Trees whose crowns are entirely shaded are referred to as Suppressed. This usage may thus be applied to the actual development of an individual tree.

Isolated trees whose crowns rise above the general canopy are a constant feature of several types of tropical forests. They are clearly Dominant in the silvicultural sense, but not in the ecological, since they exercise no general controlling influence on the forest. The term 'Predominant' is sometimes applied to them. Since this may imply a specially high degree of dominance, the term 'Emergent' is considered preferable. Emergent trees may be considered collectively as forming a discontinuous or extra layer above the general tree canopy.

Within an area of uniform climate, however, soil or other natural factors may have been at work to prevent the development of the typical climatic vegetation. Here the essential habitat and life-forms of the dominants are determined by such edaphic or biotic factors. Different Consociations and Associations which are influenced by these factors and agree in life-form, are known as Edaphic or Biotic Formations. A typical example of the former (edaphic) is Mangrove forest, occurring in deltas and around the estuaries of rivers in southeast and peninsular Thailand, along the coast of Cambodia, and North and South Vietnam.

Formations with characteristic life-forms and strikingly similar, and are obviously influenced by similar climatic pattern, are formed throughout tropical regions, no matter what part of the world they may occur. Long recognized as forming distinct entities they may be called Formation Types. For example the dense Evergreen forests in the high rainfall regions of southern peninsular Thailand, in Malaysia, sections of the Amazon basin, in western Colombia and West Africa belong to the same formation type of tropical Rain forest. They are composed of similar life-forms, although they may exhibit important floristic differences. Similarly the Deciduous forests of eastern North America and Europe, although sufficiently differentiated by their species, certainly belong to one formation type.

Thus we see that the problem of classifying tropical vegetation is more complex than in the comparatively simple forests of temperate zones, where, even after generations of intensive studies, the task of precise classification is still not entirely solved.

Any classification of tropical forests cannot be precise, but should be regarded as indicative of the type. It is essential and desirable that it should be simple, so that Forest Types, sufficently alike in physiognomy or structure, may be identifiable, despite floristic, soil or edaphic, climatic, and altitudinal variants that may prevail in widely separated regions. Furthermore, the forest types should be readily recognizable both on the ground and to a certain degree from aerial observations, preferably at medium altitudes (1,000 to 5,000 feet).

It is usually customary to assign names to Formations or Types, based on their physiognomy or habitat, such as Evergreen forest, Deciduous, Gallery or Riparian, or Swamp forest. Whatever term is used, it should be short, descriptive, applicable over wide areas, readily understood and easily translated into other languages.

F O R E S T T Y P E S

of

S O U T H E A S T A S I A

Although the Conifers, so characteristic of temperate Evergreen forests, are represented in Thailand and the other Mekong basin countries by species of *Pinus*, *Dacrydium*, *Podocarpus* and *Cunninghamia*, actually they constitute only a small fraction, less than 1 percent, of the forests of that region. Broadleafed species, represented by numerous genera, are dominant almost everwhere. So that the classification of the forests of Southeast Aisa into Coniferous or Softwood and Broadleafed or Hardwood species, is not considered applicable. A more practicable method is to segregate the forests of those countries into two broad categories: (a) Evergreen forests, which include the Conifers; and (b) Deciduous forests.

The forests of Thailand may be assigned to about twelve Climax Formations or Types, all or most of which also occur in North and South Vietnam, Laos and Cambodia. These primary types may be furthered divided into Sub-types or Sub-climax communities, according to variations induced by such factors as micro-climate, and localized edaphic or biotic conditions.

EVERGREEN FORESTS

(1) RAIN FOREST: (See Figs. 20, 21)

Synonyms: Tropical Rain forest, Evergreen Rain forest, Tropical Wet Evergreen forest, Wet forest, Wet Evergreen forest, Tropical Evergreen forest, Broad-leaved Evergreen forest; Evergreen forest and the *Forêt dense humide* of French ecologists.

Of the several terms applied to this Type, the rather long 'Tropical

Broad-leaved Evergreen forest' seems to be the most appropriate. The designation 'Evergreen forest' is not entirely applicable, because it would also include Coniferous forest. 'Rain forest', although descriptive of the cause of the Type rather than of the Type itself, is also acceptable because it is concise, readily understood, and in general use in tropical regions.

Several factors are essential for the development of the Rain forest. The major features are discussed briefly on the following pages.

Climate: The prevailing climate in the Rain forest is marked by relatively high temperatures. Variations in temperature are remarkably slight on a diurnal, seasonal or geographical basis. According to readings taken at typical sites, the mean annual temperature is said to be about 79°F. (26°C.). Soil temperatures are equally constant. Low temperature appears to be the major factor setting the altitudinal limit of the Rain forest. It is essentially frost-free except along its upper altitudinal border.

Rainfall: Rainfall is high. In areas with optimum Rain forest there is no marked seasonal drought, but precipitation is scattered throughout the year. Actually there are only limited areas in the humid tropics which are truly non-seasonal. Wet and dry seasons usually alternate. This factor, in turn, may influence seasonal rhythms in flowering, production of young leaves, and other physiological processes. Unlike the temperature range, annual precipitation is highly variable both diurnally and seasonally, as well as geographically. In some favorable distribution patterns, annual precipitation of 63 inches (1,600 mm.) might be considered as absolute minimum, whereas in the southwestern Peninsula of Thailand, 79 inches (2,000 mm.) is regarded as a typical minimum. At Takuapa, in the southwestern section of the Peninsula, the maximum may reach 164 inches (4,170 mm.), and in some years even more. Some areas with annual precipitation above the minimum indicated may have drought periods, especially in regions where there is high evaporation. Therefore, the seasonal pattern is highly important, for true Rain forest cannot exist in an area where there is a well-defined and a prolonged dry period, lasting 2 or more months.

Humidity: In addition to high temperature and abundant rainfall, Rain forest areas are characterized by uniformly high humidity. This seems to be at or near the saturation point at night, and remains high during most of the day, even during the dry season. This factor may compensate for lower rainfall at certain periods in some areas. Humidity tends to increase with elevation. For example, along the upper slopes and ridges of mountains, humidity may remain constantly close to saturation.

Wind: This is an important factor in humid areas where its effect on evaporation rate and resultant drying of the atmosphere could be critical. In general, wind velocities appear to be lower, and violent winds are usually less frequent in such tropical areas as Southeast Asia, than in temperate zones. In many parts however, thunderstorms, preceded by squalls of strong winds, are common, resulting in the felling of individual trees or stands.

Radiation: Daylight radiation averages 10 to 12 hours in Rain forest areas, with a slight annual variation. There is usually a high degree of cloudiness, which is greatest in the wet season. In addition to the presence of impurities in the air, such as dust and smoke from brush fires, the total amount of bright sunshine may be small. Radiation appears to be less intense at ground level in the Rain forest than in correspondingly high forests of temperate regions.

Soils: The soils of Rain forest are very variable in structure and in physical and chemical properties, but the majority share certain similar characteristics. They are red or yellow, lateritic, loamy or clayey in texture, although the upper layers may be sandy. They are invariably acid, with relatively low humus content, and are often deficient in plant nutrients. These qualities are influenced by the powerful action of major climatic factors, particularly heavy rainfall and high temperature. Abundant precipitation produces an almost continuous downward movement of water in the soil, resulting in heavy leaching. High and relatively uniform temperature are also a major factor in the breakdown of leaf litter and other forest debris, in addition to the action of micro-organisms. Termites and ants also contribute to the destruction of dead roots and other woody residues.

Under the influence of such dominant habitat factors, mature soils show a wide range in character, which in turn is reflected in vegetation. The physical conditions are of great importance, expecially those which control the soil moisture absorbed by the plant and the supply of oxygen to its roots. It is conceivable that, in addition to the influence of temperature and rainfall, soil factors are the most important element which contribute to the occurrence of Rain forest, and that edaphic conditions are chiefly responsible for its absence in areas which otherwise would be suitable.

Physiognomy: Among outstanding features of the optimum Rain forest of humid areas, such as those found in limited parts of Southeast Asia, the most evident are the richness of the flora, and that the overwhelming majority of dominant plants are trees and shrubs, and many of the climbing plants and some of the epiphytes are also ligneous. The trees are extremely numerous in species and varied in size. The average height of those forming the canopy seldom exceeds 150 ft. (46 m.), and usually ranges between 90 and 120 ft. (30-40 m.). A few trees in Southeast Asia, such as Jelutong (Dyera costulata), in southern peninsular Thailand and Malaysia, or a species of Koompassia in Sarawak, Northern Borneo, and Malaya, may exceed 200 feet in height.

The Rain forest is a community with a large series of co-dominants, or sometimes there may be only one or two dominants. While rich in species, the trees are remarkably uniform in their general appearance and physiognomy. Among dominant trees the boles are usually straight, rather slender in relation to their height or compared with the girth of some large trees in higher latitudes, and are generally clear of branches for 70 to 90 feet (22 to 28 m.). Their crowns are relatively restricted, of variable form from wide-spreading, round or umbrella-shaped to narrow and irregular. Plank buttresses, flange-like outgrowths at the base, are characteristic of Rain forest trees, and which are less developed, sometimes absent, in other Forest Types. The bark may be thin to thick, smooth or rough, scaly with deep fissures, plates or conspicuous lenticels.

The type and density of foliage are variable in the Rain forest. The majority of mature trees, as well as seedlings and shrubs have large, leathery, dark green leaves, with entire or nearly entire margins. The Rain forest may contain some deciduous or partially deciduous trees, but to all intents and purposes it is constantly evergreen. So that the term 'Evergreen' applied to this forest type is redundant, as there is no Deciduous or Semi-Evergreen Rain forest. Compound leaves predominate in the upper stories, simple leaves are frequent in the lower story. Most of the trees and shrubs have inconspicuous flowers, often whitish or greenish. Large and strikingly colored flowers are somewhat rare. The forest interior is usually gloomy, although when the sun is shining the floor may be dappled with sun-flecks. To some the Rain forest gives the impression of the vault of cathedral aisles. The uniform and generally somber hue of the leaves contribute in part to the monotonous character of this forest.

Unlike forests in Temperate regions, in the Rain forest there is no well-defined periodicity of new leaf crop, flowering, fruiting, or leaf shedding. It is a perpetual midsummer, although there are periods of maximum flowering, during which more species are in flower than at other times, as well as seasons of maximum production of young leaves. For the most part plant growth and reproduction are continuous, and some flowers and/or fruits can be found at any time. This is a direct influence of climate, characterized by high temperature and humidity, and slight seasonal variation.

Owing to the great range in the height of trees, the Rain forest is usually stratified or multi-layered in structure. Most often there are three layers, in addition to a lower layer of shrubs and a ground cover of herbs. In comparision with the number of woody species, life forms such as palms and pandans (Pandanus) are less abundant, but bamboos and rattans (Calamus) are frequent. Mosses, liverworts, lichens and epiphytes, including a variety of orchids, are also generally abundant, growing on the trunks, branches and in the crotches of trees and shrubs, in addition to ferns and flowering plants covering the ground. The abundance of climbers, especially stout woody lianes, is another characteristic feature of this forest. Their massive stems (See Fig.23), often of great length, cling closely to tree trunks or hang loosely like cables from the topmost branches.

Range: There are only limited areas in Southeast Asia with high precipitation, exceeding 150 inches annually, and uniformly scattered throughout the year; where atmospheric moisture ranges up to 90 percent; with a narrow diurnal or seasonal fluctuation in temperature; and where insolation or radiation is not high. Consequently, the true Rain forest is of limited extent and distribution in Thailand, Vietnam, Cambodia and Laos.

In Thailand Rain forest attains its optimum development along the southwest coast of the Peninsula, especially in the Chaklee mountains south of Ranong; around Takuapa, where the highest annual rainfall, exceeding 200 inches, in Thailand has been recorded; and in isolated sites in the mountain ranges extending close to the border of Malaysia. Stands of this forest type occur also in the southeast in the mountain ranges of Khao Sa Bap and Khao Ban That, bordering Cambodia. Additional scattered sites, similar in structure and life-form, and to some degree in floristic composition, are found in isolated sites in the Khao Yai National Forest, in the central region of Thailand.

In Cambodia the true Rain forest, as distinguished from the Moist Evergreen forest, has long been exploited to a considerable extent for timbers. So that today this dense forest is reduced to areas in the Cardamom and Elephant mountains in the southwest.

Likewise, in part owing to extensive and intensive exploitation of timbers over a period of many centuries, and the widespread practice of shifting agriculture, Rain forest forms only a minor fraction of the vegetation in North Vietnam and in the southern section of South Vietnam. Annam, in central Vietnam, has long been considered the principal forested area and source of useful timbers in that divided country. We have no record of true Rain forest in Laos.

Economic Importance: Unlike the Dipterocarp or Teak forests, or Savannas, which are burned over annually, Rain forest is usually not affected by fire, or to any appreciable extent by shifting agriculture. Small patches, of 4 to 6 acres, are cleared in the forest to grow crops for subsistence, and then abandoned after 2 to 4 years. Great areas have been cleared, however, in southern peninsular Thailand, as well as in South Vietnam and Cambodia to establish plantations of Pará rubber (*Hevea brasiliensis*).

In general the Rain forest is an important source of raw materials of commercial importance, some of which figure in international trade. These include a variety of timbers; gums and resins; rattan; edible fruits and other minor products.

Timber species of commercial importance in the Rain forest of Thailand include:

Afzelia bakeri	Dipterocarpus turbinatus
Afzelia xylocarpa	Fagraea cochinchinensis
Ailanthus fauveliana	Hopea ferrea
Amoora polystachya	Hopea odorata
Anisoptera cochinchinensis	Hopea pierrei
Anisoptera glabra	Hopea recopei
Artocarpus calophylla	Lagerstroemia balansae
Artocarpus lakoocha	Lagerstroemia calyculata
Balanocarpus heimii	Lagerstroemia flos-reginae
Calophyllum floribundum	Litsea grandis
Calophyllum inophyllum	Mesua ferrea
Calophyllum pulcherrimum	Michelia champaca
Cedrela toona	Parashorea stellata
Cinnamomum iners	Phoebe paniculata
Cotylelobium lanceolatum	Sandoricum indicum
Dalbergia cochinchinensis	Shorea cochinchinensis
Dipterocarpus alatus	Shorea curtisii
Dipterocarpus baudii	Shorea glauca
Dipterocarpus costatus	Shorea gratissima
Dipterocarpus dyerii	Shorea guiso
Dipterocarpus grandiflorus	Shorea hypochra
Dipterocarpus incanus	Shorea parvifolia
Dipterocarpus kerrii	Shorea weisneri
Dipterocarpus kunstleri	Vatica cinerea
Dipterocarpus pilosus	Vatica wallichii

Many minor forest products obtained from the Rain forest include: Rattans (Calamus species), which furnish splints exported for the manufacture of cane-seats and backs of chairs. The core remaining after the rigid outer part has been removed is used for making reed furniture and light-weight baskets. Selected canes, for making walking sticks known as Malacca canes, are derived from Calamus scipionum, growing in southern peninsular Thailand. Rattans are also utilized extensively for lashing logs into rafts. Considerable quantities of rattans have long been exported to Singapore, the center for this forest product from various countries of Southeast Asia.

Dammar resins are obtained from several species of the wood-oil family (Dipterocarpaceae), especially Balanocarpus heimii, Anisoptera spp., and Shorea hypochra. The best dammar, known as 'white dammar' and used in the manufacture of high grade varnish, is furnished by Balanocarpus heimii.

Gamboge gum, the product of Garcinia hanburyi, is a bright yellow resin of appreciable commercial importance, used especially as a coloring agent.

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- *Anisoptera cochinchinensis*
- *Anisoptera glabra*
- *Artocarpus calophylla*
- *Artocarpus lakoocha*
- *Balanocarpus heimii*
- *Calophyllum floribundum*
- *Calophyllum inophyllum*
- *Calophyllum pulcherrimum*
- *Cedrela toona*
- *Cinnamomum iners*
- *Cotylelobium lanceolatum*
- *Dalbergia cochinchinensis*
- *Dipterocarpus alatus*
- *Dipterocarpus baudii*
- *Dipterocarpus costatus*
- *Dipterocarpus dyerii*
- *Dipterocarpus grandiflorus*
- *Dipterocarpus incanus*
- *Dipterocarpus kerrii*
- *Dipterocarpus kunstleri*
- *Dipterocarpus pilosus*
- *Dipterocarpus turbinatus*
- *Fagraea cochinchinensis*
- *Hopea ferrea*
- *Hopea odorata*
- *Hopea pierrei*
- *Hopea recopei*
- *Lagerstroemia balansae*
- *Lagerstroemia calyculata*
- *Lagerstroemia flos-reginae*
- *Litsea grandis*
- *Mesua ferrea*
- *Michelia champaca*
- *Parashorea stellata*
- *Phoebe paniculata*
- *Sandoricum indicum*
- *Shorea cochinchinensis*
- *Shorea curtisii*
- *Shorea glauca*
- *Shorea gratissima*
- *Shorea guiso*
- *Shorea hypochra*
- *Shorea parvifolia*
- *Shorea weisneri*
- *Vatica cinerea*
- *Vatica wallichii*

Many minor forest products obtained from the Rain forest include: Rattans (*Calamus* species), which furnish splints exported for the manufacture of cane-seats and backs of chairs. The core remaining after the rigid outer part has been removed is used for making reed furniture and light-weight baskets. Selected canes, for making walking sticks known as Malacca canes, are derived from *Calamus scipionum*, growing in southern peninsular Thailand. Rattans are also utilized extensively for lashing logs into rafts. Considerable quantities of rattans have long been exported to Singapore, the center for this forest product from various countries of Southeast Asia.

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Gamboge gum, the product of *Garcinia hanburyi*, is a bright yellow resin of appreciable commercial importance, used especially as a coloring agent.

Gutta-percha of an inferior grade, an insoluble gutta gum obtained from the tall 'ma-sang' tree (Palaquium obovatum), of the Sapodilla family, was formerly extracted in considerable quantities in southeastern and peninsular Thailand. It has the unusual property of being an excellent insulator for heat and electricity. At one time it was used on a considerable scale for coating submarine cables, as its composition remains unchanged almost indefinitely when submerged in water.

An oleo-resin, obtained by tapping various trees of the wood-oil family (Dipterocarpaceae), especially Dipterocarpus alatus, D. turbinatus and D. pilosus, is used locally for making torches, for caulking canoes, as a varnish and to water-proof pails.

Jelutong gum, also an insoluble gum, is extracted from a large tree, Dyera costulata, growing sporadically in southern Peninsula, and Malaysia, for use as a base in the manufacture of chewing gum.

Cardamoms are derived from the fruits of several species of Amomum. The best grade is obtained from Amomum krervanh, cultivated on a limited scale in the Chantaburi province, southeastern Thailand. An inferior grade known as bastard cardamom, is derived from the fruit of A. villosum and A. xanthioides, the main source of which is in the northeastern part of the country. Cardamoms have long been known in world trade for use in medicine and for flavoring food.

Incense wood is produced from several species of trees, especially Mansonia gagei, Aquilaria crassna, and Aquilaria agallocha. The heartwood of the last-named species furnishes the so-called 'eagle wood', used for burning as incense, to make joss sticks and in the manufacture of perfumes.

Bamboos have an extensive and versatile utility, including the building of homes, in the manufacture of paper pulp, and for living fences and windbreaks. In coastal areas of Thailand they are widely used for stakes to construct fish traps. From the west coast of the Peninsula there has long been a considerable export of bamboos to Java and Sumatra, where they are utilized for making frames to cure tobacco leaves.

Chaulmoogra oil is derived from the seeds of Hydnocarpus kurzii. A similar oil is also obtained from H. anthelmintica. In Thailand, as elsewhere, chaulmoogra oil has long been used in the treatment of leprosy.

Corypha leaves, obtained from the 'lan' palm (Corypha umbraculifera), are popularly used in preparing Buddhist script and in the manufacture of hats.

A number of trees and other plants furnish edible fruits, including 'durian' (Durio spp.) and 'phungtha-lai' or 'sam-rong', obtained from Sterculia lychnophora, and which is much esteemed in confectionery.

(2) MOIST EVERGREEN FOREST

This type resembles the Rain forest in general physiognomy, life-forms, and in having a 3-strata structure, with a dense undergrowth (Figs. 22, 25, 26). Some ecologist make no distinction between Rain forest and Moist Evergreen forest, but combine them under the term Wet Evergreen forest. The dominant tree species are somewhat of lower stature than those in the climax Rain forest. They are generally up to 90 or 110 ft. (30 or 35 m.) in height, with straight trunks, and a continuous canopy of green foliage of varying hue. The ground cover contains many species of herbaceous plants, ferns, rattans (Calamus) and palms.

The annual rainfall in this type is lower than in the Rain forest, ranging between 60 and 80 inches (1,500-2,000 mm.), and supplemented by ample soil and atmospheric moisture. Unlike the absence of a dry period in the Rain forest, the seasons are sharply defined into dry and rainy periods of about equal duration. This is perhaps the principal and essential difference between the Rain and Moist Evergreen forests. The diurnal and seasonal fluctuation in temperature is slightly more pronounced than in areas with Rain forest.

This forest type may be segregated into Lowland Moist Evergreen, and Hill or Upper Moist Evergreen forest, occurring on the slopes of hill and mountain ranges at elevations up to 2,500 or 3,000 ft. (800-1,000 m.). Moist Evergreen forest is widespread in Thailand, Vietnam, Cambodia and Laos, and corresponds to what French ecologists or foresters describe as 'forêts denses'.

In Thailand, Moist Evergreen forest occurs in the southern section of the Peninsula; on the flanks of the Tenasserim range, in the west bordering Burma; in the Khao Yai National Forest in the central region; along the slopes of the Khao Sa Bap and Khao Ban That mountains in the southeast; on the island of Ko Chang, with an altitude up to 450 - 650 ft. (150-200 m.), also in the southeast; the Pokadien mountains in the Loei region, in the north, at altitudes up to 3,000 ft. (1,000 m.); in sections of the Phu Phan mountain between Kalasin and Sakhon Nakhon, in the northeast; and on the upper slopes of Chiengdao and other mountain ranges in northern Thailand.

One of the best examples of Lowland Evergreen forest is that of Kachawng, a forest reserve between Trang and Patalung, in the southern Peninsula. It resembles in many respects the Rain forest, farther west, around Takuapa, in southwestern Peninsula. Large trees with long boles, and often with buttresses, composing the canopy in the Moist Evergreen forest of Kachawng include: Hopea odorata, Anisoptera curtisii, Sandoricum indicum, Sterculia campanulata, Parkia speciosa, Hopea ferrea, Alstonia scholaris, Palaquium obovatum, and species of Artocarpus, Afzelia, Dalbergia, Intsia, Lagerstroemia, Vatica. The family Dipterocarpaceae is represented by Dipterocarpus alatus, D. turbinatus and D. grandiflorus, and the genus Shorea by S. gratissima, S. glauca, S. parvifolia and S. sericea.

As in the Rain forest, the majority of trees have dark green, leathery leaves. Generally the flowers are inconspicuous. Some of the trees are deciduous at one time or another, but the forest is constantly evergreen, and there is no well-defined period of flowering or fruiting.

In the second story, trees of the Laurel (Lauraceae), Myrtle (Myrtaceae) and Custard-apple (Annonaceae) families are well represented, intermingled with such palms as Arenga pinnata and Livistona speciosa, and woody vines or lianes, mostly of the families Leguminosae and Bignoniaceae.

The undergrowth is dense, somewhat difficult to penetrate, with many shrubs, particularly of the families Rubiaceae (coffee) and Acanthaceae, ferns, and such herbaceous plants as species of Alpinia, Amomum and Zalacca.

A typical Hill or Upper Moist Evergreen forest occurs in the Khao Yai National Park, in central Thailand, ranging in altitude from 750 to 2,500 ft. (250-800 m.). The physiognomy or life-forms of this excellent forest resemble those of the Lowland Moist Evergreen forest at Kachawng, except that many of the tree species are entirely distinct from those at Kachawng, in southern peninsular Thailand. Dominant trees in this forest are Dipterocarpus costatus, D. gracilis, and D. turbinatus. Other representative trees include species of Ficus, Altingia, Aromadendron, Cedrela, Poupatria, Anthocephalus, Carallia, Antiaris, Sapium, Lithocarpus, Persea, and Schefflera.

Trees in the substory include: Camellia confusa, Eugenia siamensis, Helicia javanica, and Maesa ramantorcea. Palms are also represented in the understory by Caryota urens, Arenga saccharifera and Livistona speciosa. Rattans include species of Daemonorops and Calamus. Among woody vines are species of Toddalia, Bauhinia, Mucuna and Entada.

The following partial list of genera, represented mostly by medium to large trees recorded in a small area, is indicative of the diversity and richness of the floristic composition of the Moist Evergreen forest at Kachawng, southern peninsular Thailand, at altitudes of 450 to 650 ft. (150-200 m):

Acacia	Duabanga	Oncosperma
Adenanthera	Durio	Oroxylon
Adina	Erioglossum	Padbruggea
Aglaia	Erythroxylon	Paederia
Alangium	Eugenia	Palaquium
Alstonia	Fagraea	Parkia
Anisoptera	Ficus	Pentapetes
Anthocephalus	Gnetum	Phoebe
Ardisia	Grewia	Pithecelobium
Arenga	Helicia	Planchonella
Artabotrys	Heterophragma	Pothos
Artocarpus	Hopea	Premna
Baccaurea	Hydnocarpus	Pterospermum
Bambusa	Intsia	Pygeum
Barringtonia	Lagerstroemia	Quercus
Bouea	Lansium	Sandoricum
Calamus	Linociera	Sapium
Carallia	Litsea	Saraca
Cedrela	Livistona	Schefflera
Ceriops	Macaranga	Semecarpus
Chasalia	Mangifera	Shorea
Cinnamomum	Melodorum	Sindora
Clerodendron	Memecylon	Sonneratia
Cratoxylon	Mesua	Sterculia
Crypteronia	Michelia	Streblus
Curcilago	Morinda	Syzygium
Dalbergia	Murraya	Tetracera
Desmodium	Myricaria	Tetrameles
Dialium	Myriopteron	Tournefortia
Dillenia	Myristica	Vatica
Dioscorea	Nauclea	Vitex
Diospyros	Neolitsea	Walsura
Dipterocarpus	Nephelium	Zanthoxylum
Dryopteris	Neuropeltis	Zollingeria

(3) DRY EVERGREEN FOREST

This forest type is composed of small to medium-sized trees. Their trunks are straight or twisted, seldom exceeding 12 inches (30 cm.) in diameter, and many species have stiff leathery leaves. There are few scattered large trees among them; woody vines are abundant, but herbaceous ground cover is somewhat sparse.

Representative of the Dry Evergreen forest is the Gallery forest, or woodland along or close to rivers and streams (Riparian or Riverain forest). Although the annual precipitation may be low, as in the northeast, the moisture in the soil along the river banks is sufficient to sustain a constantly evergreen growth. Some of the trees, of course, are deciduous.

This forest type is rather widespread in Thailand, found in such areas as around Pranburi, in the upper Peninsula; at Prachuab-Khirikhan, in the central Peninsula; in the area of Mukdahan and elsewhere in the northeast; Pokadien, in the region of Loei, in the north; and especially along banks of rivers or streams scattered throughout the country.

Woody species occurring in this type of forest vary from one region to another. For example, in the Pranburi area, a dominant plant is Streblus zeylanicum, constituting about 50 percent of the vegetation. Other trees in this dry forest include species of Vitex, Diospyros, Ficus, Eugenia, Aglaia, Walsura, Hopea, Spondias, Salmalia, and Cratoxylon.

Some of the trees and shrubs in the understory are thorny. Woody constituents are species of Hydnocarpus, Murraya, Atalantia, and Taxotrophis. Rattans (Calamus) may also be present. Bamboos are represented by Bambusa arundinacea, Dendrocalamus strictus and species of Gigantochloa.

Semi-Evergreen forest: This subtype also has a wide distribution in Thailand. The trees are of medium stature, ranging from 45 to 60 ft. (15-20 m.), although some emergent species may attain 90 ft. (30 m.). Usually they have straight trunks, with a diameter of 12 to 24 inches (30-60 cm.). The majority of the trees shed their leaves at some period of the year, but in general this subtype has a Semi-Evergreen appearance.

Typical of a Semi-Evergreen forest is found around Tak, in the northwest. Important constituents of this subtype in that area are: Afzelia xylocarpa, Alangium salvifolium, Cassia garrettiana and C. siamea, Chukrasia velutina, Dalbergia cultrata, Dillenia sp., Dipterocarpus tuberculatus, Erythrophloeum teysmannii, Garuga pinnata, Hopea odorata, Lagerstroemia flos-regina, Michelia champaca, Pterocarpus macrocarpus, Terminalia tomentosa and Vitex pubescens.

(4) MONTANE FOREST

Changes in vegetation, corresponding to increasing altitudes, are just as striking in the moist tropics as they are in temperate regions. As we ascent a forest-clad mountain slope, such as in northern Thailand for example, there is a decided change in the floristic composition and structure of the vegetation. The luxuriant Rain and Moist Evergreen forests are gradually replaced by trees of entirely different species and even genera, and generally of smaller dimensions. The Montane forest commences at an altitude of approximately 3,000 ft. (1,000 m.) and extends to the crest of high mountains to at about 8,000 ft. (2,400 m.). In between the Upper Moist Evergreen forest and the Montane forest there is usually a transitional belt of forest. The Montane forest may be subdivided into: (a) Lower Montane; and (b) Upper Montane.

(a) Lower Montane: A typical example of this sub-type is found in the Khao Yai National Forest, central Thailand (Fig. 30), on fairly steep, well-drained slopes and plateaus, at elevations of 3,000 to 4,500 ft. (950-1,400 m.), and where the annual rainfall ranges up to approximately 120 inches (3,000 mm.). The forest is moderately tall ranging up to 60 or 75 ft. (20-25 m.). Most of the trees have rather small crowns with slender branches. Their trunks are likewise more slender than those in the Rain or Moist forests, straight to fairly so, closely spaced, and usually without buttresses, a life-form that is characteristic of the Wet Evergreen forest. Woody vines are present, but bamboos, rattans and palms are few or absent. Herbaceous plants are also sparse.

Dominant trees in the Lower Montane of the Khao Yai Forest are oak (Quercus) and chestnut (Castanopsis)(Fig. 30). Of the oaks, the most common species is Quercus fleurii, and of the chestnut, Castanopsis acuminatissima. Associates of these trees are: Lithocarpus spicatus, Schima wallichii, Dacrydium elatum and Podocarpus neriifolia. This forest type also covers the plateaus along the summit of the range. There, in addition to oak species, trees of the genera Schima and Dacrydium appear to be dominants. Small patches of sphagnum bogs are found on the plateau, surrounded by trees of small stature, such as species of Olea, with their trunks and branches covered with mosses, influenced by the humid atmosphere.

(b) Upper Montane: This forest subtype is found in northern Thailand, on the slopes and summit of such mountain peaks as Doi Sutep, Doi Inthanon and Doi Chiengdao, in the region of Chiengmai (Figs. 55, 56).

The east slope of Doi Sutep, which has an altitude of 5,450 ft. (1,676 m.), is covered by Dry Dipterocarp forest up to about 2,300 ft. (700 m.). Between 2,300 and 3,200 ft. (700-1,000 m), the vegetation is an intricate mosaic of Dry Dipterocarp and Mixed Deciduous forests, mixed with species of temperate evergreen belt. The forest is composed mostly of species of oak (Quercus)and chestnut (Castanopsis). Oak trees attain a height of 50 to 65 ft. (16-20 m.), and about 12 in. (30 cm.) in diameter. A thin layer of humus and thick litter accumulate on the forest floor, but the undergrowth is poor, mostly composed matter of the ubiquitous 'khao-lang' grass (Imperata cylindrica).

The southern and southwestern slopes of Doi Sutep, up to the summit, are occupied by low evergreen trees, such as species of Quercus, Helicia, Castanopsis, Lithocarpus, Dalbergia, Phyllanthus, Camellia and Melanorrhoea. The ground cover is a dense growth of rough grass. This is probably secondary growth, as a result of shifting agriculture.

Above 4,000 ft. (1,200 m.), on the upper slopes near the summit of Doi Sutep and Doi Puy the Oak-Chestnut belt is replaced by the 3-needled pine (Pinus khasya). Small ferns and the 'kha-luang' grass (Imperata) are the most-frequent components of the ground cover. On the summit the trees are dwarfed, with twisted trunks, and are seldom more than 25 to 30 ft. (8-10 m.) tall. Mosses and other epiphytes cover their trunks and branches. During February the white flowers of a species of Rhododendron are conspicuous in the canopy. Other noteworthy plants are an epiphytic Vaccinium, and a species of Gnetum. with reddish fruit and edible seeds, growing on tree trunks.

(5) CONIFEROUS FORESTS

As indicated, Conifers do not form an integral part of the vegetation of Southeast Asia, constituting, for example, less than 1 percent of the total forested area of Thailand (Fig. 8).

Two species are the most frequent and characteristic, namely the 3-needled Pinus khasya, with furrowed bark, and the 2-needled Pinus merkusii, with scaly bark (Figs. 49, 54). Both species are found in Thailand, particularly in the north; in northern and central Laos; in the mountainous northern region of North Vietnam, and in isolated upland areas of central and southern South Vietnam. Small stands are also found in central and southeastern Cambodia.

As a forest type in Thailand, these pines are concentrated in the northern mountain ranges surrounding Chiengmai, where they form almost solid stands over a large area. In this region, they are found at altitudes between 2,000 and 4,000 ft. (600-1,200 m.), and even as high as 5,200 ft. (1,600 m.) on the mountains Doi Sutep, Doi Puy and Doi Inthanon, west of Chiengmai; also on the summit of Doi Chiengdao, northward in the direction of Fang. On the plateau of Bo Luang, southwest of Doi Anka at an elevation of 3,000 to 4,000 ft. (910-1,200 m.), there is also an extensive, pure stand of pine, surrounded by Moist Deciduous forest. To the west, towards the border of Burma, they occur in abundance between Chiengmai, Mae Hongson and Mae Sariang. To the east, pines are dominant on the plateaus of the Pokadien mountains, in the region of Loei. They are also found as low as 1,300 ft. (400 m.) in the province of Phetchabun. The 3-needled pine (P. khasya) is found in the upper altitudes, while the 2-needled P. merkusii (Fig. 52) grows at lower elevations, even mixed at times with Mixed Deciduous forest.

In addition to pines, other genera of Conifers are represented in Southeast Asia. In Thailand, for example, there are 4 species of Podocarpus. Although widely distributed they are nowhere abundant. One species, P. imbricatus, grows in Evergreen forest in the province of Chantaburi, in the southeast. Podocarpus latifolia grows in the region of Mae Hongson, in the northeast; and Podocarpus nerifolia has a wide distribution, occurring around Chiengmai and Chiengrai, in the north, and in the region of Ubon, eastern Korat plateau.

Another species of Conifers found in Southeast Asia is Cunninghamia sinensis, growing naturally in South Vietnam and in South China.

(6) SWAMP FORESTS

Vegetation in swamp lands is a characteristic feature of the landscape in Southeast Asia, as in other tropical regions. This shows a gradation from the Mangrove woodland around deltas and river estuaries along the coast, in which the soil is saline for a considerable distance inland, caused by the tide which brings in salt water, to vegetation found in brackish water, and finally the type occurring in freshwater swamps.

Consequently, Swamp forests may be segregated into the subtypes: (a) Mangrove woodland; and (b) Freshwater woodland.

(a) Mangrove Forest: This is a plant community controlled primarily by edaphic, or soil, factors (Figs. 57-63). In one sense, it is a specialized plant community forming a belt of varying width along the banks of deltas, shores, rivers and islands below high tide mark. This woodland is the result of constantly changing conditions brought about by the accumulation of alluvium deposited by streams and rivers, by tidal movements of salty or brackish water around estuaries as well as inland for appreciable distances upstream, and by the effect of wave action along seacoasts on the deposition of silt, sand and mud.

Under such specialized conditions, the effect of climate on the development of Mangrove forest is less marked than on other forest types, such as the Rain or Moist Evergreen forests, for example. Also, in general, the level of the ground is gradually rising and slowly moving farther away from the sea, as accretion seaward takes place, resulting from the continuous deposition of silt carried by rivers, especially in areas with high rainfall. As a rule, the soil along the margin of Mangrove forest usually contains a high clay fraction, is often compact, bluish and has low organic content.

The Mangrove forest is composed of about 20 species of trees and shrubs forming a characteristically dense, seemingly impenetrable, tangled evergreen mass of low forest, ranging in height from 6 to 60 ft. (2-18 m), occasionally more. The dominant species have specialized life-form features and structural adaptation to withstand periodical flooding and physiological dryness, and salinity of the water. For example, Rhizophora candelaria, common in Southeast Asia, has stilt roots; species of Bruguiera have 'knee' roots;

while those of Sonneratia, Avicennia and Xylocarpus send up asparagus-like, pointed pneumatophores. Some dominant species are also characterized by a tendency toward vivipary, in which case their seeds germinate before falling.

Another outstanding feature of Mangrove forest is the zonation of the different tree species, with definite delineation of the dominants in strips or narrow belts, more or less parallel to the shore line. This zonation is especially observable from the air. In Southeast Asia, for example, Sonneratia alba is the pioneer tree in the Mangrove forest. Later, it becomes mixed with Avicennia along the seaward margin. Rhizophora trees are on somewhat higher ground, while species of Bruguiera develop on the landward margin, often extending to the extreme tidal limit of the swamps.

Range: The coastline of Thailand measures more than 1,250 miles (2,000 km.) in length. A great part of this is flanked by stands of Mangrove of variable extent. The total area of this swamp forest is estimated at 725 square miles (1,620 sq. kms.). Of these, 286 square miles are located along the southeast coast, as far as the Cambodian border, and especially in the region of Khlung and Trat; and 439 square miles along the east and west coasts of the Peninsula, with the greatest concentration in the Kra Isthmus, and extending for about 300 miles from Ranong in the southwest to Krabi, including the several islands in the Phuket bay, to the Malaysian border.

Appreciable stands of Mangrove, composed of tall trees, grow along the coast of Cambodia. In South Vietnam extensive stands, covering about 1,800 square miles, are found along the south coast from Pointe de Camau to Cap Saint Jacques (Fig. 11). In North Vietnam the Mangrove forest covers a much smaller area, of about 360 square miles, confined to the coastal area northeast and southwest of Haiphong.

Economic Importance: Because of the series of products obtained from the Mangrove forest, it is of considerable importance in the local economy of Southeast Asia, as in other tropical countries. In Thailand, it ranks next to Teak in importance. Several tree species are important sources of firewood. The one long in demand for charcoal, furnishing the best quality, is Rhizophora conjugata. In Vietnam, owing to long and extensive exploitation, this tree is now becoming scarce, and is being replaced by Bruguiera parviflora.

Timbers useful for rafters and general house construction are furnished by: Rhizophora conjugata, Lumnitzera coccinea, Bruguiera gymnorrhiza and Carapa obovata. Bruguiera parviflora and Avicennia marina furnish poles for fish traps. Lumber, of small dimension, is cut from Avicennia marina and Lumnitzera coccinea. Timbers furnished by Bruguiera gymnorhiza, Excoecaria agallocha and Lumnitzera conjugata are used for piling in heavy construction.

Nipa Palm Association: Nipa (Nipa fruticans), or 'chak' as it is known in Thailand, is a palm with short, prostrate trunk, and pinnate leaves up to 15 or 20 ft. (5-6.5 m.) in length (Fig. 64). In Thailand, as in the neighboring countries of Southeast Asia, it occurs around the coasts, often forming rather extensive, dense pure stands on the landward side of Mangrove forest, in the neighborhood of estuaries and streams. It attains its best development in sites with freshwater as well as in areas where the water is slightly saline. For this reason, the Nipa palm frequently grows in association with some of the trees characteristic of the Mangrove woodland.

The Nipa palm plays a very important part in local economy. The leaves are used for thatch, and for this purpose it is often planted to supplement the supply from spontaneous or natural stands. The leaves are cut and plaited to make partitions for houses or to roof boats. In addition, they are used for such other purposes as umbrellas, sun hats, raincoats, coarse baskets, mats and bags. In Thailand the unopened leaves are used for cigarette-wrappers. The endosperm, covering the young unripe seed, is slightly sweet and edible, and is much sought in January and February. The hard mature seed seems to have no particular use, although some consideration has been given to crushing it for animal food, or as material for the manufacture of buttons.

(b) Freshwater Swamp: The most characteristic tree in Freshwater swamps in Southeast Asia is the 'cajeput' or paper bark tree (Melaleuca leucadendron), of the Myrtle family (Fig. 65). Known in Thailand as 'med', 'samed' or 'samet', and 'tram' in Vietnam, it is a small to medium-sized tree, from 10 to 30 ft. (3-10 m.) in height. It often forms small stands in wet soil and even in stagnant water, on the landward side of, but not mixed with, Mangrove woodland. Some ecologists consider this association to be the climax of the Mangrove formation. It is a vigorous and resistant tree, crowding out other plants, and cannot be easily exterminated by cutting or burning.

Cajeput is rather widely distributed in Southeast Asia. In Thailand it is found scatteringly along the southeast coast, especially between Chantaburi and Trat. Small stands are found in the Peninsula, particularly in the Kra Isthmus, and elsewhere in plains and low valleys behind the coast. These are protected for the sake of the firewood they provide, when Mangrove is not available.

Its reddish-brown wood, resembling beech, is hard and durable when in contact with wet ground or sea water. For these reasons it is used for posts, piling and boat building. The leaves and young twigs yield a volatile or essential oil, which is transparent, of a greenish color, and has a strong, pungent odor, similar to camphor or cardamom oil. In Malaysia, Indonesia and South China, this oil is one of the most popular household medicines.

On the landward margin of Mangrove forest, a familiar plant is a fairly tall fern, *Acrostichum aureum*. It grows as scattered individuals, in sites where the soil is somewhat dry, because of exposure to wind and sun and less impregnated with salt. But if Mangrove trees are cleared, and the site is slightly above sea level, this fern soon develops in crowded masses, 3 feet (1 m.) or more in height, and forming almost pure stands of several acres in extent. It is frequent in coastal areas of Thailand as well as in other regions of Southeast Asia. It is also found in Puerto Rico and elsewhere in the New World.

Patches of freshwater swamps are found in the southern Peninsula of Thailand. One of the most common trees scattered in such sites is *Alstonia spathula*, a small tree, usually with a twisted trunk, of the Dogbane family (Apocynaceae).

One of the most characteristic trees, in Southeast Asia, in areas periodically inundated around lakes or along the banks of certain rivers, is *Homonoia riparia*. This is also of small dimensions, usually densely spaced, and forming a continuous dark green canopy.

It is widely distributed in Thailand from Mae Hongson, in the northwest, to Trat, in the southeast, and as far south as the Malaysian border. It is one of the most frequent woody species around the Great Lake or Tonlé Sap of Cambodia.

Grassy Swamps: In sections of northeastern Korat, long drought and occasional flash floods hinder the development of forest growth. As a result, extensive grass-covered plains, or 'thung', develop which, during the dry season, are reminiscent of dry steppes. Short, slender grasses predominate, which are sparse, and are not nutritious.

During the dry period the water level in the lakes and in the deeply cut meandering stream beds is 15 to 20 ft. (4.5-6.5 m.) below the level of the plains. In the rainy season, however, the river beds and lakes quickly fill and flood over wide expanses, acquiring the appearance of an inland sea. The stream channels are indicated by low trees, shrubs and clumps of bamboos growing along the natural levees. Here and there, in low elevations, stands of trees, mostly *Dipterocarpus obtusifolius*, appear above the flood waters.

Freshwater swamps are found around lake Nong Han, at Sakhon Nakhon (Fig. 66), and near Borabue (Fig. 127), in northeastern Thailand; also the lake at Phyao, in the north; and near Nakhon Sawan, in the central plain.

DECIDUOUS FORESTS

Synonyms: Monsoon forests; Seasonal forests.

Deciduous forests are those in which some or all the trees shed their leaves, either entirely or in part, and usually during some period of the dry season. Some Evergreen trees, of course, are mixed with the Deciduous. Some trees, also, form new leaves before the old ones are shed.

The term 'Monsoon forest' is used in Southeast Asia for this type. There it is readily understandable, as the forest is influenced to a great measure by the periodic entry of dry and rainy seasons, controlled by the shift of the prevailing winds at more or less definite periods of the year, and which are often accentuated by the trend of mountain ranges. The term 'Deciduous' perhaps is more descriptive of the type. But because such factors as rhythm of leaf production, leaf shedding, flowering and fruiting are largely influenced by climatic conditions, the designation 'Seasonal' also appears to be applicable.

The character of Deciduous forests varies appreciably, especially according to the total amount of available moisture. They range from moderately dense to open stands, and are composed of one or, at the most, two stories. Often there is a thick underbrush of shrubs and undershrubs and herbaceous plants, some of which are thorny. Woody vines and creepers are relatively scarce. Grasses are usually abundant, in addition to small palms, wild pineapples and cycads. The layer of humus and litter is usually fairly deep.

Deciduous forests thrive on a variety of soil types, on plains as well as on hill slopes. They are not selective as to site and elevation, although they seldom reach an altitude of 3,000 ft. (900 m.).

They are usually less complex than the Evergreen Rain or Moist forests. The trees vary in dimensions, according to site and soil conditions, from small to moderately tall, and at times attain large girth. Their root system is well developed and often deep. Usually the trunks are not heavily buttressed, are of moderate taper, and good form. The branches are often stout, rather wide spreading, and the crowns are irregular in shape to rounded. Twigs may be unarmed or furnished with thorns, and often bear many epiphytes. The bark is sometimes thick and deeply furrowed. The leaves, usually abundant, vary in size from medium sized to large and are often coriaceous. Neither the flowers nor the fruits have special distinguishing characteristics. The woods are extremely variable in properties. Some show concentric growth rings, caused by partial or complete interruption of growth during the dry season. Many of the timbers are important in local economy, and others are suitable for export. Ground-to-ground, air-to-ground and ground-to-air visibility is usually satisfactory in this forest. Ground mobility, also, is not a serious problem.

Deciduous forests may be separated into 2 broad types: Mixed Deciduous; and Deciduous Dipterocarp forest.

(7) MIXED DECIDUOUS FOREST

This forest type is well distributed throughout continental Thailand, especially in the north and northeast (Figs. 67-69, 79). It is among the most valuable assets of Thailand, as a source of timbers, particularly teak. Bamboos also occur in abundance, constituting important articles for domestic use and for trade. Some species develop readily when the forest is cutover, or when clearings are made for shifting agriculture.

Mixed Deciduous forest may be divided into 2 subtypes: (a) Moist Mixed Deciduous; and (b) Dry Mixed Deciduous forest.

(a) Moist Mixed Deciduous forest: This subtype occurs in well-watered areas, with an annual precipitation of 50 to 80 inches (1,270-2,030 mm.), and where the onset of the dry season is marked, at least, by a brief leafless period. The total amount of rainfall is probably less important in the development of this forest subtype than its seasonal distribution, and the length and severity of the dry season.

This forest is fairly dense and tall, but is less luxuriant than the Rain forest. It shows a definite tendency toward dominance by a single family or genus. Sometimes it may be characterized by a single or few gregarious species, as in the case of teak (Tectona grandis), which is dominant in certain areas. In parts of northern Thailand, for example, teak constitutes a high proportion of the Moist Deciduous forest, and is considered the country's most valuable timber (Figs. 71-74). It is estimated that the Teak forests of Thailand cover about 25,000 square miles (65,000 sq. kms.). In addition, there are approximately 5,000 sq. miles (13,000 sq. kms.) of Mixed Deciduous forest, as in the northeast, in which Teak trees are absent.

(b) Dry Mixed Deciduous forest: In this subtype are grouped forests with less than 50 inches (1,270 mm.) of annual rainfall, mostly in the rainy season, followed by 6 or more months of dry to very dry season. Most of the rain falls in heavy showers with quick runoff, and therefore has less effective soil penetration. In general, this forest is definitely less luxuriant and less complex than the Rain forest or even the Moist Mixed Deciduous forests. It is relatively simple in structure, with a single story, but occasionally with two stories, and dominant trees measure from 50 to 75 feet (16-22 m.) in height. The canopy is often uneven, not dense, and in some areas with open-spaced trees and shrubs. Many of the trees have a straight, clean trunk of fairly large dimension; others are twisted, with low branches and flat or umbrella-shaped crown. Both trees and shrubs are leafless during the dry season, although some evergreens may be present. The leaves range in size from small, finely-pinnate or simple digitate to large and leathery. Woody vines, epiphytes and ferns are few. Stilt roots and plank buttresses are almost completely absent. The undergrowth consists of bamboos, especially Bambusa arundinacea and Dendrocalamus strictus; and a grass cover up to 3 feet (1 m.) tall, composed mainly of species of Andropogon.

The dominant and most characteristic tree in the Dry Mixed Deciduous forest in northern Thailand, especially around Lampang, Ngao and Prae, is Teak (Tectona grandis). Trees commonly associated with Teak in this forest are: Acacia catechu, Anogeissus latifolia, Cassia fistula, Terminalia tomentosa, Pterocarpus macrocarpus, and species of Dalbergia and Diospyros.

The Dry Mixed Deciduous forest yields a series of timbers in addition to certain minor forest products. Among useful timbers, in addition to Teak, are: Adina cordifolia, Afzelia xylocarpa, Dalbergia bariensis, D. dongnaiensis and D. oliverii, Erythrophloeum succirubrum and E. teysmanii, Diospyros mollis, Nauclea orientalis, Pterocarpus macrocarpus, Tetrameles nudiflora, Vitex peduncularis, and Xylia kerrii.

Minor forest products furnished by this forest type include: tannin from species of Terminalia, Anogeissus, Acacia and Diospyros. Cutch, also a tanning material, is obtained from Acacia catechu, and myrobalan from Terminalia chebula. A red dye is extracted from sappan wood (Caesalpinia sappan); a yellow dye from Curania javanensis; and a fast, shiny-black dye from the fruit of Diospyros mollis.

A large proportion of the population in Southeast Asia lives within the range of Deciduous forests. Most of the food crops, including vegetables and citrus fruits, as well as such fiber-yielding plants as cotton and kenaf are grown in the type of land where this forest flourishes.

(8) DECIDUOUS DIPTEROCARP FOREST

This forest type occupies vast tracts in northern, central and northeastern Thailand, but is sparse in the Peninsula. It covers about 57,000 square miles (142,000 sq. kms.), equivalent to about 45 percent of the country's total forested area. In Vietnam, Laos and Cambodia, likewise, it is the predominant and most extensive forest type. In general appearance it is of open nature, with trees mostly small to medium in size. It corresponds to what French ecologists and foresters, who have studied the vegetation of Indochina, classify as 'forêts claires'. The soils are generally sandy, gravelly, or lateritic, and have a profound influence on the nature and composition of this forest type.

The tree species are more or less mixed, although there is a tendency towards gregariousness, with dominance by one or a few tree species. Dipterocarp trees which predominate in this forest include: Dipterocarpus intricatus, D. obtusifolius and D. tuberculatus, Pentacme siamensis and Shorea obtusa.

The Deciduous Dipterocarp forest is of economic importance as a source of commercially useful timbers, such as: Afzelia xylocarpa, Dipterocarpus alatus, Irvingia malayana, Sindora siamensis, Terminalia tomentosa and Shorea floribunda.

The constant demand for durable timbers for railroad ties and heavy construction, for domestic use and for export, causes a heavy drain on this forest capital. In addition, the Deciduous Dipterocarp forest furnishes posts for fences and firewood.

Minor forest products obtained from this forest include: dammar, a soluble resin, from Shorea obtusa and Pentacme siamensis; wood-oil, used for torches, from Dipterocarpus alatus, D. obtusifolius and D. intricatus; seeds of nux-vomica from a small tree, Strychnos nux-vomica, which contain between 1.21 and 1.81 percent of strychine; parinarium oil, used for waterproofing locally-made umbrellas, is obtained from seeds of Parinarium annamense, scattered throughout northeast Thailand; and a viscid oleo-resin from Melanorrhea usitata, used as a varnish to cover lacquer ware, so popular in Thailand.

Dry Dipterocarp Forest: This subtype, which may also be called Dwarf Dipterocarp forest, occupies regions where the annual precipitation is low, the physical conditions are such that only a fraction of the rainfall becomes available to the trees, or the soil may be so impregnated with soluble substances as to produce halophytic conditions.

In Thailand, Dry Dipterocarp forest is frequent along the margin of the western plains, around Banpong and Kanchanaburi, and in the basin of the Khwae Noi and Khwae Yai rivers; along the border of the upper plain, in the region of Tak; between Thoern and Lampang, in the north; in the triangle between Chiengmai, Mae Hongson and Mae Sariang, in the northwest; in the Korat plateau, in the northeast; and in the region of Surin and Ubon, in the east.

In areas where this forest subtype flourishes, the upper soil horizons have suffered accumulative weathering. In many sites they have a laterite horizon, sometimes exposed at the surface, or elsewhere it may be deep. The presence of this forest usually indicates previous sandy soils, subjected to long drought and are poor in plant nutrients. As a result, the trees are usually stunted, measuring 15 to 30 feet (4.5-9.5 m.) tall. In some areas, such as between Thoern and Lampang, they may be even smaller, averaging from 10 to 15 feet (3-4.5 m.) in height.

This forest subtype is a form of transition between the Deciduous forest and Thorn forest. The trees may have upright trunk or it may be twisted, and often with a thick, deeply furrowed bark, and large, leathery leaves. During the dry season the tree trunks, branches and leaves are thickly covered with red dust, especially along the roadsides, giving rise to the term 'pa daeng' (red forest), by which this forest subtype is generally known in Thailand (Fig. 90). The flowers are usually small but brightly colored, and the flowering period is short. Fruits are abundant; the seeds have a high germination rate, and are viable for long periods. The woods vary in density, and are often higher than average in weight, hardness, durability and richness of color.

Dominant and characteristic trees in this forest are: Dipterocarpus tuberculatus, furnishing timber for house posts; and D. obtusifolius, its large leaves in some areas utilized for thatch and temporary walls or partitions. In drier zones, with poor soils, these are replaced by Pentacme siamensis and Shorea obtusa. In the Korat plateau, where the soil is mostly sandy with occasional outcrop of basalt, Shorea obtusa and its associates grow on sterile sandstone, whereas in basaltic soil Pentacme siamensis shows a significant increase.

As a rule the stands of trees, generally, are so distributed that their crowns rarely touch. Also, the foliage is sparse so that even at the height of the wet season the sun's rays penetrate to the ground, and much of the rain that falls soon evaporates. The ground cover is composed of coarse grasses, including the frequent 'kha-luang' (Imperata cylindrica), intermixed with a cycad. Of bamboos present in some areas, the most frequent are: the slender 'mai ruak' (Thyrsostachys siamensis), and the armed 'phai-pha' (Bambusa arundinacea). Ground-to-ground and air-to-ground visibility, as well as ground mobility, are generally satisfactory in this forest.

(9) THORN FOREST

This forest type is rather extensively developed in Thailand, as in the other Mekong basin countries (Figs. 96-97). It occurs in areas with very low annual precipitation, usually 40 inches (1,000 mm.) or less, high temperatures, and long periods of drought. It is found in infertile, almost bare, sandy soils. The vegetation is composed of dense clumps of small trees, shrubs, bamboos and occasionally cacti. Many of the characteristic plants in this growth are armed with sharp spines (Fig. 98), whence the term Thorn forest. Such thorny plants are frequently abundant on plains and well-drained slopes, along trails, and in the vicinity of habitations, whereas plants without thorns are relatively few or absent in such sites. One probable reason for this is that buffalo or ox-drawn carts move constantly along these trails, and it is only the armed plants that are able to withstand or to survive excessive browsing by cattle.

In Thailand Thorn forest is abundant in the upper Peninsula; in the region of Banpong and Kanchanaburi, in the west; and scattered throughout central Thailand and the Korat Plateau in the northeast. Characteristic trees, all of which are deciduous, in this forest type include: Bombax (Salmalia) insigne, Zizyphus cambodiana, Azadirachta indica, Terminalia glaucifolia, Vitex sp., Spondias pinnata, Chukrasia velutina and Croton hutchinsonianus. Dominant shrubs are: Randia dumetorum, with very long, sharp spines; Feronella lucida, a slender shrub with small, but very sharp thorns; Flacourtia indica; and a species of Bauhinia.

These trees and shrubs are intermixed with certain species of bamboos. The most frequent of these, forming dense, almost impenetrable brakes up to 15 or 20 ft. (4.5-6.5 m.) tall, is the thorny 'phai-pha' (Bambusa arundinacea). Another frequent bamboo, generally in small but fairly tall clumps, is 'mai ruak' (Thyrsostachys siamensis), which is often planted around farmhouses for live fence. Cacti, especially species of 'prickly pear' (Opuntia), may also be present. Identical plants constitute the Thorn forest of South Vietnam, Cambodia and Laos.

Ground-to-ground and air-to-ground visibility is favorable in this type of vegetation, although ground mobility would be somewhat hampered by the dense clumps and the spines present on many of the plants dominant in this growth.

(10) BEACH WOODLAND

On open sandy shores of Thailand, as in other countries of the Indo-China peninsula and elsewhere, there is usually a formation of low-growing, trailing, herbaceous plants. The most constant, and often the dominant, plant is Ipoemoea pes-caprae, which is of pantropical distribution. Other common plants in this formation are species of Canavalia, of the bean or pulse family, and Spinifex. These plants are halophytic, thriving in soil with high salt content, and are not harmed by occasional submergence.

On several stretches of shore around the Gulf of Thailand there is a gradual transition from the Pes-caprae formation to a dense, woody type of vegetation on higher elevation, beyond tidal reach, consisting of shrubs and small to medium-sized trees, mostly deciduous. The trees in the littoral woodland are frequently felled for firewood, or cleared for agricultural purpose and for the planting of coconut, so that this forest type is best developed only in thinly populated areas.

A stretch of undisturbed Beach Woodland occurs at Huay Yang, between Prachuab-Khirikhan and Chumphon, along the east coast of the Peninsula. This woodland forms what appears to be an almost solid wall behind the low-growing plants on the foreshore (Fig. 99). But in some sites the trees may be in scattered groups with intervening small, open spaces suggesting a savanna, covered with rough grasses, mostly Imperata cylindrica. The trees measure up to 40 or 50 ft. (12-16 m.) in height, are closely spaced and the undergrowth is somewhat difficult to penetrate. Their trunks are often gnarled, and the bark is scaly, rough. The wood is usually heavy, hard and durable.

Dominant trees in this vegetation are: Manilkara hexandra, also Terminalia pierrei and T. mucronata, Odina wodier, Cratoxylon formosum, Garcinia cornea, Pterospermum semisagittatum, Diospyros variegata and D. ehretioides, and Cordia dichotoma.

Inland from the Beach woodland at Huay Yang, the evergreen Acacia comosa forms a dense, continuous stand. This small, leguminous tree is of secondary growth, developing readily where clearings have been made in the inland forest, bordering the Beach woodland. It merges into a Mixed Deciduous forest, or Dry Evergreen growth along streams or in sites where there is more abundant soil moisture.

In addition to the above-named trees, other woody species in the inland Deciduous forest are: Dipterocarpus alatus, Afzelia xylocarpa, Dialium cochinchinensis, Lagerstroemia tomentosa, Melanorrhea usitata, Fagraea cochinchinese, Garcinia cornea, Mangifera caloneura, Bombax (Salmalia) insigne, Erythrophloeum succirubrum, Stereospermum fimbriatum, Spondias pinnata and Wrightia tomentosa.

Other constant and characteristic trees along the coasts are: the cosmopolitan Terminalia catappa, Calophyllum inophyllum, Barringtonia spp., and a pandan (Pandanus tectorius), widely distributed in Southeast Asia. Casuarina equisetifolia is also planted or grows spontaneously, especially on rapidly accreting shores, at river estuaries and on sand spits (Fig. 100). Another species of Casuarina, C. junghuhniana, is often planted with C. equisetifolia, as windbreak along seashores. Most of these trees seldom occur inland, although some of them are not tolerant of saline water.

(11) BAMBOO BRAKES

Bamboos represent one of the most gregarious plant associations in Southeast Asia. They occur in Thorn, Moist Mixed Deciduous, Dry Mixed Deciduous, Dipterocarp, as well as in Wet or Moist Evergreen forests, forming an important component of the vegetation of Southeast Asia, as in other tropical regions. Because of similar topography, soil and climatic conditions, bamboos are widespread and abundant in Thailand, North and South Vietnam, Laos and Cambodia. In a particular bamboo brake there is usually one predominant species, but the general structure and habit of the formation remains the same.

In Thailand, the following genera are represented: Bambusa, Cephalostachyum, Dendrocalamus, Gigantochloa, Oxytenanthera and Thyrsostachys. Individual species have well developed habitats, and for this reason they may be taken as indicators of different forest types. For example, Bambusa blumenea is frequently grown along canals, or 'khlongs', and around farmyards; the armed Bambusa arundinacea occurs on rich moist soil, such as on alluvial stretches along streams, as well as on poor soil, such as we find in northeastern Thailand; Oxytenanthera albo-ciliata grows on low plateaus or hills, on sandy or lateritic soils; Dendrocalamus strictus does well in Mixed Deciduous forest or in open areas on stony hillsides, extending into drier conditions mixed with other bamboo species; Thyrsostachys siamensis is also frequently planted as live fence and around farmyards, and is especially common in Thorn forest, on dry well-drained slopes and in impoverished soils.

Dry bamboo forest is most extensively developed in the upper Peninsula and in the west and northwest in the basin of the Maeklong river, formed by the union of the Khwae Yai and Khwae Noi. These two tributaries flow southeasterly from the border of Burma, have a wide range of water level, characteristic of rivers influenced by the monsoon. During the dry season when the water is shallow, stretches along the banks below the high water level are covered with shrubs or low trees, especially Homonoia riparia and Eugenia ripicola (Fig. 43), which are submerged during the rainy season and when the rivers are flooded. A belt of 'mai phai' (Bambusa arundinacea) marks the high water level. Its long, graceful culms, 40 to 50 feet (12-16 m.) long, often extend over the water (Fig. 101). Scattered among these bamboo brakes are medium-sized to tall trees normally found in Dry Evergreen or Deciduous forests. The bamboo brakes extend for a considerable distance from the streams, covering plains of aggradation, foothills and higher lying flats. Away from the rivers, on dry, infertile soils, 'mai ruak' (Thyrsostachys siamensis) becomes dominant, occasionally mixed with such Dipterocarp trees as Pentacme siamensis and Shorea obtusa. The soil in these bamboo brakes is almost bare of undergrowth, and during the dry season it is covered with dry bamboo leaves.

'Mai ruak' (Thyrsostachys siamensis) is also widespread in the Korat plateau and along the western margin of the central plain of Thailand, growing in small clumps and is often planted around farmhouses for windbreak and live fences (Fig. 103). In some zones this is replaced by 'mai pak' (Oxytenanthera nigro-ciliata), while in parts of northern Thailand 'mai lai' (Oxytenanthera albo-ciliata) is a dominant species.

Bamboos, especially Bambusa arundinacea, Dendrocalamus strictus and Thyrsostachys siamensis, form extensive brakes in the undergrowth in cutover areas in the Teak forest of northern Thailand. To obtain natural regeneration of forest trees it is necessary to cut the bamboo repeatedly. Frequent cutting and maintenance of suitable overhead canopy, particularly on unfavorable soils, causes the bamboo to deteriorate or leads to its complete eradication. Chemical sprays have been tested, with satisfactory results, to control bamboo under such conditions.

Clearing of Rain or Moist Evergreen forests also creates conditions favorable for the establishment of bamboo brakes. This appears to be the case in the development of brakes of Oxytenanthera albo-ciliata along the Khwae Noi and Khwae Yai rivers, in western and northwestern Thailand. Here scattered solitary trees of the tall 'yang' (Dipterocarpus alatus) and 'inthanin' (Lagerstroemia flos-reginae) still remain as remnants and indicators of the original Moist Evergreen forest, which prevailed in such sites.

Bamboos are ready colonizers, and when not wanted they are difficult to eradicate although, as indicated, they can be controlled to some extent by chemicals. Many bamboos, also, are fire resistant. Following clear cutting of Teak forest, for example, or by burning, the land is soon restocked by bamboo which produces new culms from the perennial subsurface rhizomes. Certain bamboo species also invade clearings which have remained fallow following shifting cultivation, or the 'rai' system, widely practiced in Southeast Asia. Because of the vigorous growth of their rhizomes, they discourage or suppress other species of bamboo, even some of the more common hardy weeds, including the ubiquitous Eupatorium odoratum or Imperata cylindrica, as well as tree species.

The growth of a bamboo formation is generally uniform, and usually reaches its maximum height in a very short period. Rejuvenation of the formation is continuous, year after year, by means of seedlings or young culms from the same plant. A typical bamboo in the dry forest blossoms after a vegetative growth of 20 to 30 years. Soon after flowering and seeding old culms of most species wither, then break off and fall as a result of decay. This usually occurs in the wet season. The stand may regenerate from seedlings which develop in the succeeding rainy season, or sometimes from new culms sprouting from underground rhizomes. Thus, a rhythm of death and regrowth characterizes the bamboo formation.

In the local economy of Southeast Asia bamboo is considered, next to rice, the staff of life. In many areas it is one plant material that is sufficiently cheap and plentiful to fill the tremendous daily requirements. It figures so prominently that the majority of the people would be destitute without it. The almost infinite uses of this versatile plant range from providing shelter, in the form of cheap, rapidly built homes, to numerous articles in daily use, including food such as fresh or preserved young shoots, and materials for fishing, or for the manufacture of paper pulp.

Once established under favorable environmental conditions, bamboo requires little or no attention beyond occasional thinning to keep the clumps in vigorous condition. It requires no elaborate or costly machinery to harvest, transport, or to manufacture the many objects that fill the endless needs of the natives. Living bamboo, such as Thyrsostachys siamensis, with suitable growth and in small clumps, is planted for fences around corrals, and for fishing poles. Almost every farmhouse, hamlet or village in the great central plain of

Thailand is surrounded by the tall, graceful Bambusa blumenea, which provides shade or serves as windbreak (Fig. 103). Its culms are used for making furniture and household utensils; for building granaries and bridges; rain gutters and water-conducting pipes. Coarse strips of the culms also are woven into crates for shipping pigs, poultry and garden produce; excelsior-like scrapings serve for stuffing pillows and mattresses, for caulking boats and to strengthen plaster; coarse fiber is used for cordage and for making sandals; refined, processed fiber yields cellulose for paper and rayon; poles of various dimensions are used for making ladders, rakes, tool handles, stakes to support trees, and other articles.

A large number of people in Thailand and in the adjoining countries eke a living from fishing, especially during the off-season between the planting and harvesting of paddy rice. By virtue of its versatility, bamboo supplies many of the fisherman's needs. It is used for making traps, weirs, sluices, poles for hook-and-line fishing and for punting, and to stretch nets for drying, also for spears, floats, trays to dry fish, and baskets to transport them.

(12) SAVANNA

The term 'savanna' is a vernacular term, probably of Carib origin. Tropical savannas, such as we find in Southeast Asia, are usually dominated by grasses, with an admixture of herbaceous plants, and with or without widely dispersed shrubs and small trees. Woody species, however, are seldom absent. Compared with regions of Tropical America, with similar climate, there is a comparative scarcity of grassland or open wooded savanna in Southeast Asia.

In Thailand stretches of open flat or rolling grassland savanna are found south of the Kra Isthmus in the region of Ranong, on the western side of the central Peninsula (Fig. 108). There the grass is low, mixed with small herbaceous plants, and occasional tufts of small shrubs. Some of these grass savannas are dominated by the widespread 'kha-luang' grass (Imperata cylindrica). They are apparently secondary grasslands which have developed after the clearing of patches of Evergreen or Deciduous forests for shifting agriculture, followed by repeated annual burning.

Another type is wooded savanna (Fig. 106). This is more widespread in Thailand than open grass savanna. Stretches of this type occur in the eastern region, around Surin, Ubon, Phibun Mangsahan, and towards the border of south Laos; in the northeast between Konkaen, and Kalasin and near Nakhon Phanom; northward from Konkaen to Udon, as far as Nongkhai in the upper Mekong river; and in the north, in limited areas between Tak, Thoern and Lampang. Other areas of wooded savanna are found in the west on rolling hills around Banpong, Kanchanaburi, and in the basin of the Khwae Noi and Khwae Yai rivers; and farther to the northwest between Mae Sariang and Mae Hongson.

These wooded savannas are influenced by the monsoon climate. The soil is usually improverished. Consequently, the trees are of small dimensions, usually not exceeding 30 ft. (10 m.) in height, and their crowns seldom touch. They are dominated by members of the wood-oil family (Dipterocarpaceae), especially Shorea obtusa, Pentacme siamensis, and Dipterocarpus obtusifolius. The general landscape often has a park-like appearance.

These savannas are burned over annually, but several of the trees, as well as some grasses, particularly Imperata cylindrica, and certain herbaceous plants, including Eupatorium odoratum, are capable of surviving ground fires. If recurrent fires were eliminated, resulting in the gradual restoration of the soil to its original condition of fertility, it is possible that the open grassland savanna, as well as wooded savanna, would be replaced by a Deciduous type of forest, especially the Dry Dipterocarp forest widespread in northeastern Thailand. Where the savanna woodland extends to streams or rivers, the high soil moisture content close to or along the banks is sufficient to support a Fringing or Gallery forest, of the Dry Evergreen type, already discussed. Because of the open nature of a savanna, whether grassland or wooded, ground-to-ground and air-to-ground visibility is usually most favorable. Ground mobility also is satisfactory, since the soil usually forms a hard pan during the dry season.

GROUND STUDIES OF STRUCTURE OF THAI FORESTS

About the middle of 1963 the Bangkok office of ARPA's Research and Development Field Unit arranged, on contract basis, with Mr. Tem Smitinand, forest botanist of the Royal Forest Department of Thailand, to organize a field team, with the objective of making profiles and to assemble data on the principal types of forests in Thailand. The team recruited is composed of four or more forest rangers, mostly graduates of the Forestry School at Kasetsart University, accompanied by technicians to gather soil samples, and others to serve as assistants and drivers (Fig. 121).

Under the direction of Lt. Col. W.R. Scheible (USAF) of ARPA, this project commenced in August 1963 with the study of selected sites in the Khao Khieo Forest, in the Korat area of central Thailand. Since that time a large series of profiles has been made, covering almost the entire country. Two weeks are usually spent in a selected area, to prepare profiles and to gather data and plant materials. These are evaluated later during a period of one or two weeks at the Forest Department in Bangkok, immediately following each field trip.

Briefly, the procedure followed is to select a representative plot of about two acres in a particular type of forest. A rectangular strip is staked in the sample plot. The width of the transect is usually 30 ft. (10 m.). The length varies from 120 ft. (40 m.) upwards, depending upon the type and density of the forest, and the number of species encountered within the plot. In a Dipterocarp forest, which is relatively homogeneous, the length may be only 90 ft. (30 m.); in a Dry Evergreen forest, 120 ft. (40 m.); while in an Evergreen Rain or Moist forest, which is more complex and with many varied species, the length should be at least 180 ft. (60 m.).

All trees, shrubs, vines, palms, bamboos, ferns, rattans and herbaceous plants in and around the transect site are identified botanically as far as possible, and recorded on the spot (Fig. 123). A record is also made of useful, edible or hazardous plants. Herbarium materials are collected from plants which cannot be identified immediately, and are deposited at the Thai Forest Department for later determination. A record is also made of data relating to the forest community - its physiognomy, structure, location, altitude, exposure, aspect, drainage and slope of the plot. The position of each tree on the base line, in the transect, and its distance from the base are determined and listed; also the height and girth of trunks, width of crown and angle of branches are reported; and density of foliage of individual trees is evaluated. These data are reproduced in a profile diagram drawn to scale. At the same time notes are taken on the nature, amount and depth of litter. Samples of top and sub-soils are collected, for mechanical and chemical analysis (Fig. 124), accompanied by a record of depth, color and texture of respective samples taken from different horizons in the transect.

Another phase of the project, designed to meet military requirements, is to determine ground-to-ground and ground-to-air visibility. Several methods have been considered. One simple system adopted, to evaluate horizontal visibility in a sample plot, is for a man to stand in a selected spot, while a second man paces in a straight line along one of the cardinal points through the underbrush until he is no longer visible. This is repeated on the other cardinal points. The extreme distance at which the person or object is visible in each direction is recorded to compute the average. This is taken as the index for that forest community and at that particular time of day.

To evaluate ground-to-air visibility, or penetrability through the canopy, a series of black-and-white photographs are taken at each sample plot. The equipment used is a Kodak Retina III single-reflex camera with a wide-angle lens, mounted on a square board attached to a tripod, and provided with a compass and spirit level to assure accuracy; and a Weston Master IV light-meter. A vertical photograph is taken of the canopy, followed by a series of four photographs at an angle of 60 degrees on each of the four cardinal points. The entire series of photographs when collated provides a hemispherical spectrum of the canopy, which is later used for interpretation. Light readings are taken in different directions between the cardinal points to evaluate insolation or solar radiation.

A large number of such profiles have been made throughout Thailand, covering the principal forest types and subtypes occurring in that country, and which are typical of the other Mekong basin countries.

When these field studies are completed the considerable amount of data gathered on the various forest associations or types will have to be categorized and prepared into a final report. When completed, the project fulfills important phases of military science, such as the problems of mobility, defoliation, perceptibility, by providing more precise information on the physiognomy and composition of diverse forests scattered over the major portion of Thailand. In addition, this information will be of considerable scientific value, contributing to a better knowledge of the floristic composition and structure of diverse forest associations occurring in Thailand and for comparison with the vegetation of the adjacent Makong basin countries.

AERIAL STUDIES OF TROPICAL FORESTS

In former years forest inventories were carried out entirely on the ground. However, the value of aerial surveys, either to supplement ground studies or to expedite the task of making forest inventories, has aroused considerable interest among foresters and in the forest industry during the last 40 years. Since the second World War, in particular, aerial photographs have been used on an increasing scale in the United States, Canada, Europe and other countries, and are already established as a method to conduct inventories and ecological studies of forests. There are regions in North America where considerable saving has been achieved by the U.S. Forest Service through the use of aerial photographs, for example to spot insect infestation and thereby reducing expensive ground work.

As already pointed out, a characteristic feature of certain forest types, such as the Rain or Moist Evergreen forest of Southeast Asia, as in other tropical regions, is their complex nature, composed of numerous species ranging from tall trees, to shrubs, woody vines, palms, low herbaceous plants. Tropical forests consist of a large variety of plant communities. It is particularly important to reduce the ground work in tropical forests, where such task is both laborious and expensive in time and money because of the nature of the forests, the climate, and often lack of communications. For these reasons, it is anticipated that increasing importance will be attached to aerial photography as a means of expediting the study of tropical forests or at least to complement ground studies.

Photo sampling in Thailand: Accompanied by Lt. Col. W. H. Scheiole, Col. Prasart Mokhaves, and Dr. L. T. Burcham of ARPA, and Mr. Tem Smitinand of the Thai Royal Forest Department, a brief reconnaissance was made in a helicopter, in November 1963, of the Khao Yai National

Forest, covering an approximate area of 350 square miles in southwestern Korat.

A few days previously, Mr. Tem and I made a ground survey of a section of this forest, to identify and to determine the characteristics of dominant or most frequent trees at increasing altitudes in Lowland Moist Evergreen or Deciduous stands to Hill Moist Evergreen and Sub-Montane forest on the upper slopes and summit of the Khao Khieo range.

With this first-hand information available we were able to recognize, when flying over the forest at altitudes of 1,000 to 3,000 feet, certain tree crowns in the canopy; to delineate the transition from the Lowland to Hill Evergreen forest; and to observe the gradual merging of the Hill Evergreen into the Sub-Montane forest along the summit of the range.

Further aerial observations of forest types and to locate individual tree species were made on a subsequent trip, in December 1963, from Bangkok across the Korat plateau, over Konkaen, Udon, and Sakhon Nakhon to Nakhon Phanom on the Mekong river, in the northeast.

Five more extensive flights were made during January and February, 1965, in twin-engined 'Beechcraft' planes leased from CAT by ARPA.

On January 19, accompanied by Captain John Kelly, Jr., and Mr. Christman of ARPA, and Pilots Ziml and Le Tender, we flew northward over the central plain in the direction of Nakhon Sawan, Pitsanuloke to Lampang, over large extensions of Mixed Deciduous forest in which Teak predominates; then continued northwestward to Mae Honsong, observing large tracts of Dry Dipterocarp and Pine forests, and southward to Mae Sariang, before proceeding northeastward to Chiengrai to refuel. We then continued southwestward to make aerial observations of large tracts of Dry Dipterocarp forest towards Mae Sariang, thence to the Salween river basin on the border of Burma, long an important source of Teak, before turning southeastward along the Khwae Yai river basin to Nakhon Pathom and Bangkok.

On January 26, with pilot Herzig, I flew from Songkla in the southern Peninsula, over Moist Evergreen forest between Patalung and Kachawng; extensive Mangrove stands around Krabi and the islands in the Phuket area, in the southwest; thence northward over stands of Mangrove and Nipa palm in the Kra Isthmus; and extensive Deciduous and Moist Evergreen forests covering the flanks of the mountain range along the border of southeastern Burma.

On January 28, we followed closely the southeast coast, around the island of Koh-Chang, almost to the Cambodian border, to make observations on the density and height of Mangrove forest. The objective, also, was to ascertain whether it is possible to identi.y from the air the individual tree species that constitute the mangrove woodland, from such features as the varying hue and density of their foliage; as well as to determine air-to-ground visibility in this special type of forest, which is of considerable importance, militarily, as a potential staging area. This aerial survey of Mangrove forest was concentrated around Khlung, Trat and the island of Kohchang. We then continued northward over Moist Evergreen forest, covering the mountain ranges between Thailand and Cambodia, in the direction of Aranyaprathet. Soon after leaving Aranyaprathet we had a mishap, when the tip, about 8 inches long, of one of the propellers broke off, but fortunately it did not damage the fuselage. We flew eastward, on a single motor, for a considerable distance over open Dipterocarp forest until we reached Ubon, where we landed safely. On the return journey we passed again over large extensions of Dipterocarp forest, in the east, and the upper Moist Evergreen and Lower Montane forests in the Khao Yai area of Korat.

On February 3, we flew in the CAT spray plane, piloted by Captain Herzig, from Bangkok over the large Hill Evergreen Moist forest in the Khao Yai National Forest, and Dipterocarp forest extending beyond Konkaen, in the Korat plateau.

On February 6, we continued over the Pine forest characteristic of the high plateaus around Loei, in the northeast, Teak forest in the region of Lomsak and Phetchabun, and finally southward across the central plain to Bangkok.

On February 9, accompanied by Dr. Robert A. Darrow, in charge of studies being conducted with defoliants by the Biological Laboratory at Fort Detrick, Maryland, an aerial inspection was made of the test site near Pranburi, upper Peninsula, to observe the effects of chemicals on vegetation, especially from the standpoint of desiccation, plant survival and regrowth, and as a means of improving air-to-ground visibility.

The weather and visibility during all flight periods were good to excellent. However, from early February until the end of the dry season visibility from the air is reduced somewhat, because of a heavy pall of blue-gray haze, rising from forest fires, to clear patches for tilling, and the burning of straw in harvested rice paddies, which hovers constantly over the countryside.

Comments: Photographs, several of which are reproduced in this Report, were taken with hand-held cameras. Black-and-white panatomic-x and panchromatic film (with x2 yellow filter), as well as colored film (Kodachrome K-2 with haze filter) were used for comparative purpose.

It was found that, as a rule, color film gives a better rendition than black-and-white; a more satisfactory resolution in bringing out density and hue of the foliage; color of bark; size and form of crowns, trunk or branches; and in a clearer delineation of the zonation of forest types.

The best time to take aerial photographs in Thailand, and probably elsewhere in Southeast Asia, is during the Dry Season, from the middle of November to the end of March. This is the time, also, that all the forests are in their driest state. The most satisfactory interpretation is obtained from photographs taken either vertically, or better still at an oblique angle of about 30°, opposite to the direction followed by the plane; and at a speed of 1/250th or 1/500th of a second, depending upon the film-speed, and at an altitude of 1,000 - 2,000 ft. (300-600 m.), determined by weather conditions and the amount of haze in the atmosphere, which naturally affects the depth of visibility.

It is usually possible to distinguish between forest and non-forested areas in aerial photographs. Mangrove, marshland and swamp forests can be classified into types, and the subtypes can also be recognized. This alone is a decisive advantage in making ecological observations or an inventory of forests, because it permits concentration of the ground work.

Investigations have shown that in mangrove or swampland forests, stands of Rhizophora, nipa palm (Nipa fruticans), and nibung (Oncosperma filamentosa) can be identified from the air (Figs. 60-63). Likewise pure stands of Melaleuca leucadendron have been identified in marshland forest. It should be emphasized, however, that these trees grow in pure or almost pure stands. Except in a few instances, individual tree species in certain types of forests, such as Rain or Moist Evergreen, can not be identified since they are not recognizable by their particular size and/or appearance.

Of dryland forests, such obvious types as Savanna and Dry Dipterocarp forests, Lowland and Hill forests can be recognized. But in dense Evergreen Rain or Moist forests progress in identification of individual tree species is not as yet successful. In such forests there are extensive areas that look practically homogeneous, and one type merges into another without any marked zonation or sharp line of demarcation. Consequently their classification is often difficult. The principal characteristics which are possible to evaluate from aerial photographs are tree height, crown diameter of certain species, and crown coverage.

The information obtained from aerial photographs is either directly visible from them or can be assessed indirectly. The sum of the factors of the environment that influence tree growth is measurable on aerial photographs, to the extent that the key factors of the environment can also be recognized. As indicated, tree growth is a function of local climate and soil. Local climate and soil moisture, in turn, are apt to be closely related to the topography, and topographical data can be classified accurately from the stereoscopic image.

Much progress has also been made in the identification of soils from aerial photographs. For tropical forests, however, site classification from photographs taken from the air is still largely an unexplored matter. Additional research is necessary to determine what other characteristics can be interpreted from aerial photographs.

Individual tree species have certain characteristics. Often these features are clearly descernible from the air, at a resaonable altitude. For example, such tall trees as certain species of Dipterocarpus or Lagerstroemia have straight, light-colored trunks, which stand out conspicuously (Figs. 67, 68), even when surrounded by a carpet of foliage of varying shade in the most dense forest. Under magnification, the round bole of 'yang' or 'yang-khao' (Dipterocarpus alatus) is readily distinguishable from the fluted trunk of 'tabaek' (Lagerstroemia calyculata), for example. Fig trees (Ficus) normally have a widespreading, umbrella-shaped crown, and corpulent branches. These features are brought out clearly in colored photographs taken from the air. Teak trees (Tectona grandis) can be readily spotted from the air when in flower, between July 15 and August 15, or in the dry period, especially during the latter part of January and February, from their grayish trunks and their almost entirely leafless crowns (Fig. 71). Pará rubber (Heveá) plantations can be distinguished by the regular form of planting, usually in a small rectangular pattern; in January by the yellowish color of old leaves about to fall; or later by their gray, leafless branches and slender, light-colored upright trunks. Such trees as species of Salmalia (Bombax) and Butea are conspicuous, at a height of 3,000 ft. (1,000 m.) or even higher, by their mass of deep salmon-pink flowers. Other trees, like Afzelia xylocarpa, can be spotted from the air by the size or color of their fruit, or the form of the crown.

Contrary to expectation, the Mangrove forest, as seen from the air, is not a dense, impenetrable canopy (Figs. 61-63). Air-to-ground visibility in this fairly low forest is satisfactory, and solitary huts or craft can be spotted from the air, reflected against the water showing through the vegetation. Also, the zonation of trees (Sonneratia, Avicennia, Rhizophora, etc.) from the sea-front towards the interior is better defined in color film than in black and white. Moving or even still objects, such as vehicles on the highways, people working in rice paddies, or small craft or buffaloes in the khlongs, can be readily spotted in colored air photographs.

To gain the optimal use of aerial photographs in tropical forestry, it is essential that the forester or ecologist should be able to identify the dominant tree species. In dense Rain forest, individual tree species usually are not identifiable from the air or discernable from aerial photographs taken at the usual scale. Forest type mapping with aerial photographs has been done on a large scale in the Amazon valley in Brazil, but to identify the tree species ground work was still necessary.

Perhaps the most important factor in aerial photography of tropical forests is the utilization of hue or tones to make spectrophotometric measurements. The best results are obtained when few trees are to be identified. In the tropics the great majority of tree species are broad-leaved, and are more difficult to distinguish from one another than from coniferous trees. There is also an intraspecies variation in the hue of foliage. Owing to wide variations between them, methods based on tonal differences of foliage through the use of various film filter combinations are likely to be of small importance in species identification from aerial photographs. Difficulties involved in species identification are not reduced by the fact that in the dense tropical forests not all the trees are visible or identifiable in aerial photographs. This may be solved at first by concentration on the dominant trees forming the canopy, and by deducing from that other subordinate plants associated with them.

Aerial photographs are also excellent in surface area assessment, in survey work to indicate roads, drainage and major topographical features.

In the final analysis, an aerial reconnaissance is less expensive, without sacrificing accuracy, than a ground survey. It involves only a fraction of the time spent in conducting on-the-spot study of the same area by a team of forest-botanists and their assistants, who have to be transported to and from the area, housed, fed, and moved around on the site. Combined aerial and ground data continue to be the best means to conduct ecological studies or forest surveys. Considerable research still needs to be done to determine all the characteristics of tropical forests.

<u>Additional Studies in Northern Thailand</u>: During 1955, while on an assignment with the Royal Forest Department of Thailand, Loetsch made an aerial inventory of the Teak forests of northern Thailand. The most important facts determined were that teak grows scatteringly among other species in Mixed Deciduous forest, which has a rather low stock per unit area, and that communications to the mountainous forests are generally very poor. The census started in 1955 and the results for the five of the provinces, representing the heart of the teak-bearing area and yielding about 60 percent of teak production in Thailand, were completed in June 1957.

Aerial photographs were taken on an average scale of 1:48,000 for the area below 3,000 ft. (1,000 m.) above sea level. Teak does not generally occur above 3,000 ft., so that a contour line of 3,000 ft. was marked on all the photographs of the northern provinces. The area was thus divided into two main parts: that below 3,000 ft.; and the other above 3,000 ft. The sampling technique was aimed at determining the proportions of the area of the strata recognizable on the photographs.

The following strata, according to Loetsch can be recognized from the photographs:

Below 3,000 ft:

(a) Mixed Deciduous forest - This is a Teak-bearing forest. There is, however, a rather high percentage of this forest type which does not contain any Teak. In the true teak-bearing sites, the tree seldom occurs in pure stands but is scattered among other species. Unfortunately, the bulk of the photographs were not taken during the flowering season, July and August, when it is possible to spot teak trees. On some photographs it was possible to distinguish between the substrata teak-bearing and the non-teak-bearing Mixed Deciduous forests.

(b) Semi-Evergreen forest - Large trees of the genus Hopea and Dipterocarpus alatus could clearly be recognized as white spots on small-scale photographs.

(c) Dry Dipterocarp type - A rather poor, low forest, but important for the production of fuelwood. Severely overworked areas could clearly be distinguished from old clearings or second growth. Both of the lower strata do not contain any large trees, but differ from each other in the tint of the ground on the photographs. Old clearings were originally mostly Mixed Deciduous forest.

(d) Permanent non-forested area.

Above 3,000 ft:

At this elevation the forest is inaccessible, and mostly of Hill Evergreen or Savanna forest types, mixed with some Conifers on the mountains and Semi-Evergreen forests in the valleys. These forests are of importance for the conservation of the country's water supply. The degree of destruction inflicted by hill tribes, for shifting agriculture, and annual burning could be seen in the photographs.

Aerial Inventory of Vietnam: Prior to 1939 the French Military Air Force made a number of aerial surveys of the vegetation in the delta regions of Cochinchina, now part of South Vietnam, and in the Tonkin area of North Vietnam; also along certain river basins, particularly the Mekong, and around the Great Lake in Cambodia. A total of 72,000 photographs, on a scale of 1:4,000, were taken. Unfortunately they were destroyed during a bombardment in 1945.

At the end of World War II, the British Royal Air Force conducted a series of aerial missions in southern Indochina and along the coast of Annam. The scales used were mostly 1:20,000 and 1:56,000. The quality of the photographs was variable, as climatic conditions were often cloudy. Also, since the scale was small the photographs were of little practical value for the interpretion of vegetation. The negatives were retained by the Royal Air Force, and photographic copies are not obtainable except by rephotographing the original prints deposited in the files of the Geographical Service of Indochina, stationed at Dalat.

At the request of the Geographical Service of Indochina, additional aerial surveys were made during 1948-50, using a scale of 1:20,000, over certain parts of the country. In general the photographs were good.

In 1952 the Geographical Service organized the photographing of a large section of Indochina, on a scale of 1:40,000. This was undertaken by the Photometric Service of the National Geographic Institute of Paris (I.G.N.), with good results. Unfortunately, the scale adopted was only for cartographic purpose, too small for forestry use, and indicated only the first stratification of broad forest formations to determine their boundaries.

Aerial Photography in North Borneo: According to Francis and Wood, during the period 1948 to 1954 nearly the whole of North Borneo was covered by Royal Air Force aerial photography. Flying conditions were seldom ideal and the varying quality of the photographs, together with their small scale (1:25,000 and 1:30,000), greatly restricted the amount of desirable information obtained from them.

These photographs were used at the headquarters of the Forest Department in Sandakan to prepare vegetation maps on a scale of 1:50,000. The prime purpose of the maps was to show the extent of commercial forest in the colony. At the same time different vegetation types, distinguished with reasonable accuracy from the area, were plotted on the maps. Broadly classified as forests of commercial value, other non-commercial vegetation, and vegetation resulting from man's activities, these were separated into 16 vegetation types, arranged under 6 main headings.

A. Salt Water Swamp Forest - (1) Mangrove; (2) Nipa; and (3) Mixed Coastal Forest.

B. Transitional Forest - (4) Casuarina Fringe; (5) Nibong palm, Coastal Padang and other Beach Forest.

C. Inland Forest - Drained - (6) Trees with large crown; (7) Trees with medium crown; (8) Trees with small crown; (9) Montane forest and similar growth.

D. Inland Forest - subject to Flood - (10) Trees with large crown; (11) Trees with medium crown; (12) Trees with small crown.

E. Areas under Cultivation - (13) Estate and permanent native cultivation; (14) Shifting cultivation and associated secondary growth.

F. Cleared Land - (15) Herbaceous growth and lalang - drained; (16) Herbaceous growth subject to flood.

Identification of Tree Species in the United States: In a paper presented in Washington, D. C., on March 25, 1963, Heller, Doverspike and Aldrich (Research foresters, Forest Insect Laboratory, Forest Service, U. S. Department of Agriculture, Beltsville, Maryland) discussed a study conducted near Ely, in July 1960, and repeated in the summer of 1962, to determine the best film and scale combination for identifying tree species. Forest photo interpreters, report the authors, have recognized for some time their inability to identify individual tree species on small scale aerial photographs (1:15,840 or smaller). With experience and knowledge obtained by photo scrutiny, interpreters can now separate forest stands into broad species classes, but they can seldom determine the species of individual tree images.

The terrain of the test site is rolling, interspersed with lakes and was previously glaciated. Forests cover about 85 percent of the land area. A boreal area was chosen for the study because fewer species needed to be compared. Fourteen important tree species were selected on 29 separate locations. Nineteen replicates were taken of 8 of the most important species, and fewer replicates of the other 6 species. The trees involved were species of Abies, Acer, Betula, Larix, Picea, Pinus, Populus, Sorbus, and Thuja.

In gathering ground data, trees were identified in the field on large-scale (1:1,000)black and white prints made from color transparencies. To prevent possible bias, ground identifications were made by one of the authors who did not take the interpretation test. A detailed description was made of each tree species selected, including d.b.h., height, crown class, site class, and other associated features. Only dominant, codominant, and intermediate crown-class trees were included, since overtopped trees are not visible on air photographs.

To collect air data, a Hulcher 70-mm camera with a 150-mm (5.91 inches) focal length lens was used. The films used were: Super Anscochrome (General Aniline and Film Corp.), with an ASA rating of 125 for color; and Plus X Aerographic (Eastman Kodak), with an ASA rating of 80, for the black and white photographs.

Photographic scales were approximately 1:3960, 1:1584, and 1:1188. These scales correspond to units of area measurement commonly used by foresters in the United States. White panels were placed on the ground to provide identification of each of the 29 locations on the photos while the pictures were being taken.

It was decided to determine whether morphological features, such as crown apexes and crown margins, which may be associated with tree form and growth, would help increase interpreter accuracy. The foliage density was classified as thin (less than 25 percent), medium (26 to 75 percent), and dense (more than 75 percent). A set of terms was devised to relate the foliage arrangement of the species being considered to the shape of the images found on the large-scale aerial photographs. The interpreters examined sample trees to define these foliage and branching characteristics and to write specifications as to how each species looked on aerial photographs. A Munsell gray scale was used on the panchromatic prints to correlate tone with each species.

The panchromatic photographs were examined with a 2.25 power stereoscope mounted on a specially built light table. All interpretation data were coded and put on specially designed forms before being transferred to IBM punchcards for tabulation and analysis.

The investigators found that interpretations of color transparencies were more accurate than those of black and white prints. There was a highly significant difference between the two films. Also, accuracy of interpretation was poorer with the small scale than with the two larger scales. Differences in interpretation were highly significant between all scales on panchromatic film. For the color transparencies, the two larger scales were almost equally accurate, and both were significantly better than the 1:3960 scale.

The authors came to the conclusion that color film is superior to panchromatic film for use in identifying individual tree species. This may be ascribed in part to the fact that people are accustomed to seeing and identifying objects not only by shape and form but also by the color. A ripe tomato is distinguished from the vine by its color rather than its shape, and cotton can be graded by the degree of lightness and yellowness of the fiber. A forester trained to recognize trees by certain features also has an associated color for that tree in his mind. When he is trained to recognize the tree on aerial color photographs, he is equipped with one more dimension with which he is familiar. Thus, it requires more training for an interpreter to be able to recognize objects by tones of gray than by the normal colors with which he associated the object. In panchromatic interpretation he must learn to relate the tone of the image to color, and by associating its form and texture he can identify the object.

Tree species were identified accurately enough on the large scales of color film to suggest the possibility of using them on actual inventory problems. Further study of hardwoods, especially to associate their crown and foliage characteristics with age and physiographic features, should be helpful in improving identification of these tree species.

According to the authors, perhaps the greatest contribution to species identification that color film makes is the hue-chroma combination. It is interesting to note that before taking the test, most of the interpreters had a preconceived notion that tree images would appear green or blue green with a few green yellows. The data showed, however, that most of the species were tallied as yellow to green yellow and that only two approached a green hue.

On the basis of the test, accurate identification of individual tree species requires color film at a photo scale of 1:1584 or larger. Even on color film, the 1:3960 scale produced fairly low accuracies of interpretation (63 percent).

The cost of using color film at large scales should be little more than that required for panchromatic film. While color film costs five times as much as panchromatic film, the important point is that film cost is only a small part of the total cost of aerial photography. When aircraft costs, standby time for the flight crew, elimination of the need for prints, and reduction of photo handling by interpreting color film in rolls are considered, the extra cost of color film is minor. Increased interpretation accuracy on color film would counterbalance any slight increase in cost.

Additional references to aerial photography of tropical and temperate forests are listed in the Bibliography (Part III).

TESTS WITH DEFOLIANTS IN THAILAND

In November 1963, accompanied by Colonel Niyom of CDTC, Lieut. Lloyd Wax, attached to the Biological Laboratory at Fort Detrick, Maryland, and a forest ranger from the Thai Forest Department, we inspected a portion of the 1,500 acre test-site near Pranburi, upper Peninsula. At that time a series of trails had been opened, to facilitate penetration into the area. Aerial spraying had not yet commenced.

In early February 1965, Dr. Robert A. Darrow, of the Biological Laboratory at Fort Detrick, Maryland, who has charge of the tests, invited me to accompany him on a one-day survey of the site.

In the morning we inspected several trails opened to make close-up, visual studies of the effect of chemicals on different plants, and to determine the species that had survived or showed semblance of regrowth. Cross trails had also been opened to set up a series of cameras, at intervals of about 50 feet, to obtain a photographic record of the penetration of successive applications, and to determine the resultant effect on the vegetation.

In the afternoon, we made a series of runs, in the plane used for spraying, over various plots in the test-site, to observe from the air the effect of defoliants on the vegetation, especially to improve air-to-ground visibility.

Chemical defoliants modify the general appearance of vegetation (Fig. 130), induce desiccation of stems, branches and bark, and result in the partial or complete shedding of leaves (Fig. 133). The vegetation assumes an over-all light grayish tone (Fig. 134). There is improvement in ground-to-ground visibility. However, the dried stems of shrubs and trees which remain standing continue to provide some cover for ambush. An enemy can still be camouflaged to blend with the changed color of the vegetation, which would make detection even on the ground, and especially from the air, difficult. When seen from an altitude of upwards of 1,000 feet, the grayish treated swaths are sharply defined from the untreated strips in between. There is a decided improvement in air-to-ground visibility, especially at an altitude of 1,000 to 2,000 ft., as a means to spot objects moving on the ground.

The most widespread and tallest plant pests in Thailand, Vietnam and adjoining countries are: Eupatorium odoratum, known in Vietnam as 'yen-bach'; Imperata cylindrica, called 'tranh' in Vietnam, or 'kha-luang' in Thailand; Saccharum officinarum, 'mia'; and a species of grass, Neyraudia. The first two-named are especially common along roadways, trails, in forest clearings, and in fact almost everywhere where there are open sites. They grow up to 2 or 4 feet all, and provide ideal sites for ambush, even where a helicopter may land. These plants can, no doubt, be controlled effectively or eradicated by the application of chemicals.

When we realize the great expanse and wide diversity of vegetation in Vietnam, Thailand and in the adjoining countries we recognize the complex and difficult problems involved in attempting to blanket a large area with defoliants. It seems that the application of such chemicals would be most practical to suppress or to eradicate the tall grasses, especially Imperata cylindrica, and such weeds as Eupatorium odoratum, common along highways, railroads, canals, streams and rivers, in forest clearings and savannas. Defoliants could be applied to suppress undergrowth in rubber plantations; weeds around airports and especially landing sites used by helicopters; storage areas; around hamlets; and particularly around troop concentrations and military camps.

HAZARDOUS VEGETATION

From the military standpoint, the most critical forest types in Thailand, and in the other Mekong basin countries, are the tall Evergreen Rain and Moist forests on dry land, and the coastal Mangrove swamp forest of smaller stature.

The continuous, dense canopy of the Evergreen Rain and Moist forests, in which the trees are of large dimensions, often with massive plank buttresses, many large woody vines and in particular the generally dense undergrowth difficult to penetrate, provide ideal sites for hiding. Mobility is a difficult problem in these forests. Ground-to-ground visibility is low, usually limited to 15 or 20 feet. Ground-to-air visibility may be fair to good, depending upon the depth and continuity of the canopy, but air-to-ground visibility is fair to nil.

On the other hand, while the Rain or Moist Evergreen forest is ideal for shelter and ambush, a guerrilla fighter, like the Viet Cong, as a rule does not relish remaining for long periods in this deep forest. The most serious problem is survival, especially the procurement of a steady supply of food. Second in importance is the problem of health, especially when such pests as leeches, malaria-carrying mosquitoes and other insects are prevalent. Thirdly is the depressing atmosphere of the dense forest, which may have a demoralizing and psychological effect on some, when exposed to it for long periods. People accustomed to working in open areas, such as rice fields, do not care to work in the forests. Likewise, in Vietnam as elsewhere, people who have lived in the plains do not want to move to the highlands, and vice-versa. Even the Chinese, as I once found, do not relish such experience.

Plants furnishing edible fruits, seeds, tubers, are somewhat limited and uncertain. Many fruits are often high on trees, difficult to gather, while others ripen only at irregular intervals. So that, as a rule, a guerrilla fighter prefers to remain inside but near the perimeter of the forest, within a distance of 1 or 2 miles from the periphery, in open sites in the forest or rubber plantations, in open grass-covered areas, where there is usually the 'kha-luang' grass (Imperata cylindrica) tall enough for hiding, or better still near abodes, villages or towns, where food resources, especially rice and fish, are more readily available and easily transported to the camp.

The Mangrove swamp forest is perhaps even more critical, from the military standpoint as a staging area, than the tall Rain or Moist forest, on account of its accessibility from the sea or by river, ease of mobility by water in small craft within this type of forest, and its low to fairly low stature. The network of uncharted channels in a Mangrove swamp facilitates easy, quick movement by canoes and other small craft.

Usually there are houses or hamlets scattered through the Mangrove forest inhabited by families occupied in cutting firewood or timber for charcoal, or in fishing. These abodes also provide ideal sites for hiding and as staging areas.

The Mangrove swamps furnish a constant supply of a wide variety of fish and prawns, which form an important item in the daily diet of Southeast Asians of all classes. In addition, there is an abundance of fuelwood for cooking.

For these reasons, the Mangrove forest is an ideal concentration and staging site, just as important as the tall Evergreen humid forest. Constant vigilance, both on the ground and from the air, should be maintained in this forest. Although ground-to-ground visibility may be somewhat low in the Mangrove forest, air-to-ground visibility is better than in the Evergreen Rain or Moist forests, because of its lower stature and more uniform nature.

It seems that the best craft to patrol the Mangrove swamp and forest is a small launch of shallow draft, propelled by an outboard motor with a long shaft. This appears to be the most practical and economical, able to penetrate shallow waters, where an outboard motor, with upright shaft, cannot navigate.

Bamboos are widespread in Thailand, as in Vietnam, Laos and Cambodia. One or two species are grown around farmhouses, hamlets, and along canals for live fences and windbreak. Most of these grow spontaneously, often forming extensive brakes; some flourish in Moist and Dry forests, others in moist sites along the banks of streams and rivers, and still others in open arid areas. They appear readily when a forest is partially culled or when clearings are opened, such as in the teak forest, or where land was once tilled and later abandoned.

'Mai-ruak' (Thyrsostachys siamensis) grows spontaneously over large areas of Thailand, on well-drained slopes and dry or arid plains. This slender bamboo and the tall, graceful, unarmed 'mai-si-suk' (Bambusa blumenea) are invariably grown around abodes for fences and windbreak.

The most common bamboo is the armed 'mai pha' (Bambusa arundinacea). It is widespread in Southeast Asia, appearing in thorn forest, rice-paddies and formerly tilled land, in cutover forests of various types, and along river banks. It often forms tall, dense, almost impenetrable brakes.

Bamboos as a rule are resistant to fire. Their culmns or stems may be damaged or destroyed, but new shoots soon appear, and make rapid growth when the wet season begins. Despite the fact that most species of bamboos respond favorably to chemical treatment, and are easily defoliated, the large culms that remain standing still provide some cover for ambush.

Owing to their open nature, the Deciduous and Dry Dipterocarp forests and Pine forest are not a serious problem from the military standpoint. Ground mobility, and ground-to-ground or air-to-ground visibility are favorable. The ground cover, however, is often composed of rough grasses, especially the common 'kha-luang' (Thailand) or 'tranh' (Vietnam) grass (Imperata cylindrica). This widespread grass grows from 3 to 6 feet (1-2 m.) in height, tall enough to hide a man lying down, and even to imperil the landing of a helicopter. In the upper limit of the Pine forest a low fern (Dryopteris) often forms the ground cover.

Another very common weed throughout Thailand and Vietnam, where it has become a serious pest, is Eupatorium odoratum, known in Vietnam as 'yen-bach'. It was introduced from this continent about 50 years ago. Today, in Thailand this plant, often up to 4 or 5 feet (1.25-1.60 m.) tall, is common almost everwhere, along highways and trails, in forest clearings, on the bunds of rice-paddies, and appears almost immediately wherever there are forest clearings, or when tilled land remains fallow or when abandoned (Fig. 114).

Another tall grass of frequent occurrence is a tall cane, known in Thailand as 'phong' and in Vietnam 'lau' (Saccharum spontaneum). This grass grows spontaneously, in clumps upwards of 6 or 9 feet (2-3 m.) tall. Often it grows with such vigor, especially along roadsides and in meadows, that it chokes out other plants. Another tall grass, usually in slightly moist sites in meadows, is a species of Neyraudia, similar to Saccharum spontaneum (Fig. 115).

These are the most common and widespread weeds in Southeast Asia. On account of their height and dense clumps some of them form, they provide ideal sites for ambush, and should be eradicated or destroyed as much as possible along roadways or trails, stream banks, air-fields and strips around military bases and troop concentration.

Another potential site for ambush are Pará (Hevea) rubber plantations, especially where the undergrowth is not controlled or cut down to the ground (Fig.120).

Around farmhouses and hamlets, two plants commonly grown as cash-crops are cassava or manioc (Manihot esculenta), known as 'man-samrong' (Thailand) or 'mi' (Vietnam); and castor bean (Ricinus communis), in Thailand called 'la-hung' and in Vietnam 'thau-dau'. Both are of low stature, up to 9 or 12 feet (3-4 m.) in height. Cassava has a slender stem, forms a dense, dark green canopy, and provides good cover for ambush. The large tubers are edible when processed and are the source of tapioca of commerce.

PHYSIOGRAPHIC, CLIMATIC AND OTHER FEATURES

SOUTHEAST ASIA

Although they are politically independent, and divided economically, the five countries of the Mekong basin are similar in many aspects, especially from the standpoint of inhabitants, physiography, climate, soils and vegetation. The mountain ranges, which intercept moisture-laden winds, influence the climate, resulting in a wide pattern of annual rainfall, with the dominance almost throughout of alternating rainy, southwest monsoon, and dry northern or northeastern monsoon. The varying distribution of rainfall during the year is highly significant, and is particularly noticeable in North Vietnam, Laos and Thailand. The temperatures are fairly high throughout, except in mountainous areas, with no frost at lower elevations.

THAILAND

Thailand lies between the parallels of 5° and 21° N. latitude and between the meridians of 97° and 106° E. longitude. It has a total area of about 200,000 square miles (511,936 square kilometers), almost equal to Texas, France, or approximately 60 times the size of Puerto Rico. The country is bounded on the north by upper Burma, the Shan States, and northern Laos; on the east and northeast by central and lower Laos and by Cambodia; on the west by central and lower Burma; and in the extreme south by Malaysia. Its long coast lines are flanked on the southeast and eastern Peninsula by the Gulf of Thailand, and on the western side of the Peninsula by the Andaman Sea. It has a long frontier, of about 1,400 miles (2,240 kms.), with its neighbors, which naturally is difficult to patrol effectively along the entire length.

Thailand has been a constitutional monarchy since 1932, but the divisions of administration have not been greatly changed from the old regime. The internal administration is centralized under the Minister of Interior in Bangkok. For administrative purpose the country is divided into 71 'changwats' or provinces, each under the control of a commissioner, who is directly responsible to the Minister of Interior. Each changwat is subdivided into 'amphurs' or districts. The amphur, in turn, is subdivided into 'tambons' or villages, and the tambon is made up of 'mu bans' or hamlets. A hamlet is a collection of 10 or more houses or about 100 people who elect their own elder or 'Phuyai Ban'. The duties of the elder are to report cases of crime to the headman of the village, and to maintain a register of the people in his hamlet.

According to the 1964 census, Thailand has a population of about 24,000,000. Approximately 80 percent of these are Thais; 15 percent

Chinese; and the remaining 5 percent includes Malaysians, Cambodians, Laotians and other groups. About 90 percent of the people live in communities of less than 5,000 inhabitants.

The Thais are primarily engaged in agricultural pursuits, inhabiting the thousands of small villages, concentrated mostly along highways and the network of canals and rivers. Most of the positions in the Government, police, and military organizations are held by Thais, although the Chinese minority is active and influential in the economic life of the country. It is estimated that about 50 percent of the 3 1/2 million Chinese reside in the Bangkok-Chao Phraya area, while the remainder are scattered throughout the country in commercial centers, market towns, and large villages.

Physiographic Regions

In general there are three major physiographic types: highlands, plains, and plateaus, which grade into one another and support more or less distinct types of vegetation. The highlands comprise several mountain ranges, in general extending from north to south along the entire western length of the country (Fig. 3). The central region is occupied by a great alluvial plain of deltaic form with the base at the Gulf of Thailand and its apex in the Uttaradit area. The northeastern part of the country includes an extensive plateau, flanked by mountains along its western and southern borders.

Based on land forms, which also coincide with the classification of climate and vegetation types, Thailand may be divided into five physiographic regions (Fig. 2): (1) the northwest highlands; (2) the Chow Phraya or central plain; (3) the Korat plateau; (4) the Chantaburi region; and (5) the Peninsular region.

As elsewhere in Southeast Asia, the climate of Thailand is controlled by the seasonal monsoon modified by local topography. Two broad types of climate prevail: that of the Rain forest and that of the Monsoon forest or Savanna (Figs. 4,5). Optimal Rain forest climate is characterized by uniformly high temperature and heavy rainfall distributed throughout the year with no distinctly dry season. The Monsoon or savanna climate, on the other hand, has less precipitation and is divided into wet and dry seasons.

Owing mainly to the modifying influence of topography, five climatic zones are also recognized: northern Thailand, comprising the eight provinces from Uttaradit northward; the central plain, corresponding to the area south of Uttaradit to the head of the Gulf of Thailand, and including the area north of Prachuap-Khirikhan, in the upper Peninsula; northeast Thailand, which embraces the entire Korat plateau; the southeast region along the Gulf of Thailand; and the section of the Peninsula south of Prachuap-Khirikhan. These areas correspond roughly to the principal physiographic provinces indicated.

(1) Northern Highlands

General features: This region is hilly, in parts mountainous, and is the area in which teak forest flourishes (Figs. 37, 38). It is bounded on the north by the Dan Lao range, which forms the dividing line between the Salween and Mekong river basins. On the west, the Thanon Thong Chai range extends southward from the northwest frontier to link up with the Tenasserim range. This, in turn, continues southward to form the backbone of the Peninsula. On the south this region borders the northern limit of the vast alluvial plain of the Chao Phraya basin, while on the east it is flanked by the ranges of Luang Phrabang and the Phetchabun ranges. Within this region the series of hills and mountain ranges, running remarkably parallel to one another, form the headwaters of the principal rivers - Ping, Wang, Yom - converging near the town of Paknampo to form the Chow Phraya, the largest river in Thailand, which meanders through the thickly populated central plain.

Climate: Because of the mountainous nature of the North, the variations in elevation impose a so-called mountain climate, characterized by extremes in temperatures (Fig. 5). The lowest recorded temperature is 37° F. (2.8°C.) in January, and the highest 103° (39.5°C.). Rainfall is generally moderate but of long duration, being more or less periodic in distribution. Under the influence of the southwest monsoon, a wet season prevails from the middle of May to October. The coolest and driest season lasts from October through February, and the hot season extends from March to mid-May. Fog is most frequent in March and April when it sometimes lasts through the entire day. The period from October to February, before the peak of the hot season, is considered the best for making ground surveys and aerial photographs.

(2) The Central or Chao Phraya Plain

General features: This vast plain occupies the central part of Thailand. It is bordered by a piedmont belt on the west, east and north, and by the Gulf of Thailand on the south. This central plain is about 187 miles (300 kilometers) long from north to south and ranges from 30 to 93 miles (50 to 150 kilometers) in width from east to west. It is a deltaic plain, built up by the accumulation of alluvial materials, eroded by streams and rivers, from the northern highlands. Dotting the plain are numerous isolated hills whose bases have been buried by alluvium. The rocks are similar to those of the bordering mountains. The plain commences at about latitude 18° north where the rivers flowing from the north emerge from their valleys and finally unite at Paknampo, to form the Chao Phraya. At Chainat, head of the delta, about 30 miles (50 km.) farther south, the Chao Phraya bifurcates and flows south for some 56 miles (90 km.) to the Gulf of Thailand. Near Ayuthya the Chao Phraya is joined by the Pa Sak river, which has its source near Phetchabun and drains the western slopes bordering the Korat plateau.

The central plain also receives the drainage of the Mae Klong and Ban Pakong rivers. The latter has its source near the border of Cambodia, and drains the region between the southern edge of the Korat plateau and the Chantaburi mountains.

The southern part of the plain is flat, and the rivers are linked by a network of man-made canals, 'khlongs' (Figs. 12,13), used for irrigation, drainage and transport. This plain is the rice bowl of Thailand, and is considered the most important section of the country. Because of its agricultural wealth, it supports the greatest concentration of population with the highest standard of living of any region of the country.

During the rainy season great quantities of silt are carried by the rivers flowing through the Chao Phraya plain and are deposited in the flat rice-growing areas, thereby enriching the soil. Still more silt is carried seaward where it is deposited around the delta of the Menam or Chao Phraya and the estuaries of other rivers and in mangrove swamps. It is estimated that in this manner the coastal land, along the north coast of the Gulf of Thailand, is increasing at the rate of 12 to 15 feet each year.

Climate: The climate of the central plain is of tropical lowland savanna type, with an average annual rainfall of 52.42 inches (1,344 mm.). The division of seasons into wet and dry periods is the same as in northern Thailand. The maximum monthly rainfall falls in September. The recorded average monthly precipitation is 11.10 inches (284.7 mm.) with the minimum in December of 1.45 inches (37 mm.). Temperature variations is the same as in northeastern Thailand. The extreme recorded diurnal range has reached 79.5° F. (26.4°C.). Fog is common between January and March, but generally it occurs only during the early hours of daylight. Ground surveys can be carried out from the end of October and aerial photography is best done at the end of the rainy season in October and November until March or early April.

(3) Northeast or Korat Plateau

General features: This is a saucer-shaped plateau sloping gently to the southeast, with a strip of somewhat swampy area to the northeast. It is bordered on the north and east by the Mekong river (Fig. 85); on the west by the Phetchabun mountains and the massive flat-topped peaks of Dong Phruya Yeng; and on the south by the San Kamphaeng range and the Dong Rek escarpment. The plateau derives its name from the old town of Korat, now officially known as Nakhon Ratchisima, the largest commercial center in the region.

The general surface is gently undulating with scattered low hills and shallow lakes. Large areas are flooded during the wet season, but during the dry season the region suffers severely for lack of water. The soils for the most part are thin and poor in vegetation (Figs. 126, 127).

Two rivers, the Mun and the Chee, have their sources on the western flank and flow parallel across the tableland. They join near Ubon, close to the border of southern Laos, and then fall into the Mekong. A great portion of the area is covered with Deciduous Dipterocarp forest, forming an important source of timber for railroad ties and firewood.

The northern and western borders of the plateau range from 450 to 600 feet (137-183 m.) above sea level. At the city of Ubon the altitude is reported to be about 150 feet (46 m.). The many flat-topped peaks in the Dong Phraya Yen mountains rise to altitudes of about 2,500 to 4,000 feet (760-1,220 m.), while the Dong Rek escarpment is generally about 1,500 feet (454 m.), and in places rises to 2,200 feet (670 m.). From this scarp the land falls sharply toward the Cambodian plain, but northward the slope is gradual to the Mun River.

At the northeastern edge of the plateau there is a belt 30 to 60 miles (50-96 kms.) wide which drains into the Mekong river. In this strip the largest fresh-water lake in Thailand, Nong Han, is located on the outskirts of Sakhon Nakhon (Fig. 66). This lake, with an area of about 64.3 square miles (170 square kilometers), empties into the Mekong by way of the Nam Kam river. The belt is also drained by numerous other streams tributary to the Mekong.

Climate: The savanna type climate of this region is similar in temperature and rainfall to that of northern Thailand. Since this region is a plateau, relief has less effect on the climate than it has in northern Thailand. The rainy season coincides with the southwest monsoon, which becomes more vigorous and brings torrential rainfall, especially when typhoons from the South China Sea pass over the region, usually during June through September. The recorded monthly extremes of rainfall in this region range from 0.2 inches (5.3 mm.) in January to 9.7 inches (248 mm.) in May. The highest temperature of record is 109° F. (43.0°C.) in April and the lowest is 41°F. (5.1°C.) in January. The daily range of temperature may also be more extreme than elsewhere in Thailand. The distribution of seasons is about the same as in northern Thailand.

(4) Southeastern Region

General features: The Chantaburi area, in the southeast, is separated from the Korat plateau, on the north, by the valley of the Ban Pakong river. On the west it is flanked by the Chao Phraya plain;

on the south by the Gulf of Thailand; and on the east by a mountain range, Khao Banthat, extending along the border of Western Cambodia. The region includes a well-dissected upland in the northern and central parts, and by a coastal plain in the south and west. It is drained by numerous streams, all flowing in a southerly direction. Moist Evergreen forests, on the mountain slopes (Fig. 22), and Mangrove forests along the coast (Figs. 58, 59) are the characteristic vegetation in this area. The principal rivers are the Mae Nam Chantaburi, Prasae, Wen, and Trat. The principal mountain peaks are Khao Khieo in the west, with an altitude of about 2,600 ft. (800 m.); Khao Soi Dao, altitude 5,200 ft. (1,640 m.); and Khao Sa Bap, altitude 3,030 ft. (933 m.), northeast of Chantaburi.

Climate: In some sections the climate of the southeast is somewhat of the tropical rain forest type, and is similar to that along the west coast of the Peninsula. The wettest period lasts for 6 months extending from May to October. Precipitation at Chantaburi is greatest in July and least in February, with an annual average of 97.27 inches (2,494 mm.). Temperatures are generally high and uniform. The highest recorded temperature is 101°F. (38.8°C.) and the lowest 54.5° F. (12.5°C.). Seasonal variations are similar to those in central Thailand, with the main difference that the rainfall is more abundant and well distributed. The period between November and April is best for ground surveys.

(5) Peninsula

General features: The physiographic features of the Peninsula include both plains and highlands. Plains flank the coastal areas and highlands form the backbone of the region. The total length of this region is about 469 miles (750 km.), and the width ranges from about 10 to 125 miles (15 to 200 km.). The mountain range trends from north to south and is formed of short ridges arranged in echelon. Between these ridges there are small plains and valleys which are considerably dissected.

Along the western side of the Peninsula the Tenasserim range extends southward until it separates into two ranges in the trough of the Kra Isthmus or Pak Chan river. The western range lies in Burmese territory, and the eastern in Thailand. The eastern range extends south of the Kra Isthmus to Ranong and skirts the Indian Ocean to the bay of Phuket. The main range of the Peninsula again starts anew to the north of Nakhon Srithamarat, extending in a southerly direction to the province of Satun. In the area between this main range and the island of Phuket there are isolated buttes and peaks rising sheer from the surrounding lowland. One such peak, Khao Phanom Bencha, attains an altitude of about 4,500 ft. (1,370 m.), but for the most part the buttes are only a few hundred feet high (Fig. 111).

South of Songkhla there are three other ranges running north and south. The highest peak is near Betong, bordering Malaya. In addition, there are other small, subsidiary ranges, chief of which are the limestone ridges of Phatalung and Phangna.

The east and west coastlines of the Peninsula differ from each other. The eastern shoreline is smooth, regular, with long beaches like those at Prachuap-Khirikhan, Nakhon Srithammarat, Songkhla and Patani. The only exception is the delta at Surat-thani. A plain, ranging from 6 to 21 miles (10 to 35 km.) in width, extends inland from the coastline. Conversely, the western shoreline is irregular, much indented with estuaries and fringed with islands, such as those in Phuket bay. The mountains extend down to the sea in many places. Beaches are small and few, but mangrove swamps are numerous. The lower course of the Pak Chan river has the appearance of a drowned valley, giving evidence of a submerged shoreline, and its banks are lined with Mangrove forest. Remains of buried mangrove trees, exposed in hydraulic mining at depths well below the present level, are found along the shoreline in the provinces of Takuapa and Phuket.

On the east coast there are few bays, and islands are limited in number. The west coast is much indented. There are a number of large, forest-clad, rocky islands such as Yao, Lanta, Phra Thong, Linbong, and Tarutao. The largest and most important of these islands is Phuket, center of the tin industry, and has an area of about 228 square miles (590 sq. km.).

The island of Ko Si Chang, near the northeast section of the Gulf of Thailand, forms a natural sheltered anchorage for large steamers which cannot cross the bar at the estuary of the Chao Phraya. The largest island along the coast is Kohchang, in the east, with an area of about 70 square miles (181 sq. km.) and a peak which rises to almost 2,100 ft. (640 km.) above sea level. In the vicinity of the muddy estuaries of Mae Nam Prasae and Mae Nam Wen mangrove swamps abound, but elsewhere along the coast there are many white sandy beaches, and occasional stretches of beach forests and narrow belts of Casuarina trees.

Climate: The climate of southern Thailand is the tropical rain forest type, although somewhat modified by the monsoons. It is characterized by uniformly high temperatures, two periods of greater rainfall, and rain at other times is distributed throughout the year, so that there is no well-marked and prolonged dry season. However, many local modifications occur, depending on whether the winds blow from the ocean or from the land. The highest annual rainfall, 257.63 inches (6,606 mm.), was recorded at Takuapa, in the southwest, and the lowest of record is 50.70 inches (1,300 mm.). The temperature on both coasts is uniform. The annual temperature ranges between 80° F. (26.7°C.) and 83.4° F. (28 C.). The highest temperature recorded is 103° F. (39.3°C.) and the lowest, 63° F. (17°C.). The wet season lasts from May to October and has two peak periods - one during the northeast monsoon and the other during the southwest monsoon. The cool season, from November to mid-February, is characterized by a smaller temperature range than that of other seasons. The hot season, during March and April, is milder than in central Thailand, because of the modifying influence of sea breezes and proximity to the ocean. January to April is the best period for ground and aerial survey.

Soil Types

According to World Soils Geography Unit, SCS, USDA (unpublished report, May 1962), the soils of Thailand may be segregated into five soil associations (Fig. 7): (1) Latosols and lithosols on mountains and steep hills; (2) Latosols and associated soils on plains and hills; (3) Sandy ferruginous latosols, commonly with laterite, chiefly on plains and low hills; (4) Dark tropical clay soils on nearly flat alluvial plains; and (5) alluvial soils.

Latosols are the most extensive soils in the country. Typically, they are friable acid clays and usually reddish in color, although in many zones yellow and brown colors predominate. Most latosols are well drained and permeable. They are highly leached and consequently are low in plant nutrients. For sustained high crop yields, the application of fertilizers, particularly those containing phosphates, and practices conducive to building up organic matter, are highly desirable and even necessary for some crops.

Lithosols in Thailand are shallow, stony, gravelly, steep and are entirely unsuited for agriculture. Likewise, the association of latosols with lithosols is generally unsuited for cultivation, principally because of steep slopes. The best use for the soils of this association is for tree planting, although sizeable tracts that are not too steep could be utilized for pasture.

Latosols on plains and hills are dominantly reddish loams. These soils could be more extensively cultivated than at present, and expanded for crops now grown, chiefly rubber, pine-apple, sugarcane, pepper and other food crops.

Sandy ferruginous latosols occur extensively on plains in the Korat region, on the outer fringes of the central plain and in parts of the Kra Peninsula. In general, these are very infertile soils. Many contain laterite of concretionary or platy iron-stone material, which would interfere with the deep penetration of plant roots. For the most part, these soils are in open forest. In depressions and stream valleys, where water relationships are favorable, wetland rice is grown. For good yields, manure or commercial fertilizer is highly effective.

Dark tropical clay soils occur chiefly in the Bangkok plain and in the southern part of the Kra Peninsula. These are acid clays, developed mainly from alluvium. They are difficult to work because they are plastic and sticky when wet and harden when dry. These soils are productive. Yields could be increased, however, by fertilizing and skillful management. The soils are used intensively for wetland rice. In the Bangkok area they are planted for vegetables, ornamental plants and orchards. East of Lopburi these soils are associated with heavy clay soils developed from igneous rocks. These soils are very acid and extremely infertile. Additional associated soils, entirely unsuited for agriculture, are saline clays and permanently wet soils, such as in mangrove swamps along sections of the coast.

Alluvial soils occur throughout Thailand, but are most extensive in the northern inter-mountain valleys, in the Korat plateau, upper central valley and the Kra Peninsula. These soils range in texture from loam to sandy clay, in color from reddish brown to dark gray, and with poor to good drainage, depending upon distance from the stream. In most inter-mountain valleys these soils are productive and intensively cropped. Elsewhere, particularly in the northeast, their productivity is rather low and the pattern of cultivation is generally the growing of wetland rice intermingled with scrub and forest. Although alluvial soils are among the more productive in Thailand, crop yields could be improved by irrigation and application of fertilizers.

Thai Forests

Thailand is essentially a forest country. Of its total estimated area of 200,000 sq. miles (511,900 sq. kms.), approximately 60 percent, equivalent to 120,000 sq. miles, is covered with some type of vegetation (Fig. 6). With diverse climatic and topographical patterns, three broad zones are outstanding for their distinctive landscapes: the Evergreen Rain or Moist forests of the southeast and southern Peninsula; the dry to arid Korat plateau of the northeast; and the mountainous northern and northwestern region, covered by a series of vegetation types, from Dry Dipterocarp, Teak, Oak to Pine forests. The vegetation of Thailand shows some interesting features. For example, numerous plant elements from the eastern Himalayas and Assam appear along the mountain ranges on the western border, extending to Malaysia. There is a corresponding northward extension of the flora characteristic of Malaysia into the southern part of the Peninsula. Curiously enough many species found in the south Peninsula also grow in the southeastern region.

If we exclude that part of the Peninsula south of about 10° N, the flora of Thailand is fairly homogeneous, and is characteristic of the entire Southeast Asia from the Bay of Bengal to the Gulf of Tonkin. The flora of Thailand shows a considerable amount of endemism, with about 20 percent of the species, so far known, found only in Thailand. The most common forest type is the 'pa deng' or red forest, an open Deciduous forest of small to medium sized trees covering about 45 percent of the total forested area. In this the dominant trees and widespread species include Shorea obtusa and Pentacme siamensis, both belonging to the wood-oil family (Dipterocarpaceae).

From the commercial standpoint, the leading forest types in Thailand are the Evergreen Rain or Moist Forests and the Mixed Deciduous forests.

The Evergreen forests, including Pines and Mangrove, represent about 30 percent of the total forests. In these, the 'yang' or 'yang-khao' tree (Dipterocarpus alatus) is outstanding and often predominates. But there are vast areas of Rain or Moist forests characterized by other Dipterocarps, such as Dipterocarpus pilosus, D. costatus, Hopea odorata, Cotylelobium lanceolatum, Anisoptera cochinchinensis, as well as many species of other families.

The Mixed Deciduous forests, especially in the north where Teak (Tectona grandis) is predominant, are of prime importance. Up to 10 or 15 years ago, the annual production of Teak was higher than that of all other species combined. But the ever-increasing demand for timbers forced a steady rise in the exploitation of other species. So that in recent years the felling of non-teak species has exceeded that of teak. Among these may be mentioned: Dalbergia cochinchinensis (Rosewood), Afzelia xylocarpa, Xylia kerrii, Dipterocarpus alatus, and a host of others.

The Royal Forest Department of Thailand was organized towards the end of the last century. Thai foresters are trained at the Forestry School at Prae, in the north, and some continue further studies at Kasetsart University in Bangkok.

The FAO mission to Thailand, in 1948, made several recommendations, including: the reorganization and strengthening of the Forestry Department; increase in the field staff; an aerial survey of the country; reservation of all forests important to the economy of the nation; a preliminary survey of the forest resources; stricter enforcement of existing forestry laws and regulations; setting up of uniform grading rules for exports; undertaking of a large-scale program of artificial and natural regeneration of forests; more vigorous suppression of illicit cutting and thievery; and strengthening of the Research Division of the Forestry Department.

In 1951 a 5-year program was submitted by the Forestry Department to the government. Most of the essential projects were approved. This program provides for: setting aside at least 270,000 square kilometers of forests as permanent forest reserves; protection of the reserved forested areas; preservation of protected forests; forest management based on a sustained yield; recognition of principle that all forest products should be used primarily to meet the needs of the local inhabitants and only secondarily to serve agricultural, industrial and commercial purposes; surveying marginal forest lands and waste lands as a basis for the formulation of an appropriate land-use policy; promotion of basic and higher education in forestry; study of the utilization possibilities of various timber species and other forest products; stimulating forest-mindedness in general; and encouragement of private tree planting.

VIETNAM

Vietnam, embracing both North and South, was formerly the territory of the three eastern provinces of the French Union of Indochina, namely: Tonkin, in the north; Annam, in the center; Cochin-China, in the south; and with a total area of approximately 126,000 square miles.

Under the terms of the Geneva Truce Conference, held in June 1954, Vietnam was divided at the 17th Parallel. North Vietnam, with an area of 44,800 square miles (Tonkin) and an additional 16,000 square miles of Annam, north of 17th Parallel, was ceded to the Viet Minh. The balance, with an area of about 66,000 square miles, including south Annam and Cochin-China, now forms the region referred to politically as South Vietnam. The latter extends northward from Pointe de Camau at 104° 44'E. longitude and 8° N. latitude, on a curved axis up to 100 miles (160 kms.) wide, and about 600 miles (960 kms.) long to the 17th Parallel. Forests of varying density and composition occupy more than 30 percent of this land, extending from the seacoast along the South China Sea inland to the Annam Mountains.

The northern and western parts of what was formerly called Tonkin are mountainous and rugged, especially along the Chinese frontier, with some peaks rising to more than 7,000 ft. (2,100 m.). Prior to the dissolution of the French Union, Tonkin was regarded as the center of the mining industry of the entire Indochina, furnishing coal, zinc, lead, tin, tungsten, copper, bauxite and other mineral deposits for domestic use and for export.

In the Red River delta rice is cultivated almost exclusively for local need, in addition to corn, sugarcane, tea and coffee. Upper Tonkin is the area of large-scale animal husbandry and forest industry. The bulk of the population is concentrated in the Tonkin delta. The Red River and its tributaries constantly deposit alluvial material, which makes this region one of the most fertile and most densely populated land areas of the entire Vietnam. South of the Tonkin delta there are numerous small fertile areas which are also thickly populated.

The central region - Annam - is a narrow strip of territory, about 60 miles (96 kms.) wide and 600 miles (960 kms.) long. The main Annam Mountain chain, with peaks elevating up to 8,000 ft. (2,500 m.), falls abruptly eastward to the narrow coastal plain. Its rugged, eroded, seaward slopes are largely not suitable for conventional crops. To the west, the Annam Chain slopes gently toward the Mekong River basin in lower Laos.

Economically, northern Annam is similar to Tonkin, with diverse mineral deposits, but these are exploited to a less extent than further north. Considerable forest resources are concentrated in this area, and the mountain regions are zones of animal husbandry. Southern Annam, now part of South Vietnam, is the principal zone for the planting of Pará rubber (Hevea brasiliensis), especially where red and gray soils are found. As in the north, the bulk of the population in south Annam is concentrated in the river deltas, where rice is extensively cultivated.

In South Vietnam the Mekong delta, covered with recent fertile alluvium, is intensively cultivated to rice. This area has long been regarded as the 'bread basket' of Vietnam. Another crop, second in importance, is Pará (Hevea) rubber, from plantation-grown trees.

Except for the lowland fertile plains of the Mekong and Tonkin deltas, and intervening valleys, most of the land area of entire Vietnam is not considered suitable for intensive cultivation. Much of the land is mountainous with rugged terrain, and elsewhere the drainage is poor. As in Laos, Cambodia and Thailand, farming occupies first place in the economy of entire Vietnam. Agriculture is basic to other industrial and commercial activities.

Mekong Delta and Plain: The Mekong, sixth largest river in the Far East, enters South Vietnam from Cambodia at about 105° E. longitude and 11° N. latitude. Following a series of tortuous stream beds, it flows southeasterly for about 125 miles (200 kms.) through several channels in the delta region, to fall into the South China Sea. This flood plain is approximately 125 miles in width, dividing the forested areas in the uplands, in the northeast, from about 2,000 square miles of Mangrove forest along the coast. Some sections of the plain are subjected during the rainy season to inundations by flood waters, and in parts are alternately covered by sea water, brackish and fresh water.

This great plain extends northward for about 560 miles (896 kms.), in places crowded to the coast line by mountainous cliffs, and elsewhere cutting inland, following the basins of smaller streams. Areas along the seacoast are exposed to wind-blown, fine, white sand, which covers fields, villages and highways. In former years windbreaks and shelter-belts of Casuarina and Eucalyptus trees were planted to protect the beaches. These dunes are shifting and cover everything in their path. Fields once planted to rice are now covered to a depth of 3 feet (1 m.) or more in many places.

Highlands: The Annam Mountains extend on a more or less north and south axis for about 625 miles (1,000 kms.). The crest of these mountains forms a broken series of peaks varying in altitude from 5,047 ft. (1,542 m.) to the highest peak, Ngoc-Linh, 8,251 ft. (2,589 m.) above sea-level, and is located about 60 miles (96 kms.) from the coast.

The plateau of Darlac, a basin with an irregular surface and ranging from 656 to 1,640 ft. (200-500 m.) above sea-level, occupies an area of about 5,405 square miles, located in the northwest between the mountains and the boundary separating South Vietnam from Cambodia. The vegetation on this highland is composed mainly of broadleaf trees and bamboo, which appear to thrive on dark red soils of lateritic origin.

Between the plateau of Darlac and the lower foothills there is a mountainous area, the Plateaux Montagnards du Sud, with an area of about 3,800 square miles, and varying in altitude between 3,280 and 6,560 ft. (1,000-2,000 m.). In the cool climate, prevailing at these altitudes, two species of pine, (the 2-needled Pinus merkusii and the 3-needled P. khasya) constitue the dominant forest growth, mixed with broadleaf trees and bamboos in the lower valleys and ravines (Fig. 11). Dalat, the principal city, is located near the center of this area.

The basic formation of these mountains appears to be principally granite and basaltic upheaval. Many rivers and streams have their sources in the mountain areas, but none have the magnitude of the Mekong. Among the principal rivers that have their source in the Annam Mountains and flow west into Cambodia are Se Bang Khan, Nam Lieau and Krong Pok. Other smaller streams, originating in these mountains, flow eastward into the South China Sea, such as Da Nhim, Bai Cung Son, Song Kon and Song Ben Hai, the latter separating South Vietnam from Communist-controlled North Vietnam, at the 17th Parallel.

As in the case of most rivers with mountain sources there are many rapids and waterfalls cutting through rocky gorges. Extensive areas in most of the watersheds have been denuded of forest growth by shifting cultivation. Many of the mountain-born streams carry relatively clear water, except during periods of flash floods.

In the mountainous areas of the interior, distant from the highways, there are large extensions of open Dipterocarp forests, composed of trees with short boles, and mixed with stretches of savannas. These open forest, which French ecologists classified as 'forêts claires,' grow in soils with hard pan. Other sites formerly cleared for cultivation, and later abandoned, are densely populated by encroaching brush vegetation. As in Thailand, Laos and Cambodia, shifting cultivation has long been widely practiced by the hill tribes. This primitive method is difficult to control in the more remote or inaccessible areas. For this reason there is urgent need in Southeast Asia, as in other tropical countries, for measures to control land use, forest fires, forest cutting and land development.

Climate: As in the adjoining countries of Southeast Asia, the climate of Vietnam is a tropical monsoon or seasonal type, with high temperatures and generally ample rainfall. The consideraole latitudinal and altitudinal range of the country produces noticeable climatic variations from one region to another, and the rainfall is subject to annual fluctuations. As in Thailand, in South Vietnam the rainy season ends in October, followed by a relatively dry, cool season from November to March. Along the narrow coastal plains of Annam, in central Vietnam, the rainy season may extend into January, influenced by the prevailing typhoons. In North Vietnam the total annual rainfall averages about 70 inches (1.750 mm.), compared with 80 inches (2,000 mm.) in South Vietnam. In North Vietnam, however, the rainfall is more evenly distributed throughout the year. In addition to the rainy season, there is a moderate amount of precipitation during the winter or dry months, which is sufficient to produce a second grain crop. In South Vietnam, however, it is virtually impossible to obtain a second crop, without irrigation, during the dry, cool season on account of sparse precipitation.

In North Vietnam the temperature range during the entire year is greater than in the south. However, even in the northern part of the country, the mean monthly temperature seldom drops below 63° F. (17°C.).

Population: Official statistics for entire Vietnam are not available. Estimates place the total population at between 25 and 26 millions, with about 14 millions in South Vietnam. In recent years of conflict the population in the South has been increased by the influx of more than one million refugees. These migrants, formerly merchants, artisans, industrial workers and miners, have created an economic problem in an area where the majority of the inhabitants are small-scale farmers. These displaced persons from the North, as well as those from the interior of South Vietnam, rely more and more on agriculture and the exploitation of forest products to meet their necessities. Agriculture, particularly rice growing and rubber tapping, provides a livelihood for about 90 percent of the people. The remaining 10 percent depend on fishing, forestry and mining for subsistence.

The population is unevenly distributed. For economic, social, health and now political or military reasons, most of the people prefer to live in the plains and avoid the mountain areas. The result is the concentration of population, especially in the delta regions.

The land use and population pattern of North and South Vietnam are determined by variations in terrain, climate and soils. In South Vietnam, with its great Mekong delta, it is estimated that about 80 percent of the land is under cultivation; in the mountainous central region, about 20 percent; and in North Vietnam, also in great part mountainous, only about 30 percent of the land is cultivated.

In both North and South the highest concentration of population is in the rice-producing areas of the deltas and plains. This ranges from about [illegible]50 inhabitants per square mile in the rice land of the Mekong delta, to an average of more than 1,500 in the central region, and almost 1,800 in the Red river delta of North Vietnam. In other areas the population density drops to 20 or 25 inhabitants per square mile, while some comparatively large zones are totally uninhabited. There are several reasons for this diversity, but the predominant factor is the deep-rooted attachment to their ancestral homeland. In general the people are reluctant to leave their relatives, friends and the village where their ancestors lived. Also, those accustomed to the lowland plains are hesitant to move, even for temporary periods, to upland areas.

Far from being divided into Buddhists and Catholics, the inhabitants of Vietnam include an extraordinarily diverse number of tribes and faiths. There are one million Montagnards (mountain people) who have little resemblance to the more Mongol-looking Vietnamese of the plains. There are 3 million Confucianists and ancestor worshippers, a holdover from the 900-year Chinese rule. Taoists number about 500,000. The followers of the strange Cao Dai religion who worship Joan of Arc and Victor Hugo as well as Buddha, number at least a million and a half. There are 500,000 members of the Hoa Hao faith, which is a mixture of animism, miracle working and Buddhism. Catholics number a million and a half. There are 500,000 other Christians including Baptists, Mennonites, Seventh Day Adventists and converts of the Christian and Missionary Alliance. Finally there are 500,000 Hindus and Moslems, including the people of the non-Mongol Cham tribes.

The result is that out of the 14 million people in South Vietnam 9 millions are not Buddhists. This leaves 5 million Buddhists, or slightly more than 33 percent of the total population.

Forests: According to French publications there are more than 1,500 species of woody plants in Vietnam, varying in size from mere shrubs to large trees; from hard-stemmed reeds to palms and bamboos; and many species of woody vines or lianes, and herbaceous plants. These furnish timbers and minor forest products of diverse types which have long played an important part in the local economy as well as for export.

In the aggregate the dense and open forests, savannas, brushland and bamboo brakes cover approximately 40 percent of the total area of Vietnam.

In most areas the forests are mixed, represented by a large number of species within an area of a square mile. Rain forests are relatively limited, while pure stands are few. The nearest approach to pure types are the pines, the 3-needled Pinus khasya and 2-needled P. merkusii, growing in the uplands, as in Thailand, and Mangrove forest in coastal swamps. These are usually associated with other woody species, constituting for the most part less than 20 percent of the forest type.

As in the adjoining countries of Southeast Asia, the forests of Vietnam vary greatly in specific composition and physiognomy. Some are of commercial importance, others have a low economic value. The introduction of modern logging methods in recent years has drained some of the more accessible forests of many desirable timbers below mature and over mature dimensions.

As in Thailand, the diversity of forest composition in Vietnam may be ascribed to: (a) the variety of growing conditions, influenced primarily by climate, soils, drainage and exposure, which vary in ascending from sea level to the high mountains; and (b) forest practices, principal of which is the routine burning, resulting in the destruction of inflammable plants exposed to uncontrolled fires that escape from shifting cultivation, as practiced by people in the interior, and in contrast to naturally protected areas in the humid Rain or Moist Evergreen forests.

In addition to typical tropical species found in abundance at lower elevations there are sub-tropical species, similar to those found in Thailand, such as species of Quercus, Castanopsis, Pinus, Podocarpus and others growing in the mountainous country. Brushwood, bamboo, weeds and tall grasses invade cutover forests, and grow along arterial highways, railroads, and around hamlets and populated centers. Unexploited primary forests occur in precipitous and inaccessible mountain areas. Between the cutover areas and the upland forests there are other mixtures of forest types.

Forests of South Vietnam: The forests of South Vietnam have been devastated for many centuries. First nomadic or semi-savage people occupied the land and destroyed the forests without discrimination. After that came the Annamites who, in spite of a more advanced civilization, regarded the forest as capable of regenerating itself indefinitely, and gave no thought to its protection. Despite ample rainfall and other favorable conditions for growth, the forests were unable to re-establish themselves after prolonged periods of destruction. As a result, much of the so-called forest of what was formerly Cochin-China, now forming southern South Vietnam, consists in the main of cleared or brush land.

The forests may be divided roughly into three distinct zones: (a) the eastern or high, dry zone; (b) the western or flooded, in many parts marshy, zone; and (c) the central area between these two regions, covering the former provinces of Cholon, Tanan, Mytho, Gocong, Bentre, Travinh, Soctrang, Ganth, Binhlong Sadec and Longxuyen.

These areas are now almost entirely rice producing or covered with swamps, with small scattered stands of trees around villages.

The forests of the high zone cover the provinces of Tayninh, Thudaumot, Bienhoa, and the greater part of the province of Baria, extending northward into the forests of Binh-Thuan and into Cambodia. These forests vary greatly in appearance. They are composed of many species of trees, mostly of secondary growth, mixed with bamboos, shrubs and woody vines.

Within this zone there are about 150 small islands, scattered through the Gulf of Thailand and the China Sea, as well as isolated mountain forests, with low elevation, in the provinces of Chaudoc, Longxuyen and Hatien, emerging like islands from the basin formed by the swamps to the west. These stands include many species which are represented in the forests of the eastern provinces. Generally they are of smaller dimensions, and therefore differ in appearance. These forests have been exploited for many centuries for their timbers, as sources of mine-props and for building and repairing boats, so that some species are now rare.

The forests of the flooded zone extend throughout the region between western Vaico and the Gulf of Thailand, with many cultivated areas, swamps and few low mountains clad with trees similar to those in the eastern section. These inundated forests are distributed among the provinces of Baclieu, Rachgia, Hatien, Soctrang, Chaudoc, Giadinh and Baria.

Part of this extensive territory is covered with salt water intermittently at the period of high tide, or during the equinoxes. The salinity of the water decreases with increasing distance from the seacoast and finally disappears entirely. This variation in salinity is a determining factor on the nature of the vegetation. Two distinctive zones are found in the inundated forest: (1) the Mangrove forest, requiring salt water for its development, covering an area of about 1,800 sq. miles along the coast; and (2) stands of the cajeput tree (Melaleuca leucadendron), or 'cay tram', growing in fresh water, although it can endure a slight degree of salinity. These forests are distinct from one another and from those of the east coast in that they consist of a single or a limited number of woody species.

The forests of the west coast, like those of the east, have been intensively exploited from time immemorial, owing to continued and growing demand for fuel wood. Originally the banks of the rivers were flanked far into the interior with a curtain of mangrove trees. At one time they were protected by law from being cut less than 500 feet from the banks. When these laws were abrogated the felling of mangrove trees continued as before. The subsequent filling of river beds with sand and silt, constant shifting of sandbanks, and changes in the courses of streams contributed to the disappearance of the mangrove forest. These conditions make navigation difficult, and necessitate continual dredging at considerable expense. Mangrove forest formerly existing in the provinces of Baria, Bienhoa and Giadinh have been much depleted, but considerable areas still exist on the peninsula of Camau to Pointe St. Jacques.

The villagers consider the forests growing in the local domain as their property. They install charcoal furnaces, and sell their produce mainly to the Chinese. For many years sea-going Chinese boats, even from Singapore, have been stopping at deserted points along the coast of South Vietnam, to cut down Mangrove trees to obtain firewood, to make charcoal or to gather the bark as a source of tannin.

In addition to such commercially valuable woods as rosewood and ebony, the timber wealth of the southern part of South Vietnam is represented by species of two families in particular, namely those of the bean or pulse (Leguminosae) and of the wood-oil (Dipterocarpaceae), found throughout the dryland forests. Species of these yield excellent timbers for building and joinery. Other useful timbers are furnished by members of the families Lauraceae, Sterculiaceae, Verbenaceae and Guttiferae.

For many years timber operators have experienced increasing difficulty in procuring timbers for building, and have been obliged to secure supplies in areas remote from shipping points, since suitable dimensions are no longer available along highways and streams.

In addition to timbers, South Vietnam possesses many minor products of plant origin. Among secondary products bamboo is the most important, and is considered 'the poor man's provindence'. It is found throughout the forests in the eastern part, represented by a number of species and each of which has special uses. In Vietnam, as elsewhere, bamboos are of universal utility, furnishing material for building huts, cooking utensils, furniture, as well as vases, plates and ornaments of varied kind. It is utilized for baskets, ladders, bridges, irrigation pipes and gutters. The sprouts are edible, and animals are fond of the young leaves and branches. In addition to these local uses, certain species of bamboo are especially suitable for pulp and paper manufacture. There are some species of bamboos, however, which are veritable forest pests, developing immediately after a patch of forest has been felled or cleared, choke out almost all other plants, and when well established are difficult to eradicate.

Rattans (Calamus), of which there are several species, are found in South Vietnam as in Thailand, some growing in tufts and others in single stalks. Some species are armed with spines, others are entirely unarmed. Rattan is used for cordage, and the stems split lengthwise are used for basketry and for making light-weight furniture.

The forests of South Vietnam contain several types of woody vines or lianes, furnishing cordage. Other plants are sources of latex for gutta-gum, such as species of Palaquium obovatum, an inferior gutta-percha, and dyes. In addition, there are several species of palms, some furnishing leaves to thatch huts, to make junk sails, hats, and other similar uses.

Resins, which are natural or accidental exudations of pale yellow or amber color, are furnished by species of the wood-oil family (Dipterocarpaceae), especially of the genera Hopea and Shorea. Exuded along the trunk, branches and roots, such exudations have long been gathered by woodcutters and others without any systematic method of tapping, for making torches, to caulk boats and in the manufacture of varnishes.

Wood-oil is furnished by species of Dipterocarpus, especially the tall 'dau' (D. alatus) or known as 'yang-khao' in Thailand. This product is gathered in a primitive manner during the dry season, by making a hollow with a hatchet in the trunk, about 3 feet above ground (Fig. 17), to gather the oil that flows out. When the flow ceases the hollow is filled with straw or twigs, which are set on fire to induce the flow of oil. It is difficult to estimate the yield of oil obtained from an individual tree. The natives claim that a 30-year old tree will continue to flow for many years, and that the quantity obtained from a single tree may range up to about 60 pounds each year. In normal years it was estimated that the southern portion of South Vietnam produced in excess of 2 million pounds annually of wood-oil. This is used locally for making torches, for caulking boats and junks, and for varnishing furniture.

Forests of Central Vietnam: The forests of Annam, now divided to form a section of South Vietnam and a portion of North Vietnam, at one time covered approximately one half the total area of the former French protectorate, or about 15 million acres (23,440 square miles). These forests form a continuation of those of North Vietnam, corresponding to what was formerly known as Tonkin, extending southward into South Vietnam, and westward into Laos. They represent an enormous timber wealth, containing such rare woods as rosewood, as well as ordinary woods, some of them suitable for paper pulp.

Of broad-leaved trees, species of the wood-oil (Dipterocarpaceae) and bean or pulse family (Leguminosae) are widespread and the most valuable. While the Dipterocarps furnish timbers for heavy construction, those of the bean family supply fine cabinet woods and building timbers, and others for turning, carving and decorative purposes.

There are a number of species of Conifers, especially the 3-needled pine (Pinus khasya) and the 2-needled pine (P. merkusii), scattered over thousands of acres (Figs. 48-51). But some of the stands occur in remote regions with few roads and sparse population. In many areas their exploitation has been hindered also by high cost of logging and problems of transportation. In addition to pines other Softwoods, such species as Chamaecyparis, Cunninghamia, Taxus and Thujopsis, are found. These Coniferous forests occur either in pure stands or mixed with other timber species. The province of Lang Bian is said to contain extensive stands of pine, with a potential annual production estimated at one time to be between 14 and 21 million cubic feet. But these forests also are difficult of access.

A great amount of timber has been wasted over the decades in the forests of south Annam. Tall timber trees normally have a large base, which makes cutting difficult and slow. Woodcutters saw these trees at a height of 5 to 7 feet above the ground, so that there is much waste. Much damage has also been done to seedlings in removing heavy logs from the forest, usually hauled by buffaloes. Similar waste has also been practiced in cutting firewood because, as a rule, smaller trees are felled for fuel.

Most of the burning of the forests in Annam is done, as elsewhere, for shifting cultivation, the 'rai' system widely adopted throughout Southeast Asia. In this process thousands of acres of forests are burned each year, followed by planting field crops on a few hundred acres. After 2 or 3 crops the patches are abandoned. Soon the ubiquitous lalang (Imperata) and other grasses and weeds develop, which are burned regularly each year. In normal time this practice is difficult to suppress among the tribes in the mountain areas, although it can be controlled to a great extent in the plains, where people are in closer contact with authorities. It is reported that during a single year the inhabitants of a large village may destroy a complete forest within a radius of 15 miles. Bamboo brakes are also destroyed by fire. The effect of deforestation is evident in central Vietnam, as shown by a gradual increase of uncultivated land along the base of the mountains, caused by erosion of soil from the bare mountain slopes, filling up the beds of streams, and with consequent floods.

In addition to timbers, the forests of the Annam region, or central Vietnam, yield a series of minor products, including bamboos, rattans, resins, gums, tanbark, fibers, oil-producing seeds, cardamoms and vines, which in the aggregate have been an appreciable source of revenue. Tapping of pine for resin has been carried on for many years in the reserves of [illegible]-Mai, in Lang Bian and at Dang-Kia. But the tapping of the product has been hampered by the difficulty of securing labor and material. The results have not always been entirely satisfactory.

Forests of North Vietnam: It was estimated by the French Forest officers that the forested area of former Tonkin, now part of North Vietnam, amounted to about c. [illegible]5,000 acres, or 13,500 square miles. The forests on the whole have been very much depleted, with bare mountains covering vast areas. The primary forests have been devasted over a period of several centuries ago, others during the French occupation. The total area designated as forests included much forest land not capable of restoration by means of natural or artificial reseeding or replanting. In addition, it included areas of marginal land, planted to rice, and forests parceled out to the natives to exploit minor products.

The trees in Tonkin, in upper North Vietnam, for the most part are broad-leaved, mixed with Conifers, mostly Pines, in some regions. Pure stands of Pine, of one or more species, are rare. As many as 50 different species of broad-leaved trees are generally found on a single acre. But the forests have lost their original character, as the result of extensive felling over a period of several centuries. Primary forests are found only at high elevations, from 2,300 to 4,900 feet (700-1,500 m.), and even higher. In the valleys and plains the forests have also been devastated, and now furnish only inferior, undesirable timbers. Even second-growth has disappeared over vast areas, giving place to brush and grass-covered savannas.

Undoubtedly, primary forests covered much of the lower regions of Tonkin at one time, but these were progressively cleared for the planting of field crops. Such tropical families as Dipterocarpaceae, Anonaceae and Sterculiaceae are now represented by only a limited number of woody species. Genera typical of temperate regions, such as oak (Quercus), chestnut (Castanopsis), maple (Acer), ash (Fraxinus), magnolia, and others appear in the highlands. There are species with hard and soft wood. The softwoods usually develop in secondary forest growth following fire, felling or clearing. For the most part the trees are of much smaller dimensions than those growing in the Rain or Moist forests of Thailand, or those found in the highlands of central Vietnam and Cambodia.

The effects of excessive deforestation in upper North Vietnam is shown in the regimen of streams. River-beds are clogged with rocks and sandbanks. The action of torrents is evident on the mountain slopes as well as in the cultivated valleys. Sand, gravel and even rocks are carried along by rushing waters, forming deposits of detritus which damage rice planting in the upper valleys.

Timbers graded as first and second class in Tonkin include: 'gie' and 'soi' (Quercus and Pasania spp.) of the oak family; 'cyp' (Parashorea sp. and Dipterocarpus tonkinensis); 'tau' (Vatica tonkinensis); 'cham' (Canarium tonkinense, C. nigrum, C. copaliferum); 'bode' (Styrax tonkinense); also Melia spp; Pygeum arboreum, Toona febrifuga, Spondias tonkinensis, Mallotus cochinchinensis, Casesalpinia sappan and Nauclea purpurea. These genera are represented also in Thailand.

CAMBODIA

Cambodia is an ancient country named after Kambu, the mythical founder of the Khmer race who inhabit it. The country has suffered many vicissitues in its long history, and has seen the rise and fall of diverse civilizations. It came under French domination in the 19th century when it was incorporated as a part of the French Union of Indochina. Only since World War II has it emerged as a newly independent kingdom, following the breakup of the Union.

Bordered on the north by Laos, on the west by Thailand, and on the east and southeast by South Vietnam, it has an area of about 66,800 square miles, roughly the size of the State of Washington or South Dakota. It is a relatively compact country, extending about 350 miles (560 kms.) from east to west, and in its north-south axis it varies from 150 miles (250 kms.) in the east to 280 miles (480 kms.) in the west. The central plain, an alluvial plateau bordering on the Mekong river and Tonlé Sap (Great Lake), covers about three-fourths of the country. To the south and west there is a high plateau, flanked by the Elephant Mountain Chain extending to the Gulf of Thailand. In the west and north the Cardomom and Dangrek Mountain ranges extend along the border of Thailand. The Moi plateau, to the east, is inhabited by more than 50,000 primitive hill people.

The Mekong river enters Cambodia from southern Laos and traverses the country in a southerly direction before it enters South Vietnam. Tonlé Sap, or Great Lake, is an important geographical feature. Once an arm of the sea, this large lake is now linked with the Mekong river by a channel at Phnom Penh. During the rainy season, the waters of the Mekong flow into this lake and increase its area to about 770 square miles. In the dry season, however, the current is reversed and the lake is reduced to approximately 100 squre miles. This is surrounded by wet, fertile land admiraoly suited for rice cultivation. The lake teems with fish, so that an extensive fishing industry has developed in the area.

Population: The population of Cambodia is estimated to be about 5 millions and is said to be increasing at the rate of 2.2 percent per annum. The population density, of about 75 inhabitants per square mile, is low for this part of the world, and the country is considered to be underpopulated. More than 80 percent of the inhabitants are of Cambodian or Khmer stock; 6 percent, Vietnamese; 5 percent, Chinese; and an unknown number of Chams (Cambodian Moslems) and hill tribe people. Europeans, mostly French, formerly numbered about five thousand. The heaviest concentration of population is in the river areas. The Provinces of Kandal, which includes the capital Phnom Penh, Kompong Cham, and Prey Veng have the densest population.

Although they still represent only a small percentage of the population, the Vietnamese have been immigrating into Cambodia since the

17th century. They have not been completely assimilated and still remain as a separate group. They are influential in the urban areas as skilled artisans and small merchants, but in rural areas they have become successful farmers. The Vietnamese provide the backbone of the labor force of the country.

The Chinese are mainly engaged in trade, banking and transportation, and as a result they dominate to a large measure the economy of the country. The Khmers resent this Chinese influence, but at the same time admire the shrewdness of the Chinese. The Chams, numbering approximately 75,000, are an autonomous religious minority. They are devout Moslems and have been allowed to retain their religion and cutoms. Intermarriage between Chinese and Cambodians has given rise to a group of Sino-Cambodians who appear to have more prestige than the Eurasians. The primitive tribal people inhabiting the Moi plateau, to the east, recognize no authority outside their own villages, and are essentially a race set apart.

Nearly all Cambodians are followers of Hinayana Buddhism. Life expectency is roughly 30-40 years, and the estimated per capita income in 1960 was $100.00.

Climate: The climate of Cambodia is of a tropical monsoon type, similar to that of Thailand. It has a dry season during the northeast monsoon, from December through May, and a wet period, during the southwest monsoon, from June through November.

The mean annual precipitation at Phnom Penh, the capital, over a 22-year period, is 56 inches (1,422 mm.), with an absolute maximum of 91 inches (2.311 mm.), and an absolute minimum of 30 inches (765 mm.). In the mountainous area precipitation is much higher. The Cardamom Mountain and the Elephant range in the western part, lying in the path of the southwest monsoon have the highest annual rainfall in the entire Indo-China Peninsula. At Val d'Emeraude, for example, the mean yearly precipitation is 210 inches (5,334 mm.), with an absolute maximum of 246 inches (6,248 mm.), and an absolute minimum of 160 inches (4,294 mm.). Nine-tenths of the precipitation falls during the rainy season, and the showers, torrential in nature, quickly pass.

The temperature ranges between 68° and 97° F. (20° to 36°C.). As in Thailand, the most comfortable months are December and January, and the hottest are April and May. The humidity is consistently high, and mildew presents a persistent and troublesome problem. Mosquitoes abound throughout the year, and the variety of other insects is large.

Forests: Cambodia's 33,700 square miles of forests cover approximately 50 percent of the country's total land area, and are entirely in the public domain. The Evergreen Rain and Moist forests, covering about 11,700 square miles, are composed of a wide variety of large trees similar to those of corresponding forest types in Thailand.

The remaining 22,000 square miles are covered by open to fairly open forest, of the Seasonal or Deciduous type, in which most of the trees shed their leaves during the dry season. Because of poor soil conditions in many areas, the dominant trees belong to the wood-oil family (Dipterocarpaceae), composed of species similar to those in eastern Thailand.

The forests may be segregated broadly into three types: (a) inundated or riparian forests: (b) seasonal or deciduous and second-growth forests; and (c) dense forests.

(a) Forests flooded over periodically contain only inferior tree species, mingled with woody vines and rattans (Calamus). As in the case of vegetation around hamlets, these have been much cutover during the years, since the rich soil in these sites has always been much in demand for agriculture, especially for rice planting. Because of the difficulty to supervise an efficient and methodical exploitation of these forests, they were much neglected by the French forest administrators of the protectorate.

(b) Seasonal or Deciduous forests; the principal species are: 'phdiek' (Anisoptera cochinchinensis); 'sokram' (Xylia dolabriformis); 'tbbeng' (Dipterocarpus obtusifolius); 'trach' (Dipterocarpus intricatus); and 'khlong' (Dipterocarpus tuberculatus), growing scatteringly and with little or no undergrowth.

From August to November the ground is covered with tree seedlings, sprouting amoung the grasses. During January, at the beginning of the dry season, the young plants and grasses are destroyed by fires set by the natives. These periodic fires injure the soil, destroy the young plants, and often damage irreparably the larger trees, so that natural regeneration is difficult.

(c) The dense forests, or remnants of these, are located in the districts of Stung-Treng, Kratie, Kompong-Thom, Kampot, and Battambang. They contain many useful timber trees, much esteemed in local industry. As in Thailand, the species rarely, if ever, occur in pure stands, but are mixed in such a way that it is often possible to identify more than 100 species within a small area. Stands along the principal rivers have been cut over indiscriminately by the natives. But a few miles from floatable streams there are still almost intact, undisturbed stands. In some areas attempts have been made to exploit and develop these stands by opening up roadways.

The forests of Cambodia contain a number of timber species suitable for industrial use, such as for cabinetwork and furniture, vehicles, general construction, railroad crossties and mine timbers. The minor products in these forests are also varied. They include resins, gutta-gum, barks, dyewoods, tanning extracts, fragrant woods, textile and fiber plants, bamboos and rattans, which are also found in Thailand and Vietnam. But these have not been exploited on a scale comparable to Thailand.

Rubber: Cambodia ranks as an important producer of Pará rubber (Hevea brasiliensis), tapped from trees grown on large plantations, which were formerly all French-owned. In an attempt to encourage participation of Cambodians in this economic product, in recent years the government has been promoting a small-holder rubber program among individual farmers.

More than 90 percent of the estimated 92,700 acres planted to rubber trees is located in the northern and southeastern sections of the Kompong Cham Province, where soil and climatic conditions are especially suitable for this introduced tree. Possibilities for increased rubber production exist also in the red soil areas of Battambang and Kratie Provinces.

Rubber production amounted to 38,000 tons in 1959, and 40,985 tons in 1960. Virtually the entire output is exported, principally in the form of smoked, crêpe and latex rubber, with about 50 percent of the annual production, during those years, shipped to the United States.

LAOS

This landlocked country extends along the main ridge of several mountain chains that form the watershed of the Indo-China Peninsula of Southeast Asia. Its present frontiers were established in 1893 when the country became a French protectorate. The French called the country Laos (pronounced La-os), and the inhabitants were designated as Lao (La-o, not Laotians).

On its western flank Laos borders Thailand for about 1,000 miles (1,600 kms.), with the Mekong river forming more than 500 miles (800 kms.) of the boundary. On the east it has a long border with North and South Vietnam; to the north it adjoins Burma and the Yunnan Province of Mainland China; and on the south is flanked by Cambodia. The total area of the country is approximately 91,500 square miles, roughly the size of the States of Pennsylvania and New York combined.

Laos is the largest in area, but the least populated, of the territories that formerly constituted Indochina. Its long axis is about 600 miles (900 kms.), extending roughly northwest by southeast. The northern half, or Upper Laos, has a maximum width of 300 miles (480 kms.); the southern half, Lower Laos, is narrower, being only 60 miles (96 kms.) at its narrowest part. Three fourths of its land area is mountainous country and plateaus, the rest being plains along the margins of the Mekong basin, and where most of the population is concentrated.

The country may be divided into three topographic regions: (a) Upper Laos, mainly rugged mountain chains and gorge-like valleys, with some peaks attaining a height exceeding 8,000 feet (2,500 m.); (b) sloping tablelands that border the Annamite Chain in Lower Laos; and (c) lowland valleys of the Mekong river and its tributaries.

The Mekong river, which has long played an important role in the life of the Lao people, flows for several hundred miles, in a broad valley along the western border and through northern Laotian territory. It constitutes the country's main artery of communication. During low water the river is shallow, but at the height of the rains it rises more than 20 feet (6 m.). (See Fig. 85.)

Soil fertile enough to support intensive agriculture is limited to the river valleys and on the Boloven Plateau near the Cambodian border. The people's life is closely tied to agriculture and rice is largely cultivated for domestic needs.

<u>Population</u>: No accurate data are available regarding the population figure of Laos. Recent official estimates range from 1.5 to 3 millions. The sparse population is unevenly spread, with the greatest concentration in the basin of the Mekong, and is comprised of many tribal groups with divergent backgrounds. For administrative purposes they are classified into two principal groups: (a) Lao, probably descended from tribes whose origin was Thai, account for approximately 42 percent of the total population. The related Thai, representing about 15 percent of the population, have a somewhat similar ethnic heritage. These people inhabit the plains, living in densely populated villages, and their livelihood depends entirely on rice growing. Their predominant religion is Buddhism. (b) Lao-Theung, who live mostly in the hills and mountainous area, constitute about 29 percent of the population. With inheritance stemming from several different ethnic cultures, these upland tribes include the Kha, Meo, Yao, Phouthai and Lu. They inhabit the forests of the high plateaus and mountains, and practice the shifting system of agriculture, by burning off hillsides to secure tillable land and seek new fields when soil exhaustion makes old sites undesirable (Fig.118). On these small patches they grow annual crops, upland rice and other food produce, as well as opium poppy.

In addition, tribes of proto-Malayan stock or Indonesian descent, live under primitive conditions scattered in the mountains and forests. Foreigners who reside in the towns and conduct most of the banking and commerce include Vietnamese, Chinese, Cambodians, Indians and Pakistanis.

It is impossible to determine the exact number of inhabitants by region, but the following figures indicate the approximate density of the population. In mountain regions there are roughly 5 inhabitants per square mile; while in the plain regions the average is about 39 inhabitants per square mile.

Climate: Laos has a tropical climate with two distinct seasons: a rainy period from May or June to October, regarded as the season to till the land; and a dry cool season, from November to February, prolonged into a warmer summer period from March to May. Humidity is high throughout the year, and the heat is oppressive and enervating in the lowlands.

The climate of Vientiane, the administrative capital, is rather well defined seasonally, characterized by 5 or 6 months of heavy rainfall. The average is between 11 and 12 inches per month during the rainy southwest monsoon period, from May to September or October inclusive. This is followed by 5 or 6 months of drought, with a monthly average of about one-half inch of rain, falling on an average during 2 days a month.

April is the hottest month, with an average maximum of 93° F. (34°C.), and an average minimum of 72.5°F. (22.5°C.). The coolest month is January, when the average maximum temperature drops to 83°F. (28.3°C.) and the average minimum to 57°F. (14°C.). In the spring there are strong winds from the south, which occasionally cause damage to buildings and trees.

At Vientiane temperatures range from 70° to 90° F.(21° to 32°C.), although temperatures under 50°F. (10°C.) and above 100°F. (37.8°C.) have been recorded.

Throughout Laos, the temperature and rainfall vary somewhat from place to place. On the plateaux of Boloven and Tran-Ninh the winter cold may be severe enough to damage local crops. Temperatures frequently fall below freezing at elevations around 4,000 ft. (1,300 m.) in Xieng Khouang Province.

Forests: Studies on the vegetation of Laos have been made principally by French ecologists and foresters. However, these investigations have been carried out only on a limited scale, so that only meager information is available on the specific composition and precise distribution of the various forest types in Laos.

It is estimated that the forests of Laos cover approximately 62,000 square miles, or equivalent to about two-thirds of the total area of the country. All forest land is owned by the government, but parcels may be leased to private firms. As in adjoining countries, shifting cultivation accompanied by periodic fires is practiced throughout the years by hill tribes inhabiting the mountains and plateaus. This has resulted in extensive destruction of valuable primary forests. In addition, uncontrolled exploitation of commercial timbers and minor forest products has long been conducted in a wasteful manner.

With similar topography, climate and soils, the forest types of Laos are closely similar to those of continental Thailand, with

Mixed Deciduous and Dipterocarp forests being predominant. For example, a dominant tree in the northwestern section adjoining Thailand, between Vientiane and Luang Prabang, is Teak (Tectona grandis), which is also found in the neighboring regions of northwestern and northern Thailand. It is estimated that there are about 173,000 acres of this valuable timber in the Saraboury region of northwestern Laos.

Farther east in Upper Laos, from Paksane northward toward Xieng Khouang, there are stands of the 2-needled Pine (Pinus merkusii), which is also found in northern Thailand. This pine forest extends into the uplands northeast of Thakhek towards the border of North Vietnam (Fig. 11).

Still farther north, along the border between Laos and the northwestern part of North Vietnam, a frequent and characteristic tree is 'bo de' (Styrax tonkinensis). In the uplands along the border of North Vietnam, also, there is a species of oak (Quercus), as well as such trees as Aglaia gigantea and Sindora tonkinensis. Farther south, 'trac' (Dalbergia cochinchinensis) is a frequent tree, much valued for its timber. All these genera are represented in eastern and northern Thailand.

While the forest types of Upper Laos are comparable to northern Thailand, those of Central and Lower Laos resemble the forests in the region of Nakhon Phanom, Mukdahan and Phibun Mangsahan, in northeastern and eastern Thailand, adjacent to the Mekong river. In these areas there are extensive areas of open Dry Dipterocarp forest, mixed with localized stands of Mixed Evergreen forest, and occasional small patches of Savanna.

ANALOGOUS FEATURES

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SOUTHEAST ASIA, PUERTO RICO AND TEXAS

To establish analogous features of the vegetation in widely separated areas with such extreme climatic conditions, ranging from tropical, subtropical to temperate, that prevail in Southeast Asia, Puerto Rico and Texas, consideration should be given to topography and soil types. These factors, as we have indicated, influence considerably the types of vegetation that prevail in these divergent regions.

Area: The five countries of Southeast Asia under review have a total area of about 500,000 square miles; Puerto Rico covers 3,423 square miles; and Texas, 262,400 square miles.

Topography: The general physiography of Southeast Asia is that of mountain ranges, with peaks upwards of 6,500 feet (2,000 m.) in altitude, deep gorges, plateaus and great plains. The entire region is drained by numerous rivers, most of which flow in a southerly or southeasterly direction, and their estuaries form extensive deltas.

Puerto Rico contains three physiographic regions: (a) a central mountainous core of volcanic origin; (b) an elevated area of coral limestone, formerly marginal marine deposits, surrounding the mountain ranges; and (c) the northern and southern coastal plains. Few countries of comparable size are so well-watered as Puerto Rico. Within its mountainous area there are many swift-running streams, flowing through deep gorges and steep-sloped valleys. It is reported that the island has about 1,300 small and large streams, of which the Rio de la Plata, about 45 miles (72 kms.) long, is considered the largest. Except for small boats, these rivers are navigable only in their tidal reaches.

On a broad basis, there are three major physiographic conditions in Texas: (a) mountains and basins of the Trans-Pecos; (b) fairly level plains as exemplified by the high plains and Gulf prairies; and (c) rolling or irregular topography as typified by the rolling plains, South Texas plains, Hill country or Edwards plateau, and East timberlands.

The principal mountains of Texas are in the Trans-Pecos region where the Rocky Mountain system crosses over from New Mexico to Old Mexico. The highest point is Guadelupe peak, 8,751 feet (2,650 m.). The Balcones Escarpment provides a rather distinct dividing line between the eastern Edwards plateau and the South Texas plains and Blacklands. Another prominent physiographic feature is the Cap Rock Escarpment, separating the high and rolling plains. Many streams dissect the State, flowing irregularly from the northwest to the Gulf Coast.

Climate: In Southeast Asia the climate is controlled by the seasonal monsoon, modified by local topography. Two broad types of climate prevail: that of the Rain forest and of Savanna. The optimal Rain forest climate is characterized by a uniformily high temperature and rainfall distributed throughout the year, with no prolonged dry season. The tropical Savanna climate, on the other hand, has less precipitation, varying up to 80 inches, with distinct rainy and dry seasons of almost equal duration. This is modified regionally under the influence of topography. The prevailing winds in Thailand are the southwest monsoon, which corresponds to the wet season, and the northern or northeast monsoon, during the dry season.

Owing mainly to the modifying influence of topography, five types of climate are recognized in Thailand: (a) Northern region, with a monsoon climate influenced considerably by local elevation, producing a so-called mountain climate, with temperature extremes ranging from

37° F. (2.8°C.) to 103°F. (39.5°C.). Rainfall is moderate, but of long duration. (b) The northeast or Korat Plateau has a tropical savanna climate, and is little affected by topographic relief, since this is mostly a plateau. The highest temperature record is 109°F. (42.8°C.). Recorded monthly extremes of rainfall range from 0.2 inches (5.3 mm.) to 9.7 inches (248 mm.). (c) In the Central Plain, the climate is also a lowland savanna (monsoon) type, with a mean minimum temperature of 72.4°F. (22.7°C.) and mean maximum of 92.3°F. (33.5°C.). The average annual rainfall is 52.42 inches (1,344 mm.). (d) Along the southeast coast the climate is of the tropical Rain forest type. Temperatures are generally high and uniform, with the highest recorded at 101°F. (38.8°C.) and the lowest, 54.5°F. (12.5°C.). Annual precipitation averages 97.27 inches (2,494 mm.). (e) The climate of peninsular Thailand is also of the Rain forest type, characterized by high temperatures, and with no prolonged and well-marked dry season. The yearly annual temperature ranges between 80°F. (26.7°C.) and 82.4°F. (28°C.). The highest temperature recorded is 103°F. (39.3°C.) and the lowest is 63°F. (17°C.). The highest annual rainfall, of 257.83 inches (6,606 mm.), has been recorded at Takuapa in the southwest and the lowest of record is 50.70 inches (1,300 mm.).

Although Puerto Rico is well within the tropics, it has an equable climate because the modifying influence of the ocean is accentuated by the position of the island in the direct path of the North Atlantic trade winds. The prevailing winds vary in direction from northeast to southeast. The temperature throughout the year is uniform. Records maintained by the United States Weather Bureau show an average annual temperature of 76°F. (24°C.). The daily range in temperature is more pronounced than the seasonal. The average rainfall is much more variable than the temperature. The average for a 12 year period showed 77.30 inches (1,963 mm.). The geographic distribution of rainfall shows a still wider variation. The heaviest precipitation is recorded in the Luquillo range, in the northeast, where the average annual rainfall reaches 135 inches (3,429 mm.), at times even 170 inches (4,318 mm.). The minimum average annual rainfall of 37 inches (940 mm.), is recorded at Guánica, on the southwest coast, while 21 inches (533 mm.) has been recorded as the absolute minimum in recent years.

In Texas precipitation records have been maintained by the U.S. Weather Bureau for about 100 years. Most of the precipitation falls as rain, but there are locations, in West Texas, where snowfall contributes significant amounts of moisture. The warmest part is in the Lower Rio Grande Valley, with an annual mean temperature of 74°F; and the coldest section is the Panhandle with an annual mean of 54°F. The highest rainfall area is in the extreme east Texas, with annual average of more than 55 inches (1,375 mm.), but on occasions it has reached more than 80 inches (2,000 mm.). Precipitation decreases from east to west. Rainfall throughout the State is highly erratic, usually with more years below than above average. Drought of a temporary or sometimes prolonged nature is a common occurrence, forcing its impact on the vegetation. Climatic zones in Texas have been characterized as arid or semi-arid and humid or sub-humid, even though the State lies within temperate latitudes.

Soils: There is a considerable diversity of soil types in the various regions of Thailand. The characteristic soils of the northwest highlands are shallow and stony, interrupted by loamy, recent alluvial soils. The soils of the Korat plateau, in the northeast, are either fine sandy loam, quartzitic and siliceous sandstone, or laterite, interspersed occasionally with alluvial deposits, especially near the Mekong river. The central plain has dark heavy clay with profiles not well developed. The southeastern region around Chantaburi and Trat has a variety of soils from fine sandy loam to very coarse sand, generally at the foot of granite hills. In the Peninsula the soils are rather complex and interspersed with fine sandy loam, characteristic of that of Roi-et in the northeast, as well as loams typical of the Chiengmai region, in the north. There are also coastal soils with sandy ridges, alternating with strips of low clay.

The soils of Puerto Rico also show considerable variation. In some areas they have been derived by erosion, and distributed for the most part by water. On mountain slopes, as in the southern part, plants often grow between loose rocks or appear to spring from rock crevices, in which their roots are firmly embedded. This condition results in soils of differing depth, ranging up to thick deposits occurring in alluvial coastal plains. The soils also vary in the amount of moisture they contain, some being very moist, others are dry. In some coastal areas, such as the region of Guánica in the southwest, the soils are saline. On hill slopes the soils are more or less calcareous. On eruptive rocky hills and mountains and in granite and shale areas they are often predominantly clay. Along river banks, especially in the northern coastal plains, the soils are almost pure sand or gravel, as also in the coastal beaches and dunes.

The soils of Texas in general have been influenced by relatively recent Cenozoic clay and sand sediments in the eastern and western thirds of the State. The central region has been affected by intermediate-age limestone, marls, sands and clays of the Mezozoic and Paleozoic eras. In addition, minor outcrops of older rocks occur in the Trans-Pecos. Alluvial soils occur along most of the streams and major river systems.

Vegetation: The three regions, especially Southeast Asia and Puerto Rico, are rich in plant species. In Thailand it is reported that there are about 10,000 species of plants, ranging from small herbs to giant trees in the Rain forest; and about 1,500 woody species in Vietnam. In Puerto Rico and the Virgin Islands there are several thousand plants, including 500 species of woody plants, from tall trees in the Evergreen Moist forest to dwarf species in the upland Montane forest and in arid regions. Approximately 4,500 species of plants are recorded in Texas.

Coniferous forests, especially species of pines, are found in Southeast Asia, but they constitute only a minor part, less than 1 percent in Thailand, of the total forests. There are two species of pines (Pinus) in Thailand, which are also found in adjacent countries to the east, growing at medium to high elevations, where they sometimes form almost pure stands. Pine is not native to Puerto Rico, although several species have been introduced into the island and grown successfully. In Texas, 6 or 7 species of pines form an important element of the vegetation, especially in the Pineywoods area in the eastern part, at elevations of 200 to 500 ft. (60-150 mm.). These include: loblolly (Pinus taeda), shortleaf (P. echinata), longleaf (P. palustris) and slash pine (P. caribaea).

Several species of oak (Quercus spp.) are of common occurrence, mixed with other species, in the Montane forest of northern Thailand, as well as in Vietnam and in the adjoining countries. Oaks, also, constitute a major element in the vegetation of Texas. About 35 species are represented in the State, in addition to a large number of varieties. Along with hickory, maple and pine, oaks are dominants in the Pineywoods area of eastern Texas.

The forests of Southeast Asia may be divided into two broad classes: Evergreen and Deciduous. The same general classification may be applied to Puerto Rico.

In Thailand 12 forest types are recognized, all or most of which occur in the other Southeast Asiatic countries. The Evergreen forests include: Rain; Moist; Dry Evergreen; Montane; Coniferous; Swamp, which includes Mangrove woodland; and Deciduous forests, separated into Mixed Deciduous, which may be further divided into Moist Mixed and Dry Mixed forests; Deciduous Dipterocarp forests; in addition to Beach forest, Bamboo brakes, and Savanna.

Most of these formations are represented in Puerto Rico. Although the forest types in the two respective regions may differ in species composition, they exhibit analogies in physiognomy and life-forms.

In Texas there are four major plant formations; Grassland; Deciduous forest; Woodland; and Desert-scrub. Representative associations in the grassland formation are mixed-prairie, coastal prairie, and desert plains. The short-grass area of the Texas high plains may be regarded as a grazing disclimax to mixed-prairie. The dominants of the Deciduous forest are oak and hickory. The woodland climax formation is represented on the Edwards plateau and in the Davis and Guadelupe mountains as piñon-juniper association. The arid section may be classified as desert-scrub.

In Thailand Rain forest is found in the Takuapa region, southwest Peninsula, and in isolated sites on the summit of the mountain chains in the southeast, along the Cambodian border. There the annual rainfall sometimes reaches in excess of 150 inches. Rain forest is found also in western Cambodia in the Cardamom and Elephant mountain ranges. There are some isolated stands of Rain forest, also, in the Annam Mountains of central Vietnam. In Puerto Rico Rain forest is confined mostly to the upper slopes of the Luquillo mountain, in the northeast. Dominant trees in this forest are Dacryodes, 'tabanuco', associated with Sloanea. On the summit of these ranges in Puerto Rico dwarf trees form what some call 'Elfin woodland' in the Montane forest. The same type of forest is found on the summit of mountains Inthanon, Sutep, Angka, Puy, and Chiengdao in northern Thailand.

Mossy forest occurs at the upper limit of the Montane forest in Thailand as well as in northeastern Puerto Rico. In this forest the tree trunks and branches are covered with mosses and lichens, and the ground is a moist, sphagnum bog.

Evergreen Moist forest is widely distributed along the lower and middle windward slopes of hills and mountains both in Thailand and Puerto Rico. Stands of Dry Evergreen forest are scattered in eastern and western Thailand, and along the north coast of Puerto Rico.

Mixed Deciduous forests are also a common occurrence in Thailand, Puerto Rico, as well as in Texas.

The mountain cabbage or 'sierra' palm (Euterpe globosa) is a distinctive and characteristic feature of the vegetation in upland areas of Puerto Rico, often forming extensive stands. In Thailand palms are also well represented by several species, but nowhere do they form large, dense stands, comparable to the Puerto Rican Euterpe globosa.

Trees of the wood-oil family (Dipterocarpaceae), represented by several genera, are a dominant and characteristic feature in Southeast Asia. In Thailand they constitute about 45 percent of the total forested area. These trees do not grow naturally, and no attempts have been made to propagate them either in Puerto Rico or Texas.

Bamboos, of which there are about 19 species in Thailand, are widely distributed throughout Southeast Asia, develop rapidly and form extensive brakes in forest clearings and play a very important part in supplying the daily needs of the people. Bamboos are not native to Puerto Rico or Texas, but several species have been introduced and propagated successfully in Puerto Rico.

A distinctive topographical character, with a characteristic plant cover, are the limestone bluffs, 'haystacks' or 'mogotes', frequent in northern Puerto Rico. Similar limestone buttes, often with steep slopes covered with distinctive vegetation are found in widely scattered areas of Thailand, especially in the southern Peninsula where they form a prominent feature of the landscape (Fig. 111).

Thorn forests are common in cleared land in Thailand, especially where the annual precipitation is low and the soil is poor. Many of the plants, ranging from shrubs to small trees mixed with bamboos and cacti, are armed with sharp thorns. A similar formation occurs around Guánica, in southwestern Puerto Rico.

The best analogy, in comparing the vegetation types of Southeast Asia and Puerto Rico, is the Mangrove forest, which occurs in both hemispheres. This is a special edaphic association, flourishing in saline soil in deltas and around the estuaries of rivers. Several identical genera grow in this forest type in both regions. While some stands of Mangrove forest in Thailand and South Vietnam may be taller than those along the north and south coasts of Puerto Rico, their physiognomy and life-forms are closely similar. The canopy is uniform and continuous, with foliage of varying shades of green, according to species.

Teak (Tectona grandis) is a characteristic tree of the Mixed Deciduous forest of northern Thailand and northwestern Laos. This commercially valuable timber tree is not native to Vietnam, Cambodia, or Puerto Rico, although it has been planted successfully in all these countries.

Numerous species of grasses, some forming dominants in the ground cover, are represented in Southeast Asia, Puerto Rico and Texas. Several species are cosmopolitan. In addition, certain weeds, such as Eupatorium odoratum, are pantropical, frequent in forest clearings and along roadways.

Many plants, especially those of economic value as source of food, fruits, tubers, or planted as ornamental plants, have been introduced from tropical America into Southeast Asia, and likewise from Asia to Puerto Rico. Among these may be mentioned: corn, tobacco, cotton, cassava or manioc (Manihot esculenta), peanuts, and such fruit trees as Mango (Mangifera indica), tamarind (Tamarindus indica), papaya (Carica papaya), pomarosa (Eugenia jambos), and almendra (Terminalia catappa); in addition to mahogany (Swietenia mahagoni and S. macrophylla), African tulip tree (Spathodea campanulata), and the raintree (Enterolobium saman) grown along avenues and in parks.

A list of plant families common to Southeast Asia, Puerto Rico and Texas, and indicative of the similarity of the vegetation of these widely separated regions, follows:

Plant Families
in
Southeast Asia, Puerto Rico and Texas*

	Thailand	S. Vietnam	Puerto Rico	Texas
Acanthaceae	X	X	X	X
Aceraceae	X	X		X
Aizoaceae	X	X	X	X
Alismaceae		X	X	X
Amaranthaceae	X	X	X	X
Amaryllidaceae	X	X	X	X
Anacardiaceae	X	X	X	X
Annonaceae	X	X	X	X
Apocynaceae	X	X	X	X
Araceae	X	X	X	X
Araliaceae	X	X	X	X
Aristolachiaceae	X	X	X	X
Asclepiadaceae	X	X	X	X
Balanophoraceae		X	X	
Balsaminaceae	X	X	X	
Basellaceae		X	X	X
Begoniaceae	X	X	X	
Berberidaceae	X	X		X
Betulaceae	X	X	X	X
Bignoniaceae	X	X	X	X
Bixaceae	X	X	X	
Bombacaceae	X	X	X	
Boraginaceae	X	X	X	X
Bromeliaceae	X	X	X	X
Burmanniaceae	X	X	X	X
Burseraceae	X	X	X	
Cactaceae	X	X	X	X
Campanulaceae	X	X	X	X
Cannaceae	X	X	X	
Capparidaceae	X	X	X	X
Caprifoliaceae	X	X	X	X
Caricaceae	X	X	X	
Caryophyllaceae	X	X	X	X
Casuarinaceae	X	X	X	
Celastraceae	X	X	X	X
Chenopodiaceae	X	X	X	X
Chloranthaceae	X	X	X	
Combretaceae	X	X		
Commelinaceae	X	X	X	X
Compositae	X	X	X	X

* A partial list, selected for their cosmopolitan distribution.

	Thailand	S. Vietnam	Puerto Rico	Texas
Connaraceae	X	X	X	
Convolvulaceae	X	X	X	X
Crassulaceae	X	X	X	X
Cruciferae	X	X	X	X
Crypteroniaceae	X	X		
Cucurbitaceae	X	X	X	X
Cyatheaceae	X	X	X	
Cyperaceae	X	X	X	X
Dilleniaceae	X	X	X	
Dioscoreaceae	X	X	X	X
Dipterocarpaceae	X	X		
Droseraceae	X	X		X
Ebenaceae	X	X	X	X
Elaeagnaceae	X	X		
Elaeocarpaceae	X	X	X	
Equisetaceae	X	X		X
Ericaceae	X	X	X	X
Erythroxylaceae	X	X	X	
Euphorbiaceae	X	X	X	X
Fagaceae	X	X	X	X
Flacourtiaceae	X	X	X	X
Geraniaceae	X			X
Gesneriaceae	X	X		
Gleicheniaceae	X	X	X	
Gnetaceae	X	X		
Goodeniacease		X	X	X
Gramineae	X	X	X	X
Guttiferae	X	X	X	X
Hamamelidaceae	X	X	X	X
Hernandiaceae	X		X	
Hippocrateaceae	X	X		
Hydrophyllaceae	X		X	X
Hypericaceae	X	X	X	X
Icacinaceae	X	X		
Iridaceae	X	X	X	X
Juglandaceae	X	X	X	X
Labiatae	X	X		X
Lauraceae	X	X	X	X
Lecythidaceae	X		X	
Leeaceae	X	X		
Leguminosae	X	X	X	X
Liliaceae	X	X	X	X
Linaceae	X	X		X
Lobeliaceae	X	X	X	X
Loganiaceae	X	X	X	X
Loranthaceae	X	X	X	X
Lythraceae	X	X	X	X
Magnoliaceae	X	X	X	X

	Thailand	S. Vietnam	Puerto Rico	Texas
Malpighiaceae	X	X		X
Malvaceae	X	X	X	X
Marantaceae	X	X	X	X
Melastomaceae	X	X	X	X
Meliaceae	X	X	X	X
Menispermaceae	X	X	X	X
Moraceae	X	X	X	X
Moringaceae		X	X	
Musaceae	X	X	X	
Myricaceae		X	X	X
Myristicaceae	X	X	X	
Myrsinaceae	X	X	X	
Myrtaceae	X	X	X	
Naiadaceae		X	X	X
Nyctaginaceae	X	X	X	X
Nymphaeaceae	X	X	X	X
Ochnaceae	X	X	X	
Olacaceae	X	X	X	
Oleaceae	X	X	X	X
Onagraceae	X	X	X	X
Ophioglossaceae	X	X	X	X
Orchidaceae	X	X	X	X
Oxalidaceae	X	X	X	X
Palmaceae	X	X	X	X
Passifloraceae	X	X	X	X
Pandanaceae	X	X	X	
Phytolaccaceae		X	X	X
Pinaceae	X	X		X
Piperaceae	X	X	X	
Plumbaginaceae	X	X		X
Podocarpaceae	X	X	X	
Polygalaceae	X	X	X	X
Polygonaceae	X	X	X	X
Polypodiaceae	X	X	X	X
Pontederiaceae	X	X	X	X
Portulacaceae	X	X	X	X
Primulaceae	X	X	X	X
Proteaceae	X	X	X	
Rafflesiaceae	X	X		X
Ranunculaceae	X	X	X	X
Rhamnaceae	X	X	X	X
Rhizophoraceae	X	X	X	
Rosaceae	X	X	X	X
Rubiaceae	X	X	X	X
Rutaceae	X	X	X	X
Sabiaceae	X	X	X	
Salicaceae	X	X	X	X
Samydaceae	X	X	X	
Sapindaceae	X	X	X	X
Sapotaceae	X	X	X	X

	Thailand	S. Vietnam	Puerto Rico	Texas
Saxifragaceae	X	X		X
Schizaeaceae	X	X	X	X
Scrophulariaceae	X	X	X	X
Simarubaceae	X	X	X	X
Solanaceae	X	X	X	X
Sonneratiaceae	X	X		
Staphyleaceae	X		X	
Sterculiaceae	X	X	X	X
Styracaceae	X	X	X	X
Symplocaceae		X	X	X
Taxaceae	X	X	X	
Ternstroemiaceae	X	X		
Theaceae	X	X	X	X
Thymeleaceae	X	X	X	
Tiliaceae	X	X	X	X
Turneraceae		X	X	X
Typhaceae		X	X	X
Ulmaceae	X	X	X	X
Umbelliferae	X	X		X
Urticaceae	X	X	X	X
Vacciniaceae	X	X		X
Valerianaceae	X	X	X	X
Verbenaceae	X	X	X	X
Violaceae		X	X	X
Vitaceae		X	X	X
Xyridaceae		X	X	X
Zingiberaceae	X	X		
Zygophyllaceae	X	X	X	X

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PART II

FORESTS OF SOUTHEAST ASIA

MAPS

and

ILLUSTRATIONS

FORESTS OF SOUTHEAST ASIA

This Part contains 11 maps and 125 illustrations. Most of the photographs were taken by the author, while conducting field investigations in Thailand during 1963-64 and 1964-65.

A series of maps shows the principal physiographic regions, mountain ranges and river system of Thailand; and the mean monthly rainfall and temperature range, according to region.

Several maps indicate the distribution of the forested areas of Thailand; the principal Evergreen and Deciduous forest types of that Kingdom; and a composite map of the major forest types of Vietnam, Laos and Cambodia.

A number of photographs illustrate the characteristics and structure of various vegetation types of Thailand, as being representative of similar formations in other regions of Southeast Asia.

Several forest types are illustrated by ground and aerial photographs, to compare their aspects as seen horizontally and vertically.

A limited number of forest areas or types of South Vietnam, Laos and Cambodia are reproduced.

Some of the most common and widespread weeds of Southeast Asia are illustrated. These are considered hazardous, as potential sites for ambush, because of their prevalence along paths, roadways, railroads, canals, on bunds of paddies, in forest clearings and second growth in general.

Photographs taken at the test-site near Pranburi, upper Peninsula, show the effect of chemical defoliants on vegetation.

A few photographs illustrate the predominant forest types and general conditions in northeastern Thailand, long considered the most backward and vulnerable part of that country.

Two photographs illustrate phases of studies being conducted by a joint expedition of Kyoto University, Japan, and Chulalonkorn University, Thailand, to investigate soil producitivity in Thailand.

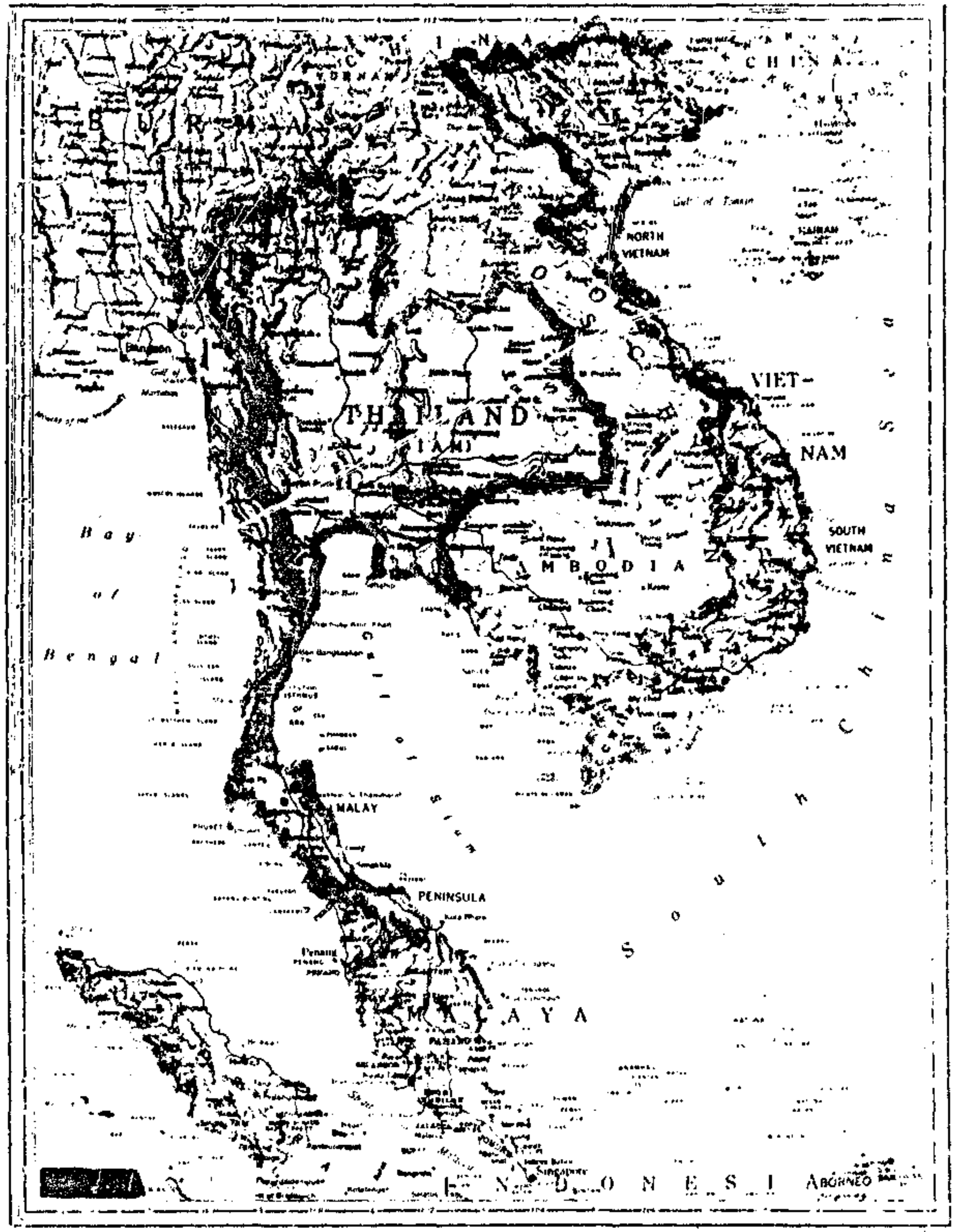

Figure 1.-The five countries of Southeast Asia discussed in this report - Thailand, North and South Vietnam, Laos and Cambodia - cover an area of approximately 500,000 square miles.

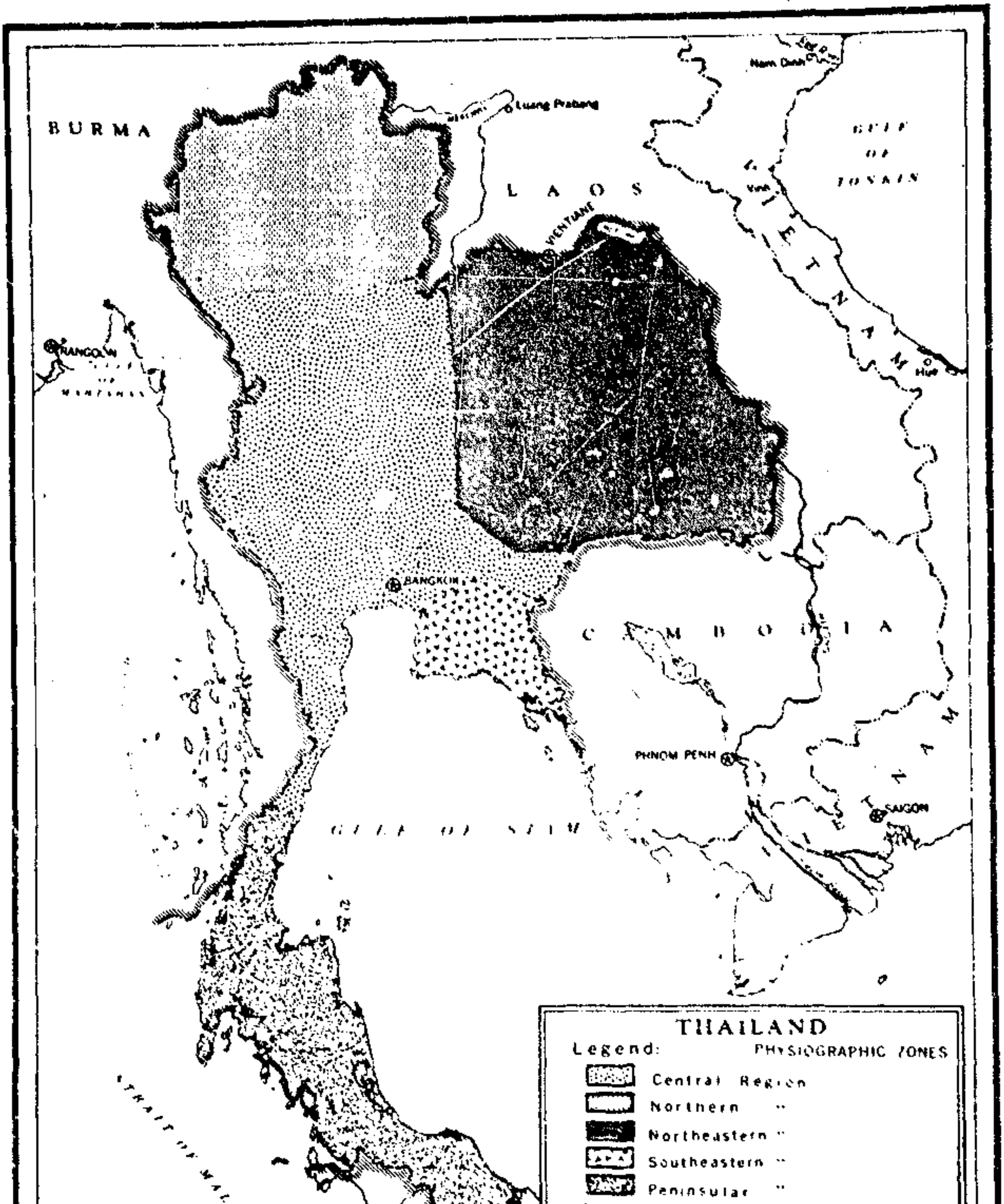

Figure 2.-The five physiographic regions of Thailand, each with somewhat distinctive types of vegetation, soil and climate.

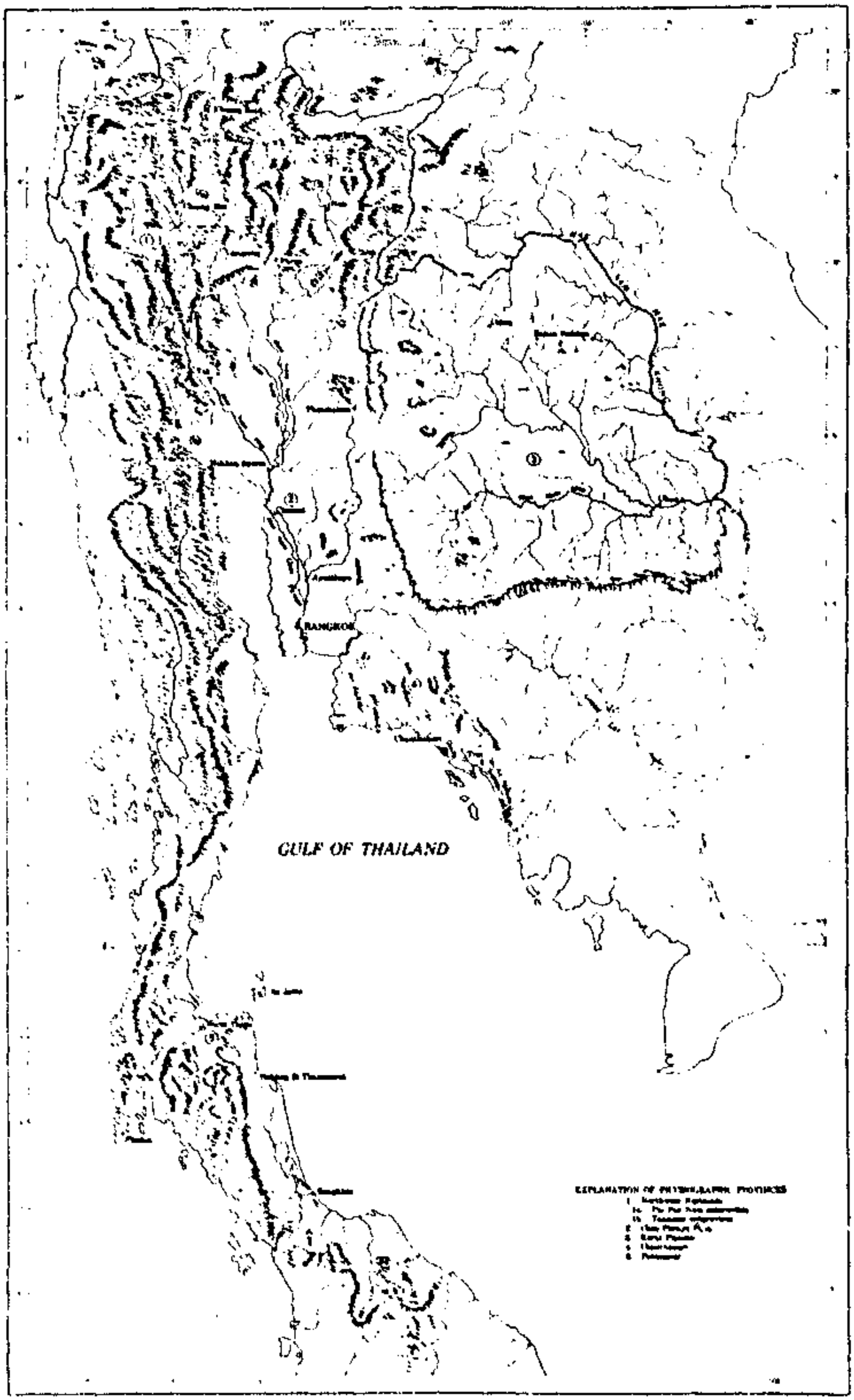

Figure 3.-Mountain ranges and river system of Thailand.

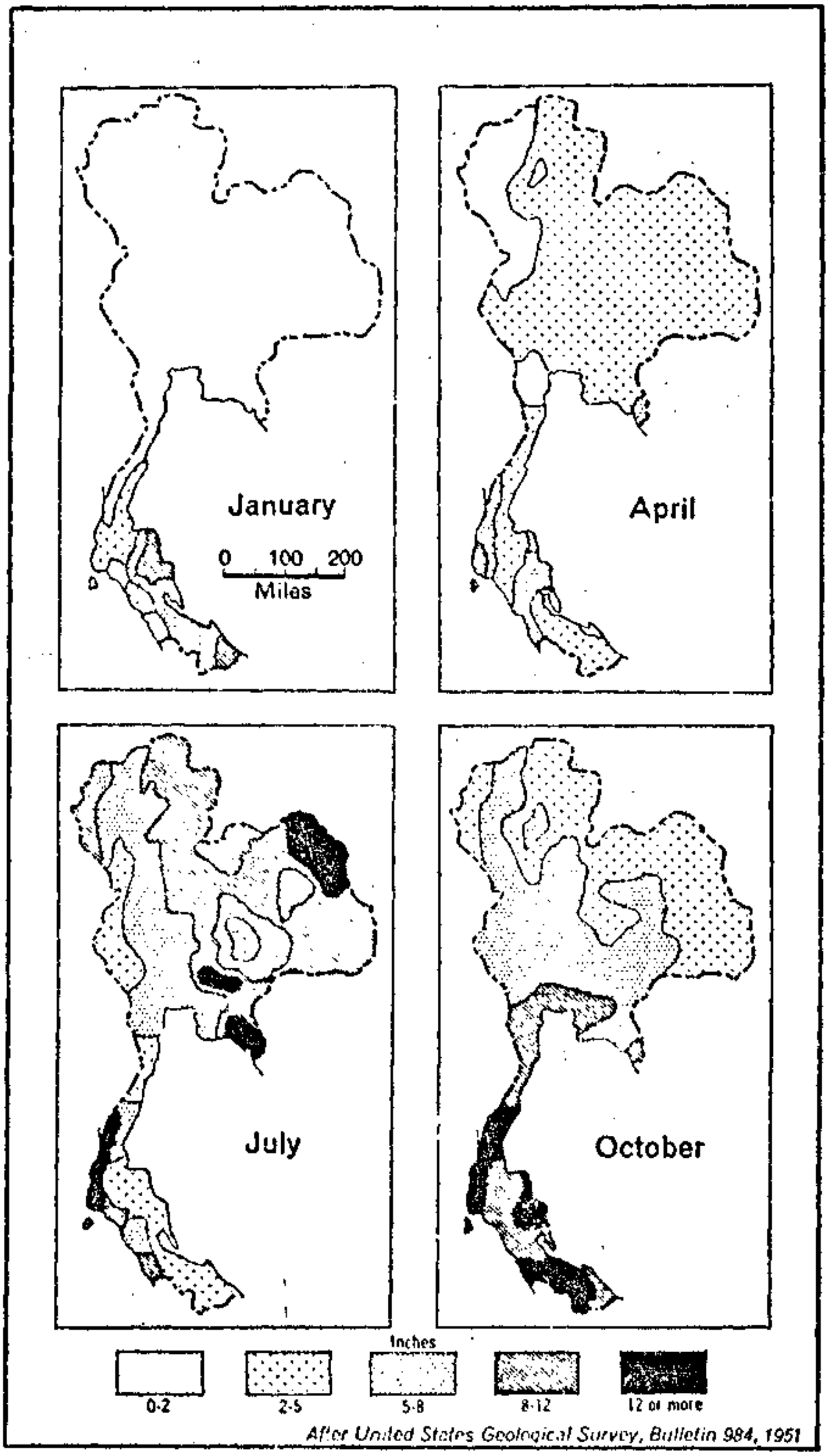

Figure 4.-Mean monthly rainfall of Thailand, on a regional basis.

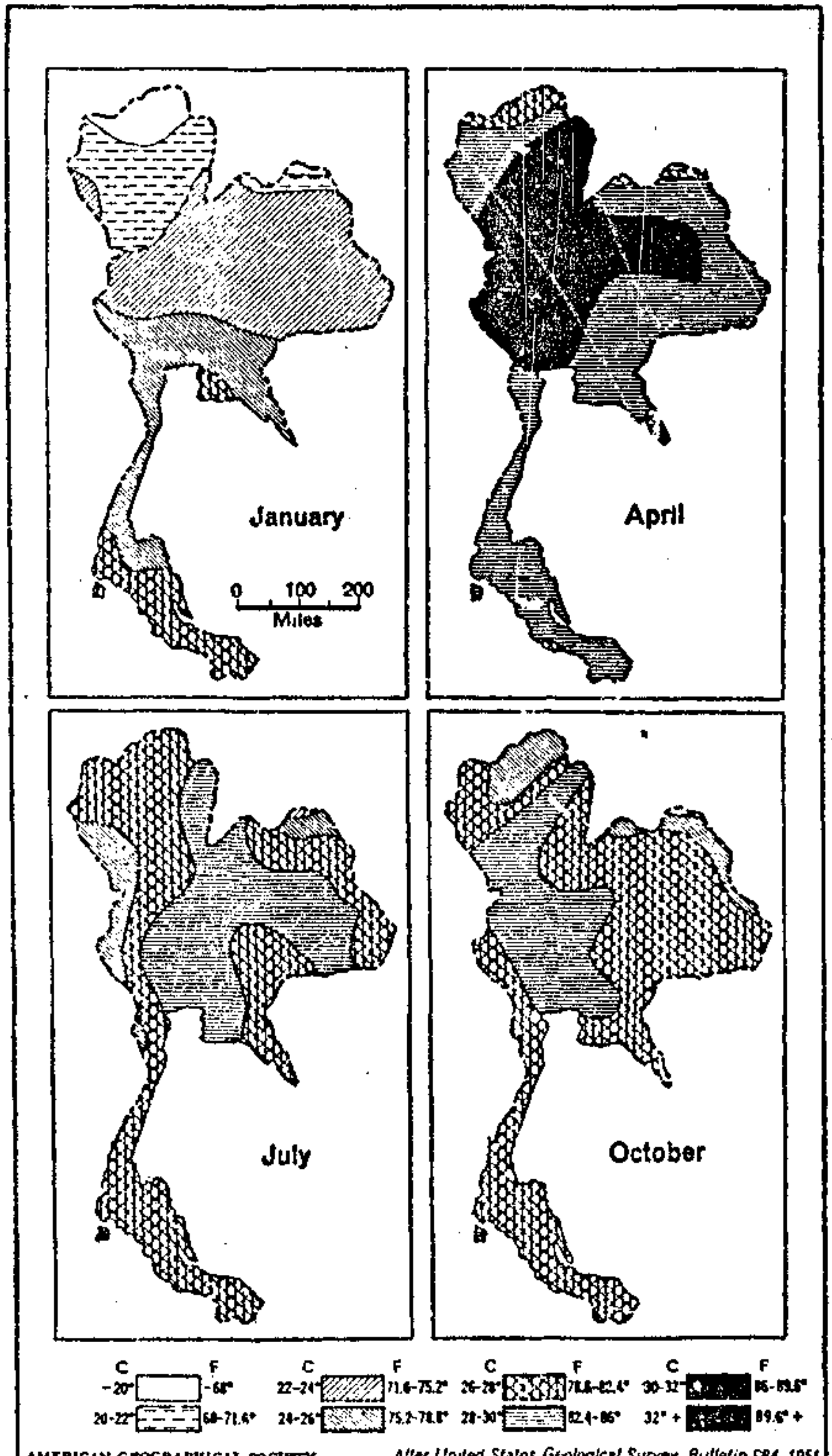

Figure 5.-Mean monthly temperature of Thailand according to region.

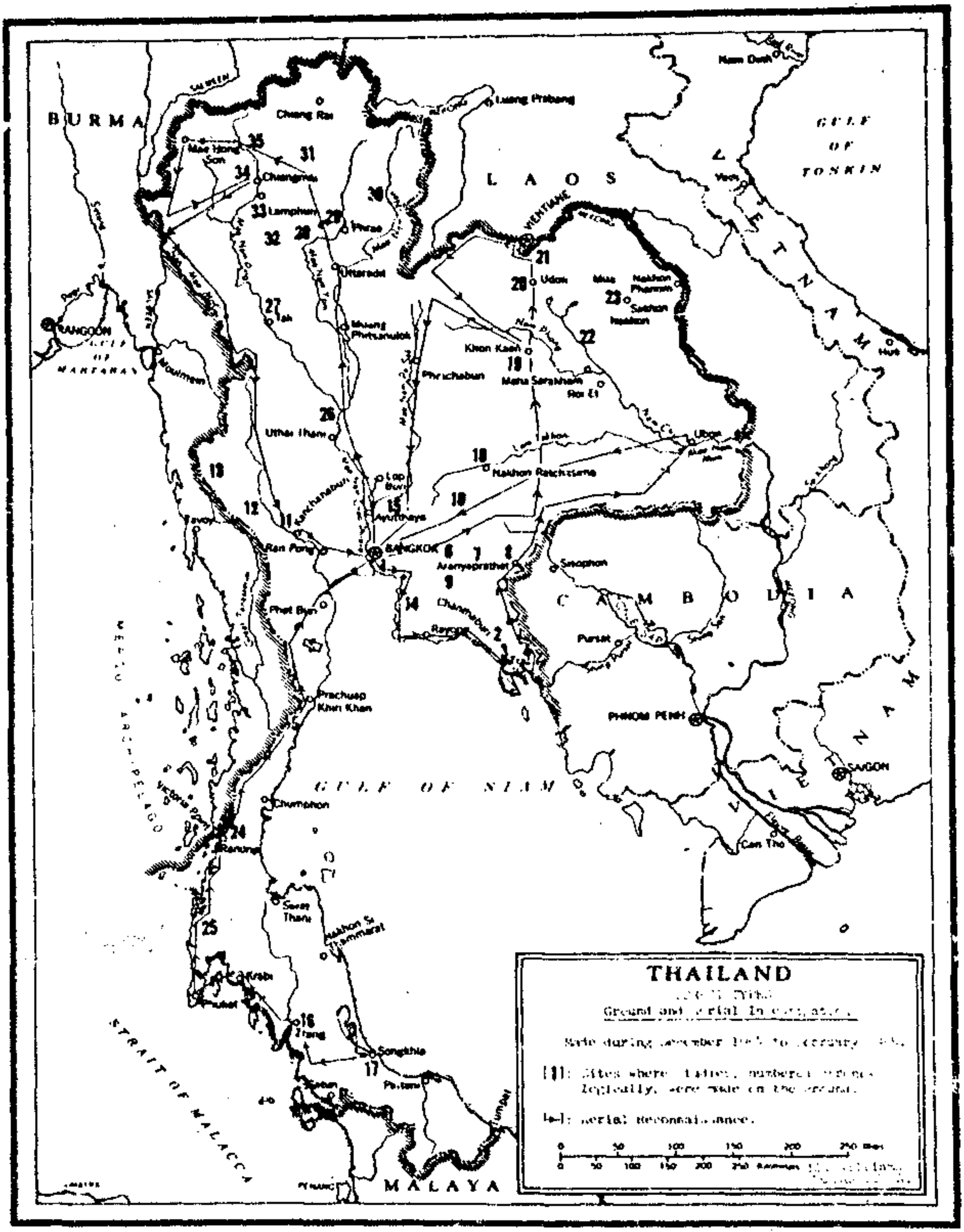

Figure 6.-Areas investigated in Thailand on the ground and on aerial surveys during November 1963 to January 1964, and from December 1964 to February 1965.

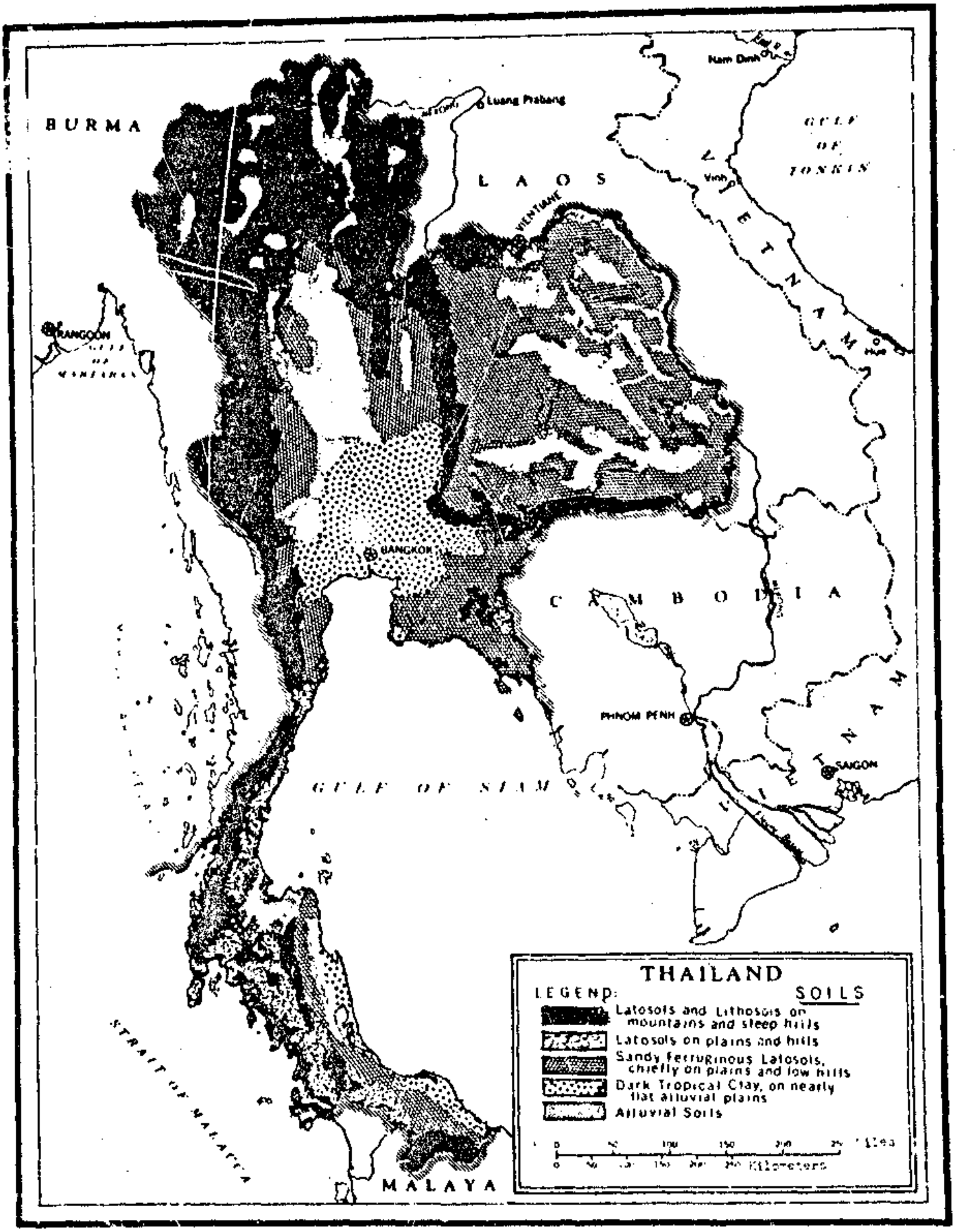

Figure 7.-Soil types of Thailand. Adapted from data furnished by World Soil Geography, U. S. D. A.

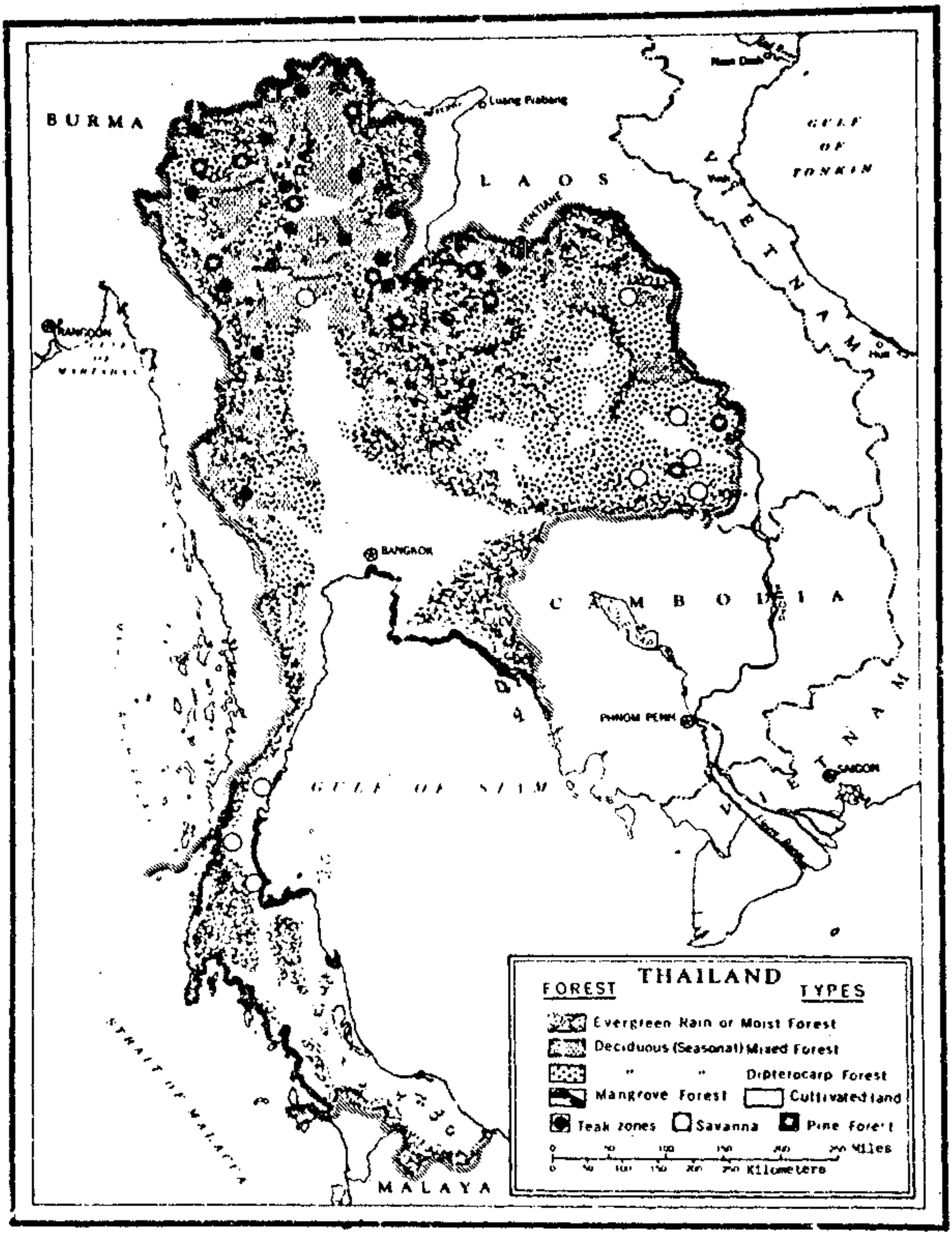

Figure 8.-Distribution of principal forest types of Thailand.

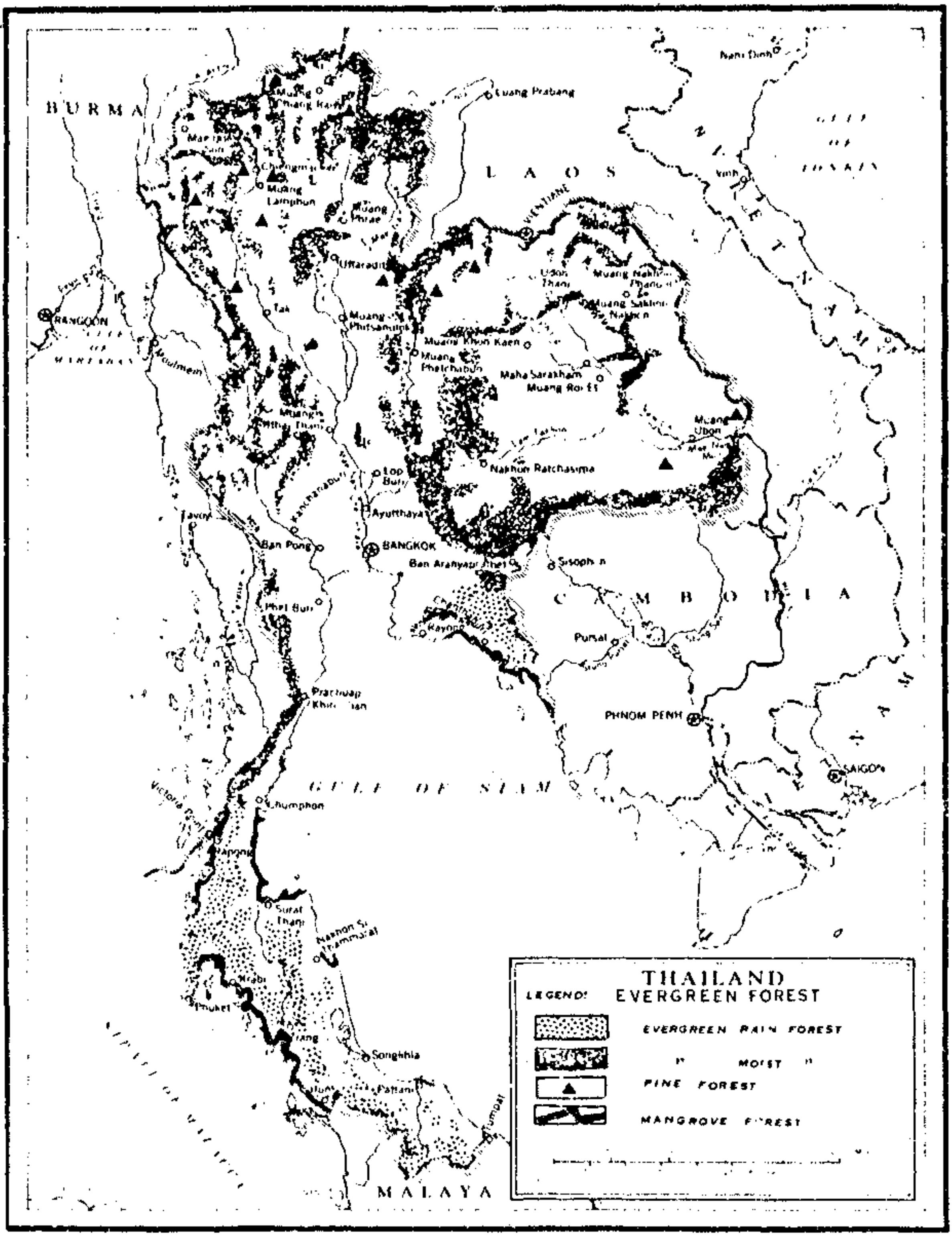

Figure 9.- Distribution of Evergreen forests in Thailand.

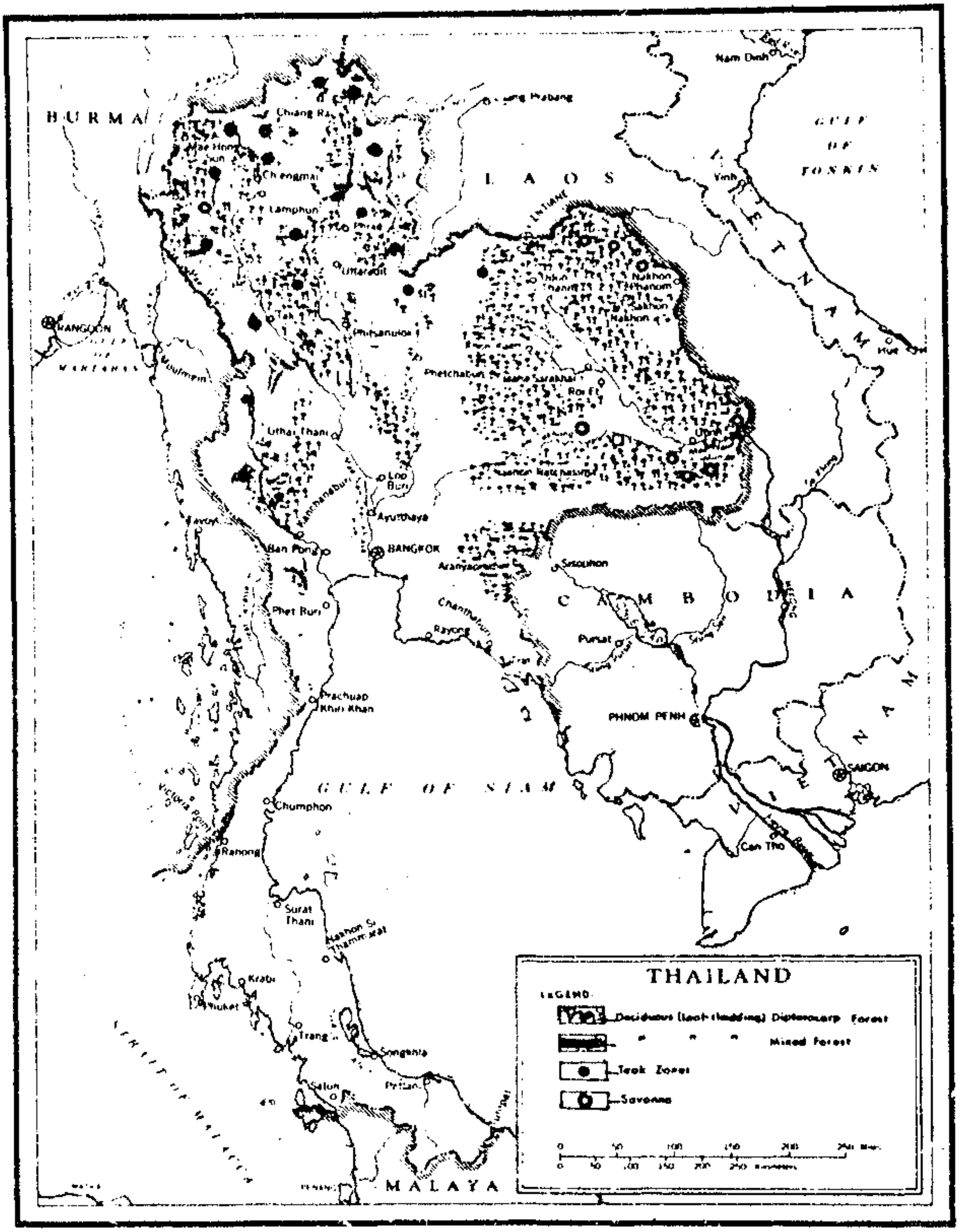

Figure 10.-Distribution of Deciduous (Seasonal or Monsoon) forests in Thailand.

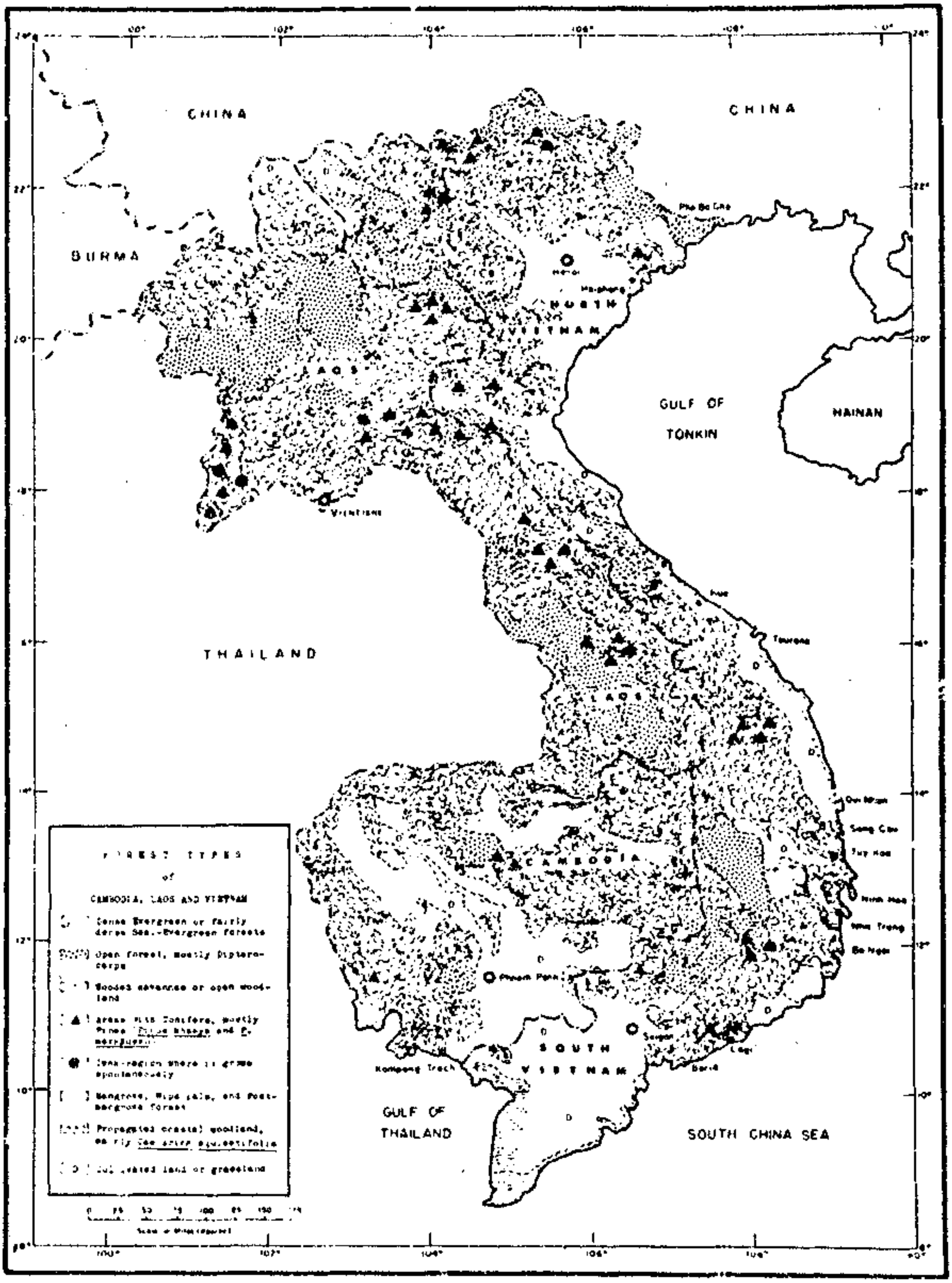

Figure 11.-Major forest types of Vietnam, Laos and Cambodia.

Figure 12.-The Central Plain of Thailand, irrigated by a network of rivers and man-made canals, 'khlongs', is one of the most important rice-producing areas in Southeast Asia.

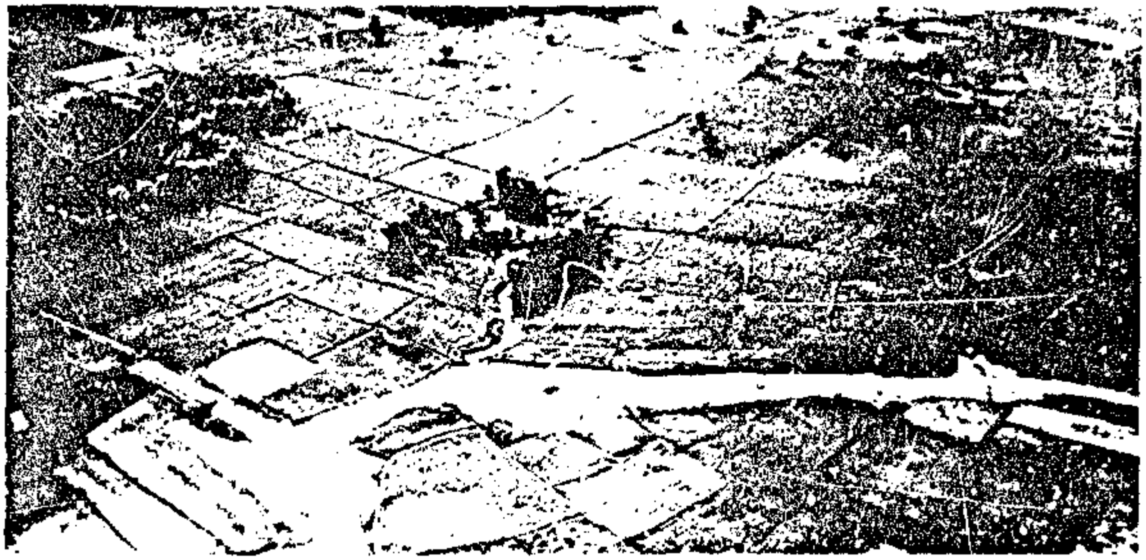

Figure 13.-Rice paddies as they appear during the beginning of the dry season, immediately before harvest. Light-colored patches in left and right foreground have been harvested. Most of the plants propagated around farmhouses are bamboo, especially Bambusa blumenea and Thyrsostacheys siamensis, fruit trees and banana plants. Between Bangkok and Saraburi, central plain. Nov. 1963.

Figure 14.-Bamboos and banana are the most frequently propagated plants around abodes. The toddy palm (Borassus flabellifer) is commonly grown in rice paddies, forming large stands west of Bangkok and in the upper Peninsula. Nov. 1963.

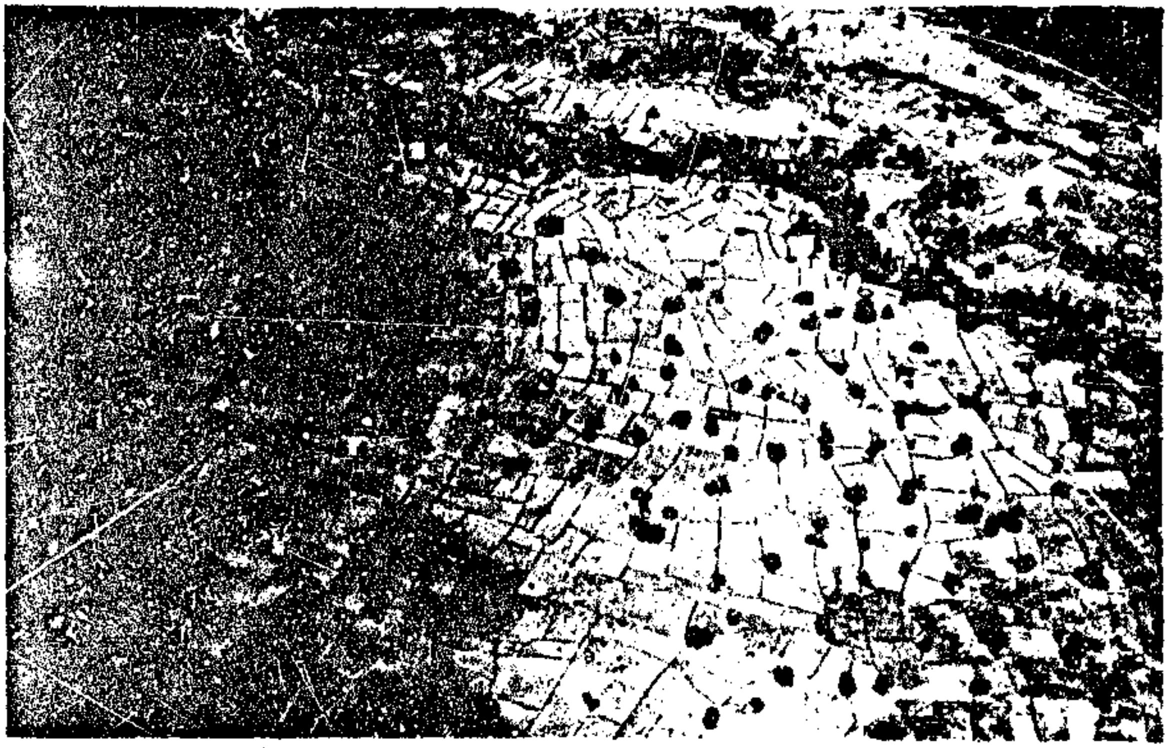

Figure 15.-Much of the forest between Konkaen and Udon in the northeast has been cleared for rice paddies. Dominant trees are 'mae yang khao' (Dipterocarpus alatus), and such fruit trees as mango (Mangifera indica) and tamarind (Tamarindus indica). Jan. 1965.

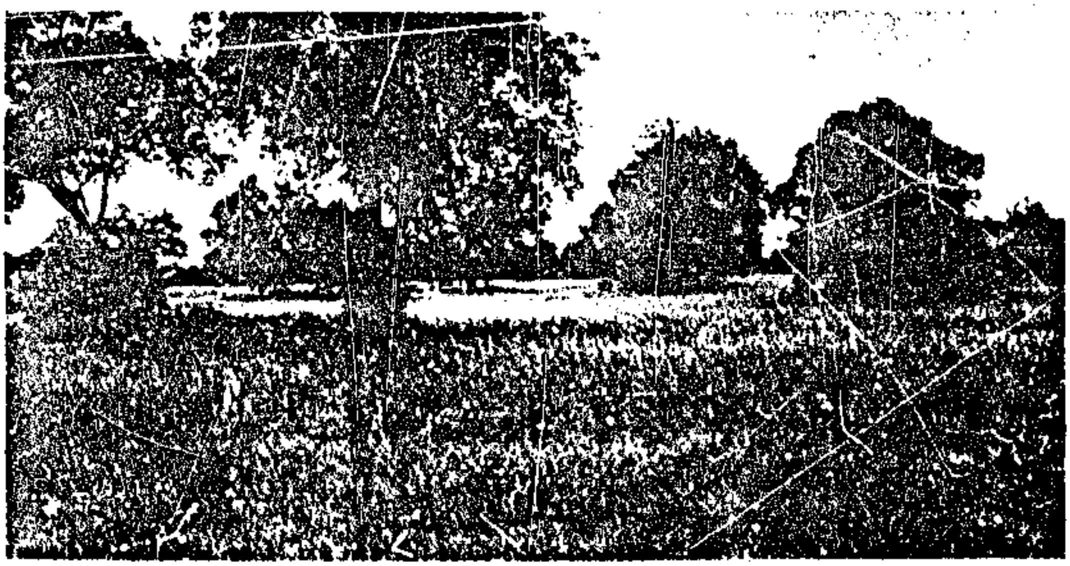

Figure 16.-Fruit-bearing trees, such as 'mango' (Mangifera indica), 'tamarind (Tamarindus indica) and 'phutsa' (Zizyphus spp.), are protected in rice paddies. Near Saraburi, central Thailand. Nov. 1963.

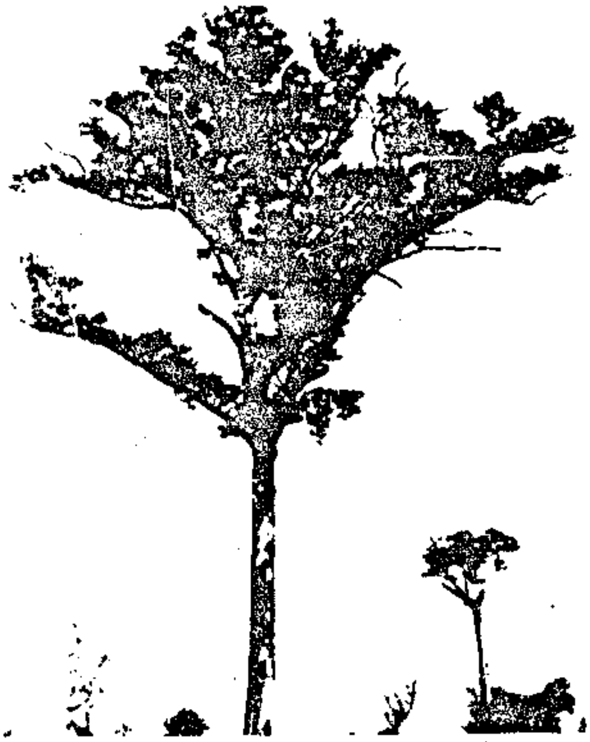

Figure 17.-'Mae yang khao' (Dipterocarpus alatus) is the tallest tree left standing in the rice paddies, and is widely distributed throughout Thailand. Its trunk yields an oleo-resin. Konkaen, Korat Plateau, northeastern Thailand. Feb. 1965.

Figure 18.-The tall 'yang khao' tree (Dipterocarpus alatus) is readily distinguished from the air by its tall, straight, light-colored trunk. Phibun Mangsahan, eastern Thailand. Dec. 1963.

Figure 19.-Extensive areas of forests have been felled in some areas of Thailand, especially in the north, for shifting agriculture, and which are later abandoned (top left). Progress is being made in such zones to establish stable agriculture for growing rice, fruit trees, cotton, tobacco, etc. Near Nakon Nayok, Korat Plateau. Northeastern Thailand. Nov. 1963.

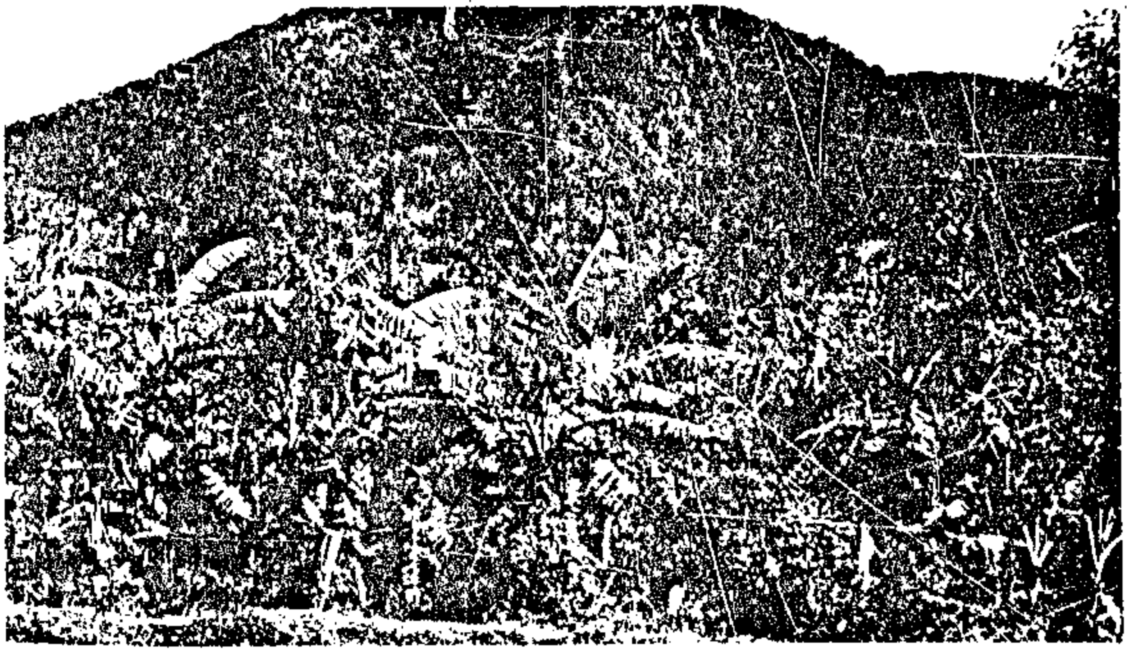

Figure 20.-Evergreen Rain forest at Kachawng, south Peninsula. Jan. 1965.

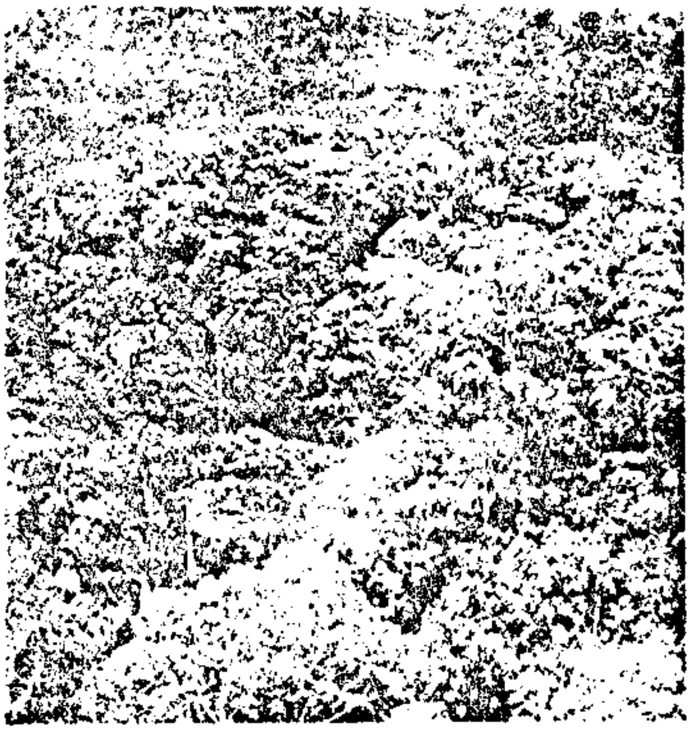

Figure 21.-Mobility is difficult, and ground-to-ground and air-to-ground visibility is low in the Rain forest. Kachawng, south Peninsula, Thailand. Jan. 1965.

Figure 22.-Evergreen Moist forest on slopes of Khao Sa Bap, southeastern Thailand, close to the border of Cambodia. Dec. 1963.

Figure 23.-Stout woody vines, or lianes, are characteristic of Evergreen Rain or Moist forest. Mukdahan, eastern Thailand. Dec. 1963.

Figure 24.-Undergrowth in Evergreen Moist forest of Khao Sa Bap, north of Chantaburi, southeastern Thailand. Species of Amomum, of the ginger family, are frequent in the ground cover. Dec. 1964.

Figure 25.-Upper or Hill Moist Evergreen forest. Trunk of Lagerstroemia calyculata in right foreground. Phu Phan, northeast Thailand. Feb. 1965.

Figure 26.-Upper or Hill Moist Evergreen forest in Salween River basin, along border of Burma, northwest Thailand. Jan. 1965.

Figure 27.-Oblique view of Upper Moist Evergreen forest. Bamboo (Bambusa arundinacea), rattan (Calamus) and wild banana (Musa moluccensis) develop rapidly wherever clearings are made in this forest type. Khao Yai National Forest, Korat Plateau. Nov. 1963.

Figure 28.-Evergreen Moist forest fringing the Korat Plateau. In Thai land, Evergreen Rain or Moist forest is confined mostly to the southeastern and southern provinces around the Gulf of Thailand. A stretch of Evergreen forest occurs also on the southern and southwestward slopes where the Korat Plateau drops into the central plain. In this forest type, trees reach 90 to 130 feet (30-40 m.) in height, are often buttressed, and with dense, continuous canopy. Northwest of Nakhon Nayok, east-central Thailand.

Figure 29.-Upper Moist Evergreen forest in Khao Yai National Forest. The canopy and understories are dense, so that horizontal (ground-to-ground) and vertical (air-to-ground) visibility are poor in this forest type. Such medium-sized trees as species of oak (Quercus), chestnut (Castanopsis), Podocarpus, Lithocarpus and Dacrydium occur in the Lower Montane forest, on the upper slope and on the summit of Khao Kheo Range (background). Nov. 1963.

Figure 30.-Profile of Lower Montane forest on upper slopes and plateau in Khao Yai National Forest, at approximately 3,600 ft. (ca. 1,200 m). Most common trees are species of Quercus (oak), Castanopsis (chestnut), Lithocarpus, and Dacrydium. Nov. 1963.

Figure 31.-Oblique view of Upper Moist Evergreen forest. Canopy is continuous, and undergrowth is dense, so that mobility in this forest is difficult, and ground-to-ground and air-to-ground visibility is poor. Nov. 1963.

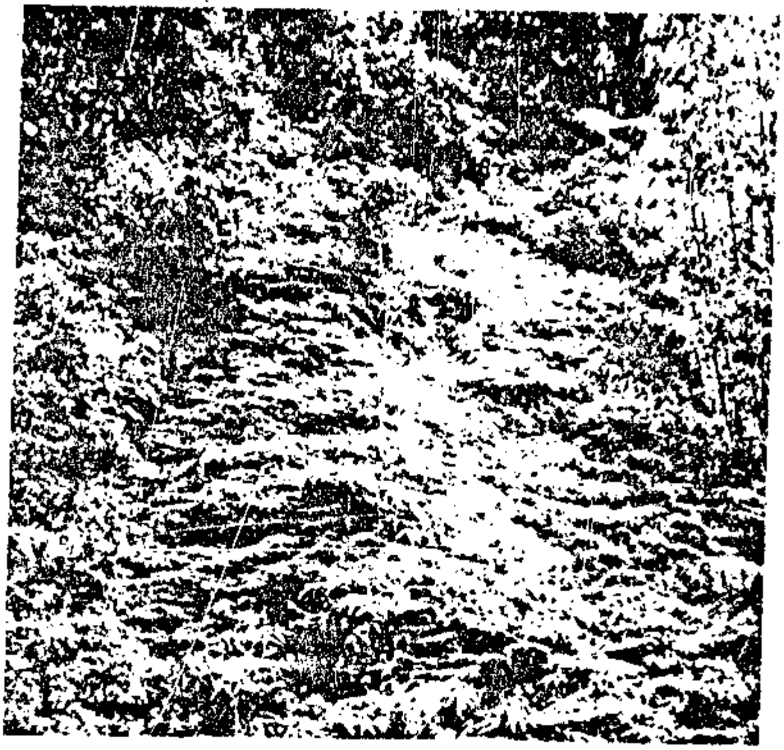

Figure 32.-Ferns, bamboos, especially Thyrsostachys siamensis, wild bananas (Musa moluccensis) develop in clearings made in the Evergreen forest. Lower slopes of Khao Yai National Forest. Dec. 1964.

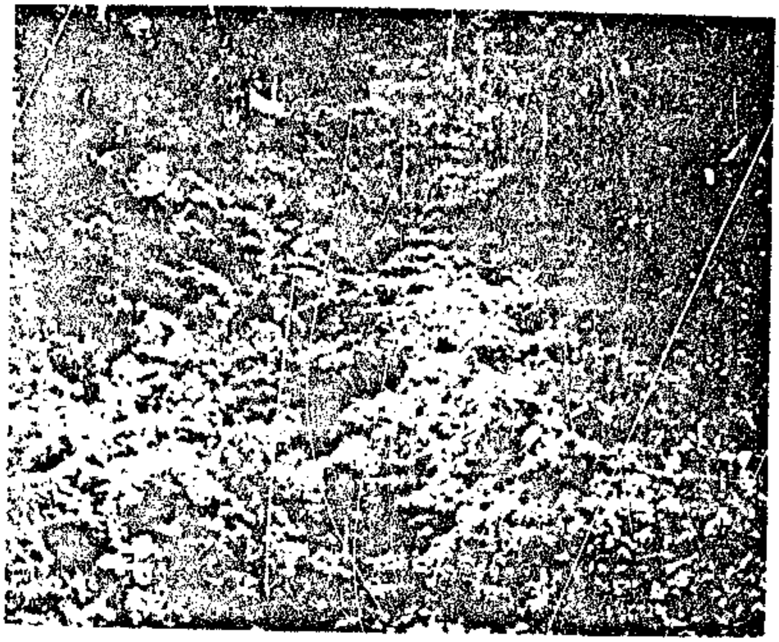

Figure 33.-Secondary growth, composed of bamboos and wild banana, in cleared site in Moist Semi-Evergreen forest of Lang Bian, Dalat region, South Vietnam.

Figure 34.-Aroids in low moist sites along road from Saigon to Dalat, South Vietnam. Stand of trees of Lagerstroemia angustifolia in background. (Photo by Forest Research Institute, Saigon.)

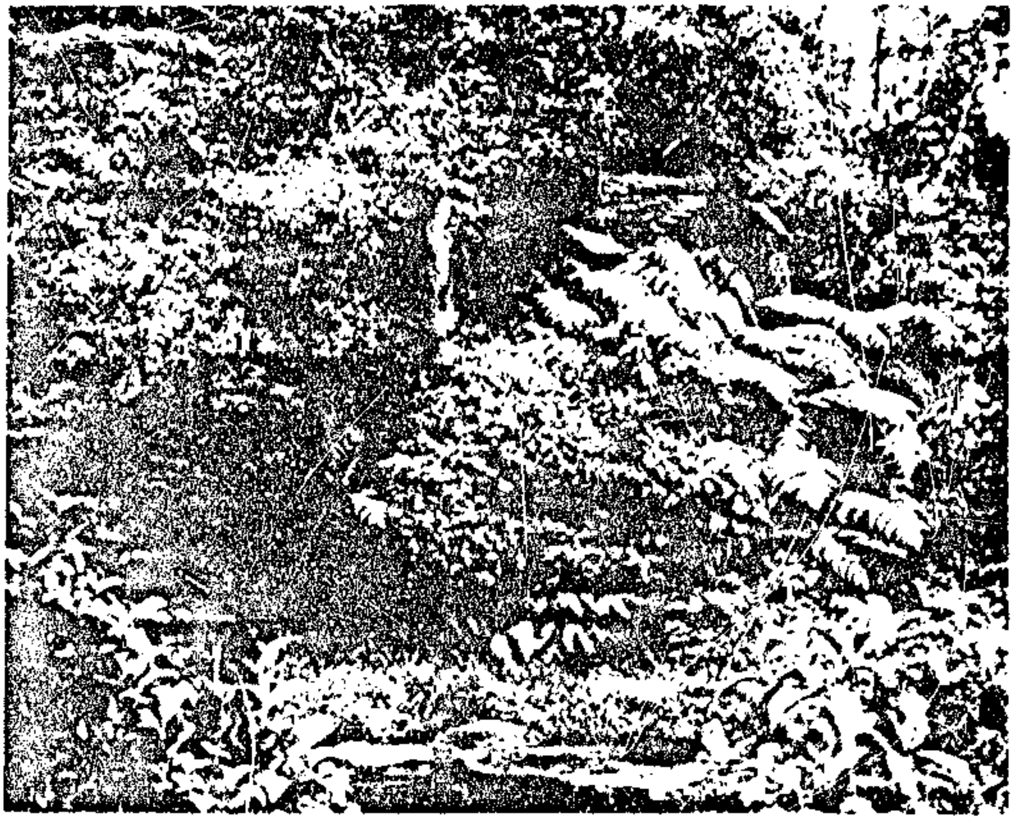

Figure 35.-Dense, Upper or Hill Moist Evergreen forest, on Plateau of Bolovens (1,200 m), southern Laos. (Photo by Vidal.)

Figure 36.-The mountains of northern Thailand are covered with forests of several types - Dipterocarp forest, and Dry and Moist Mixed forests containing Teak, at lower altitudes; Upland Evergreen forest on the middle slopes; and stands of Pine on the summit of the ranges. Doi Inthanon, northern Thailand. Jan. 1965.

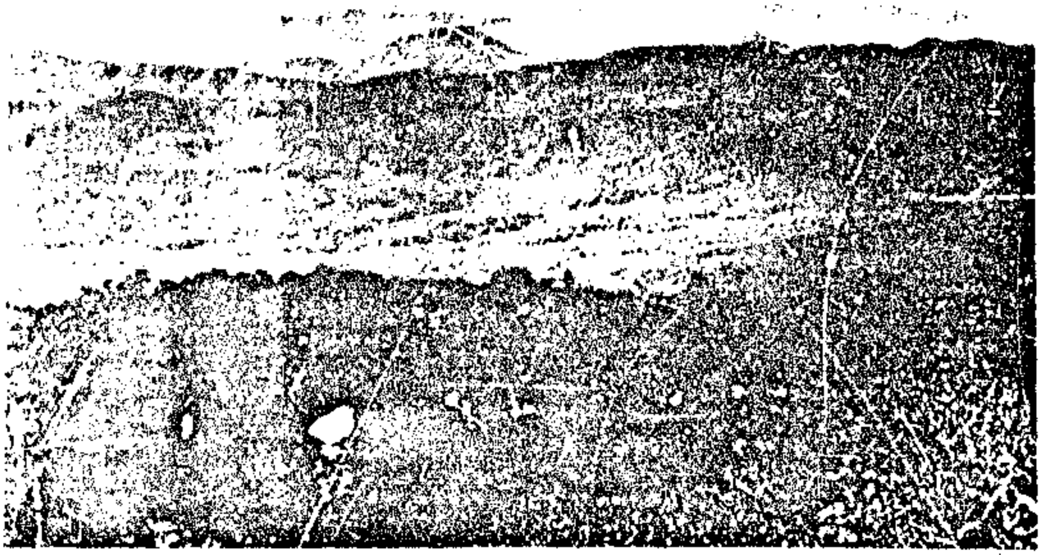

Figure 37.-Hill or Upland Moist Evergreen forest, mostly undisturbed, around Chiengmai in northern Thailand, as seen from the mountain Doi Sutep. The small clearings were made by hill tribe Meow for shifting agriculture ('ray' system). Jan. 1964.

Figure 38.-Semi-Evergreen forest between Thoern and Ban Hong, northwestern Thailand. Teak grows at lower elevations in Mixed Dry and Moist Deciduous forests. Jan. 1964.

Figure 39.-Much of the upland forest on the slopes of Doi Sutep as on other mountain ranges in northern Thailand has been cleared for shifting agriculture by hill tribes, the Meo, Lisau, Lua and Karens. Jan. 1964.

Figure 40.-Riverain or Gallery forest along banks of streams flowing into the Mekong River, eastern Thailand. Average height of canopy in this forest is 50 feet (16 m). Undergrowth is moderately dense. East of Phibun Mangsahan, near border of southern Laos. Dec. 1963.

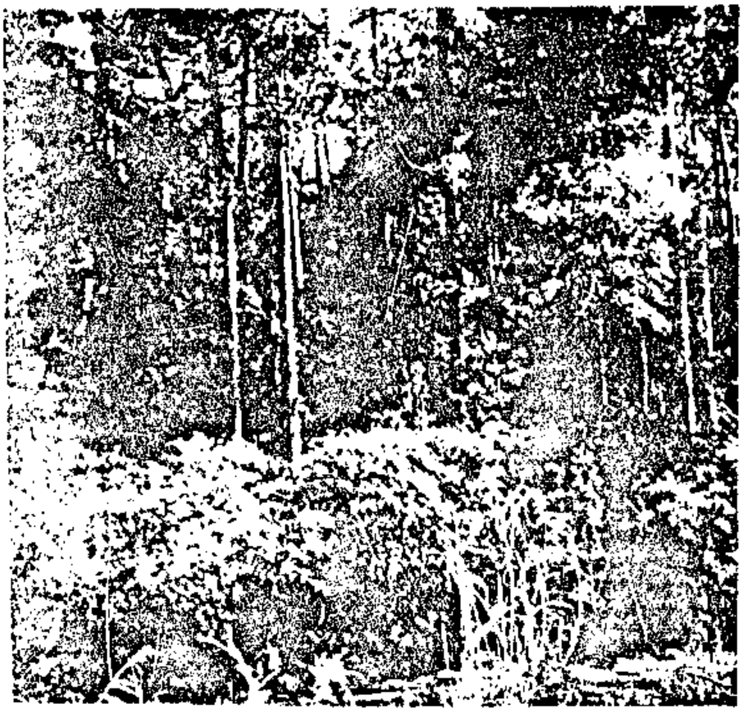

Figure 41.-Gallery or riparian forest. During the dry season the rainfall, over the greater part of central and northern Thailand, is too sparse to support Evergreen forest growth. However, the supply of underground moisture along streams and rivers is sufficient for the development of Gallery forest in narrow belts. Characteristic trees in this forest type include Dipterocarpus alatus, D. costatus, and Hopea odorata. Mae Hoi, northern Thailand.

Figure 42.-Type of vegetation along banks of streams in Hill or Upper Moist Evergreen forest, in the Khao Yai National Forest, Korat plateau. Livistona palm and rattans (Calamus spp.) are especially abundant. Nov. 1963.

Figure 43.-Type of riparian vegetation along the middle and upper Kwae Noi River, western Thailand. Bamboos, especially Bambusa arundinacea and Thyrsostachys siamensis, are abundant along river banks. Dec. 1964.

Figure 44.-Dry Evergreen forest. Undergrowth is fairly dense; horizontal and vertical visibility is moderately satisfactory. Mukdahan, northeastern Thailand. Dec. 1963.

Figure 45.-Dry Evergreen forest, with Lagerstroemia calyculata tree being dominant. Cambodia.

Figure 46.-A transition from Evergreen Gallery forest, in foreground, to Temperate Evergreen forest, in background. This transition is usually found at an altitude of about 3,000 ft. (1,000 m). On mountain Doi Sutep, northern Thailand.

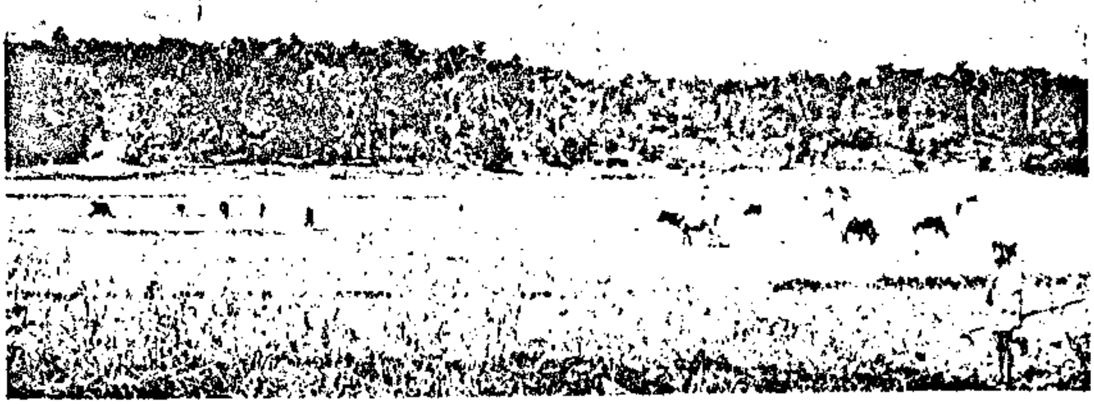

Figure 47.-Mountain range of Chiengdao, northern Thailand. Lower slopes are covered with Mixed Deciduous forest, in which Teak (Tectona grandis) abounds. Upper Moist Evergreen forest dominates the middle slopes. Three-needled Pine (Pinus khasya) occurs on the summit. Jan. 1964.

Figure 48.-The plateau of Lang Bian, in the uplands of Dalat region, South Vietnam.

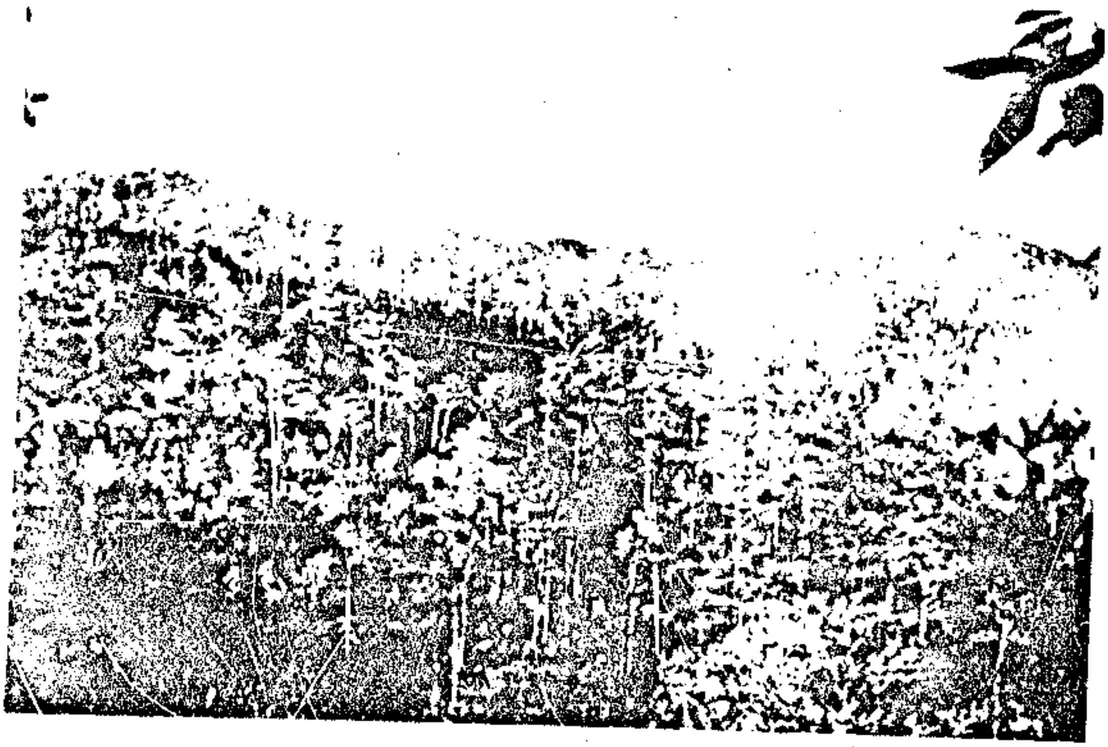

Figure 49.-Pine forest of Manline, Lang Bian, in the Dalat area of eastern South Vietnam.

Figure 50.-Two-needled pine (Pinus merkusii) in the region of landing strip at Lien Khank, Dalat region, South Vietnam. Note density and height of ground cover, composed mainly of grasses.

Figure 51.-Open stand of pine on fairly compact soil. Trees are of small to medium height and with low branches. Klang Yang, South Vietnam.

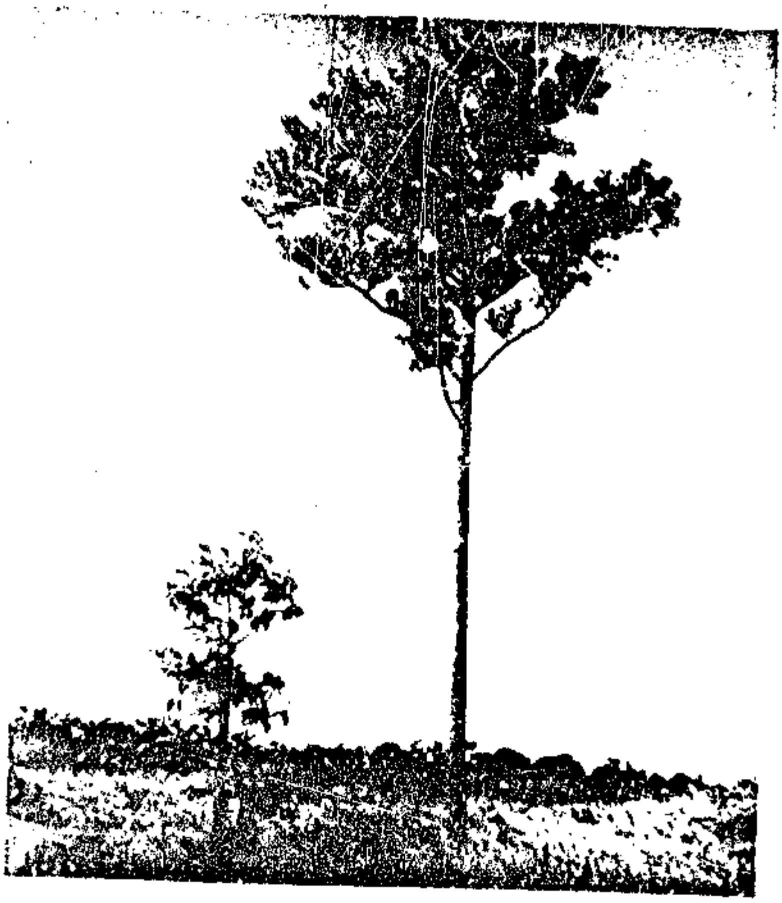

Figure 52.-The 2-needled Pine tree (Pinus merkusii) grows at medium altitude, and occasionally at low elevation mixed with Dipterocarp and Mixed Deciduous trees. Phibun Mangsahan, east Thailand. Dec. 1963.

Figure 53.-Pseudo-steppe with 3-needled Pine (Pinus khasya). Tranninh (alt. 1,200 m), northern Laos. (Photo by Vidal.)

Figure 54.-Temperate Evergreen forest on the east slope of Doi Inthanon, northern Thailand, at an altitude of about 4,000 ft. (1,200 m). Stout trunks of <u>Terminalia triptera</u>, in foreground, suggest the transitional character of the forest from Subtropical to Temperate forest, with trunks of 3-needled Pine (<u>Pinus khasya</u>) in the background.

Figure 55.-Upper Montane or Temperate Evergreen forest occurs in the highland of northern Thailand above 4,500 ft. (1,300 m.). This is characterized by the dominanace of Evergreen oaks (<u>Quercus</u>) and chestnut (<u>Castanopsis</u>), which sometimes occur as pure stands. In well developed oak forest their trunks are densely packed and often exceed 12 inches (30 cm.) in diameter. Doi Sutep, northern Thailand (ca. 1,200 m.).

Figure 56.-Mossy forest on mountain ranges. As in other tropical regions, Temperate forests in northwestern Thailand are sometimes heavily inhabited by mosses, especially on the summit of high peaks and crests. This is a sphagnum bog on Inthanon Mountain, northern Thailand. Mature Rhododendron trees, growing around the bog, bear festoons of moss.

Figure 57.-Mangrove forest, showing uniformity of canopy and density of stand. Pneumatophores of Avicennia in foreground. Khlung, southeastern Thailand, near border of Cambodia. Dec. 1964.

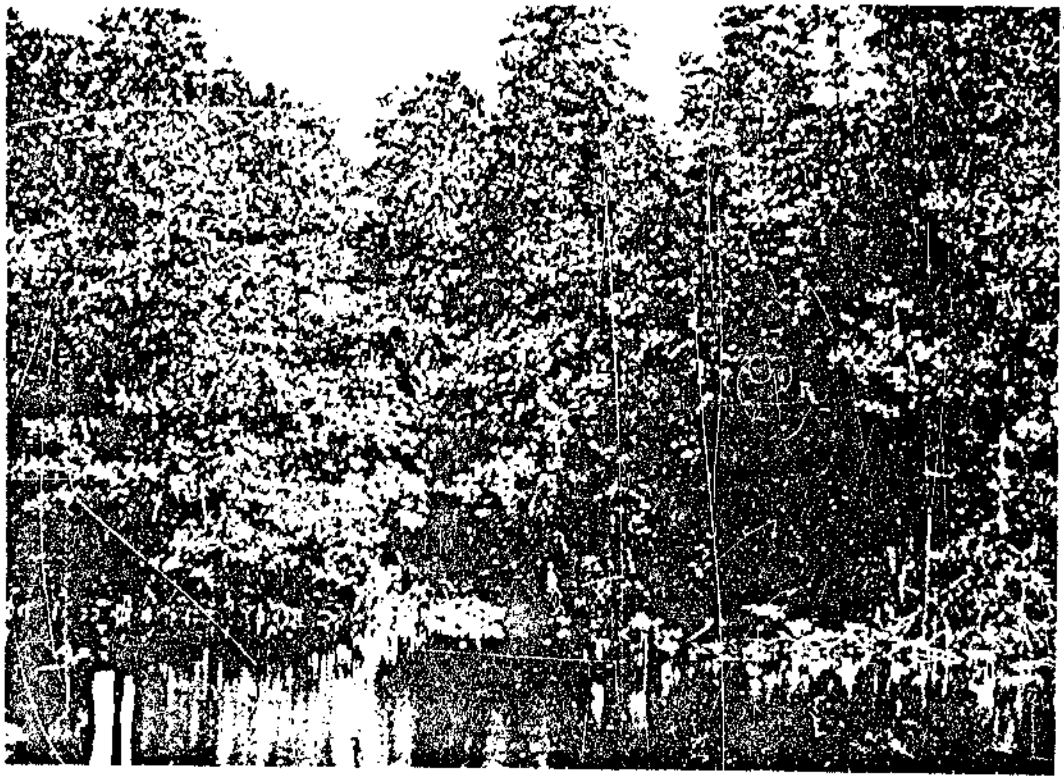

Figure 58.-Mangrove woodland submerged at high tide. This forest is an important source of fuelwood, charcoal, and tannin, as well as seafood for domestic consumption. Khlung, southeast Thailand. Dec. 1963.

Figure 59.-Another view of Mangrove woodland, submerged at high tide. Khlung, southeastern Thailand. Dec. 1963.

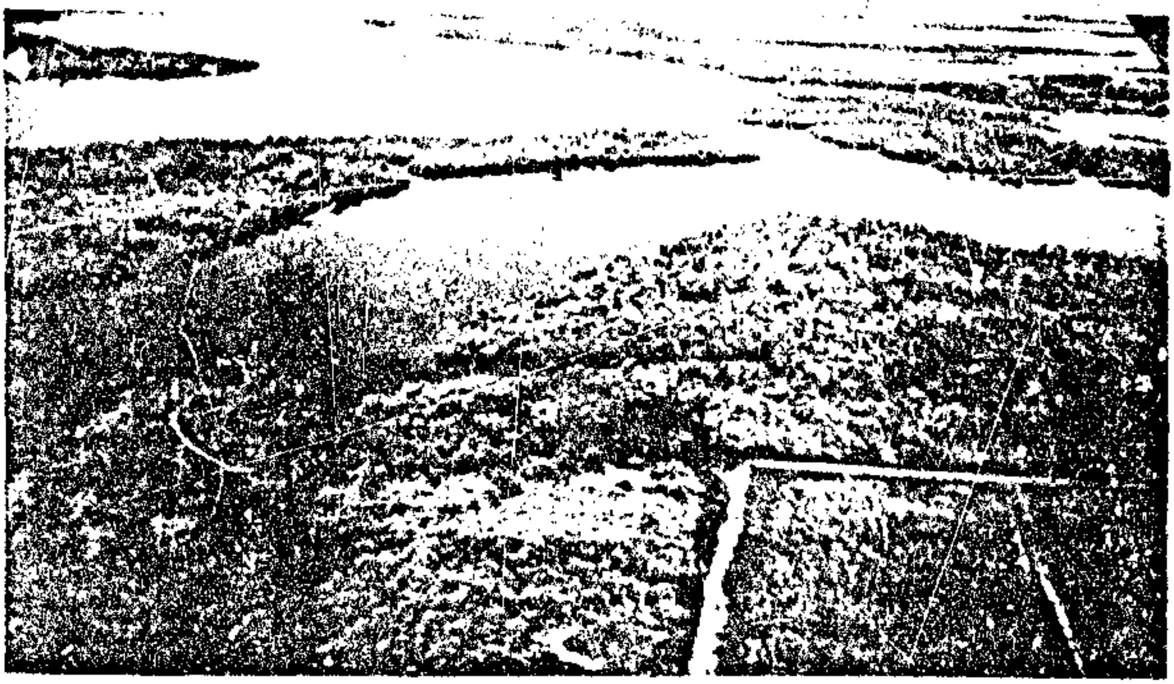

Figure 60.-Mangrove swamp forest covers considerable areas around Krabi, Phuket and other islands in southwestern Peninsula of Thailand. Feb. 1965.

Figure 61.-Mangrove forest along southeast coast of Thailand. Different tree species forming this forest type can be distinguished by the hue of foliage. Khlung, southeast Thailand. Jan. 1965.

Figure 62.-Stand of Nipa palm (Nipa fruticans), mixed with species of mangrove. Khlung, southeast Thailand. Feb. 1965.

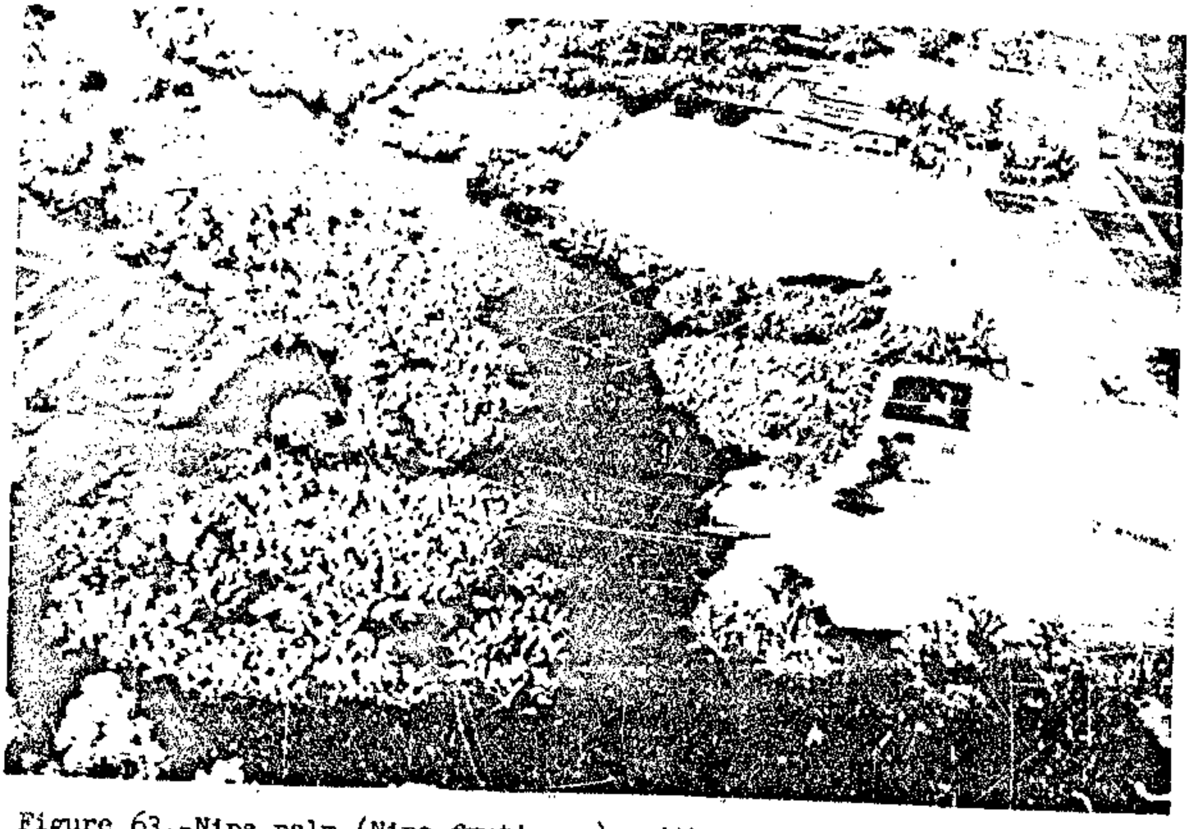

Figure 63.-Nipa palm (Nipa fruticans), with rice paddies on right. Note black color of brackish water. Khlung, southeast Thailand. Feb. 1965.

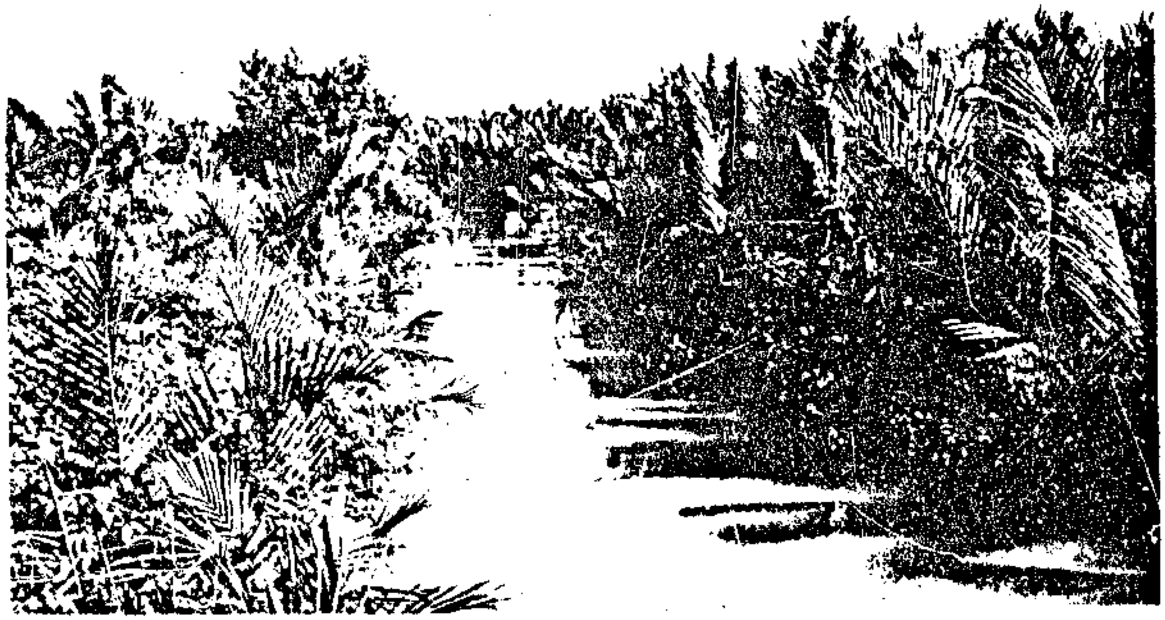

Figure 64.-Nipa palm (Nipa fruticans) grows in fairly large stands in Thailand around the estuary of the Chao Phraya and the deltas of other rivers in the Southeast, and in the Kra Isthmus. It occurs also in the vicinity of mangrove woodland along the coast of Cambodia and North and South Vietnam.

Figure 65.-Stand of 'cajeput' or 'samet' (Melaleuca leucadendron). This tree grows in brackish water, and is frequent along the southeast coast of Thailand and in the Kra Isthmus. Near Chantaburi, southeast Thailand. Nov. 1963.

Figure 66.-Fresh water swamp around Lake Nong Han. Sakkon Nakhon, northeast Thailand. Feb. 1965.

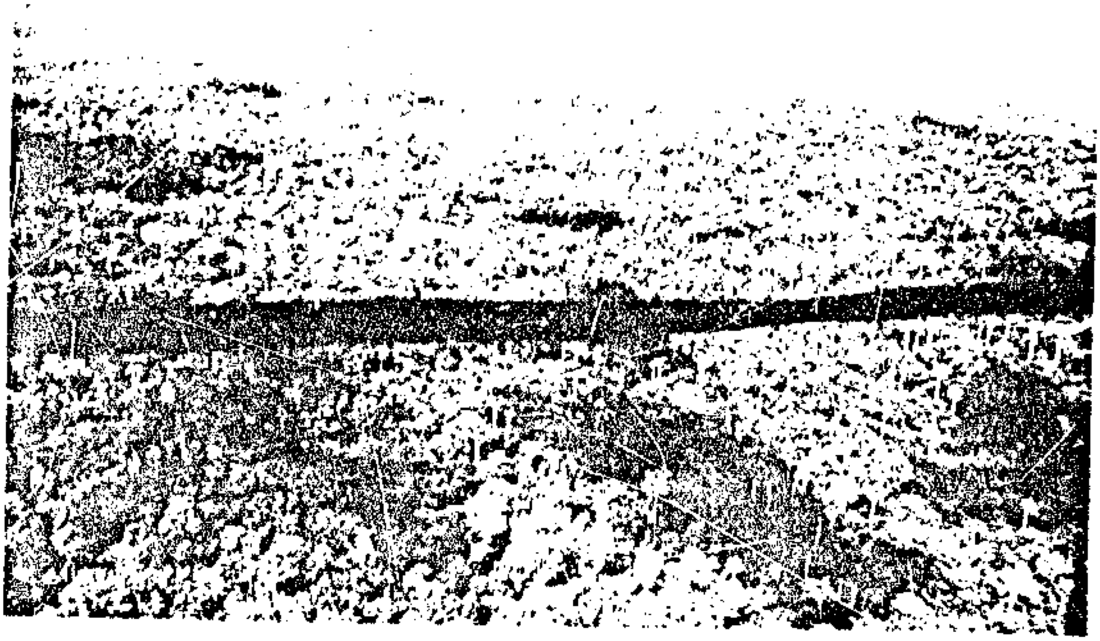

Figure 67.-Low oblique view of Lowland Semi-Evergreen forest, with Dipterocarpus alatus and Lagerstroemia calyculata as dominants. Northern margin of Khao Yai National Forest. Nov. 1963.

Figure 68.-Oblique aerial view of lowland Semi-Evergreen forest. Tall trees with straight, light-colored trunks are 'yang khao' (Dipterocarpus alatus) and 'pua'ai-daeng' (Lagerstroemia calyculata and L. balansae). Khao Yai National Forest, Korat Plateau. Nov. 1963.

Figure 69.-Stand of Lagerstroemia calyculata trees, recognized by light-colored trunks, in Semi-Evergreen forest. In lowland adjoining Khao Yai National Forest. Dec. 1964.

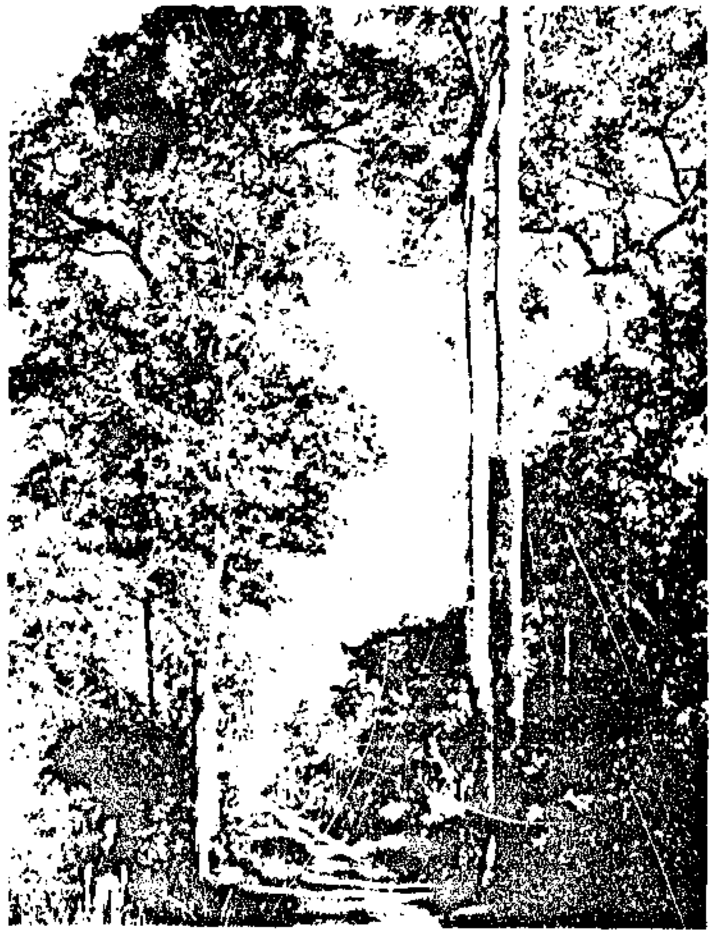

Figure 70.-Mixed Semi-Evergreen forest is found scatteringly in eastern Thailand. Many of the trees have straight, columnar trunks. East of Phibun Mangsahan, eastern Thailand. Dec. 1963.

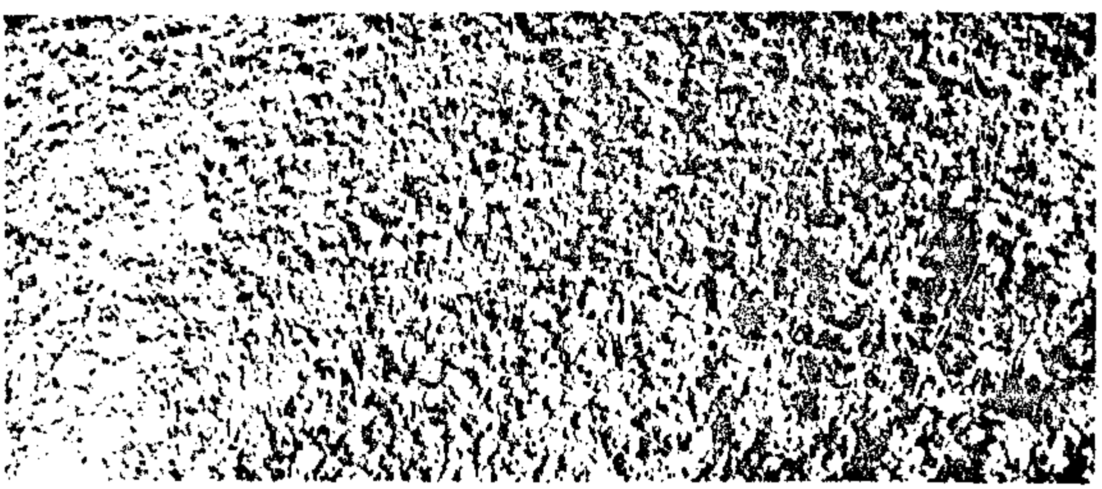

Figure 71.-Teak (Tectona grandis) forest - trees with light-colored crowns - between Loei and Phetchabun, northern Thailand. Feb. 1965.

Figure 72.-Cutover Teak forest (Tectona grandis) at Chiengdao, northern Thailand. Jan. 1964.

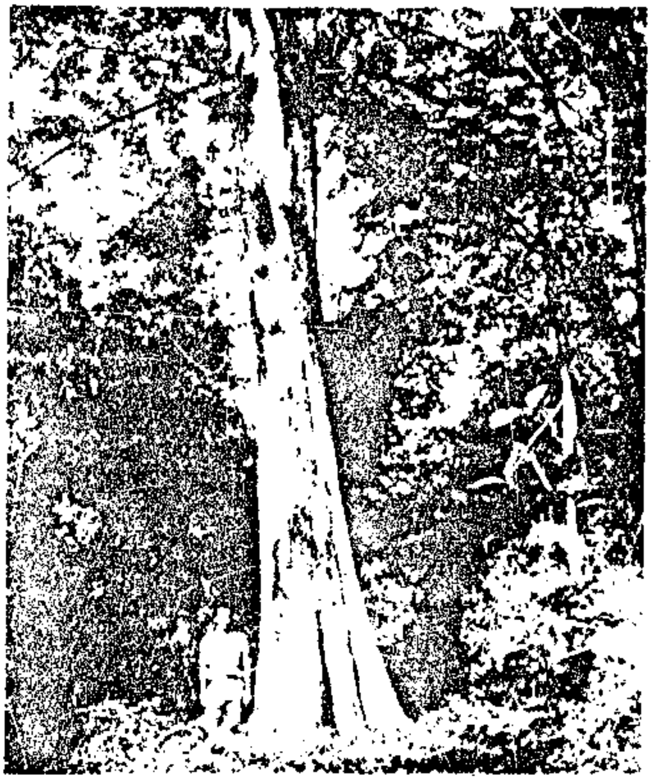

Figure 73.-Teak (Tectona grandis) is the most important commercial timber tree in Thailand, growing in Moist and Dry Deciduous forests of the northern regions. Sayok Forest Station, middle Khwae Noi River, western Thailand. Dec. 1963.

Figure 74.-Teak plantation (Tectona grandis), about 15 years old, at Mae Thak, Lampang region, northern Thailand. Feb. 1965.

Figure 75.-Logging camp in Teak forest. Logs in foreground ready to be floated; teak plantation in right background; and teak forest in left background. Near Paklay, northern Laos.

Figure 76.-Mixed Deciduous forest. Undergrowth in this forest type is moderately dense. Phu Phan, northeast Thailand. Dec. 1963.

Figure 77.-Mixed Deciduous forest on slopes around Tak, northwestern Thailand. Dominant species include Xylia kerrii, Shorea obtusa, Lagerstroemia calyculata and Dipterocarpus tuberculatus. Jan. 1964.

Figure 78.-Semi-Evergreen forest on slopes of Tak, northwestern Thailand. The armed bamboo, 'phai-pha' (*Bambusa arundinacea*), is abundant in this forest type wherever clearings are made. Jan. 1964.

Figure 79.-Mixed Deciduous forest east of Tak, northwestern Thailand, as it appears at height of dry season. Feb. 19[illegible]5.

Figure 80.-Known in Thailand as 'kabak' or 'krabak', Anisoptera cochinchinensis is a characteristic tree in Mixed Deciduous forest, and occasionally associated with Dipterocarp trees. Phibun Mangsahan, eastern Thailand. Dec. 1963.

Figure 81.-A characteristic tree of Mixed Deciduous forest in Thailand is 'krang', a tall epiphytic fig tree (Ficus altissima). Tak, northwest Thailand Jan. 1964.

Figure 82.-'Krang' (Ficus altissima), one of the largest fig trees in Thailand, is characteristic of Evergreen and Mixed Deciduous forests. Mukdahan, northeast Thailand. Dec. 1963.

Figure 83.-The large crown of 'krang', a fig tree (Ficus sp.), characterized by moderately stout branches, rising at a sharp angle. Mukdahan, northeast Thailand. Dec. 1963.

Figure 84.-*Lagerstroemia calyculata* (left) and *Bombax* (*Salmalia*) *insigne* (right) are typical trees of Mixed Deciduous forest, thriving in red or brown soils. Near Mukdahan, northeast Thailand. Dec. 1963.

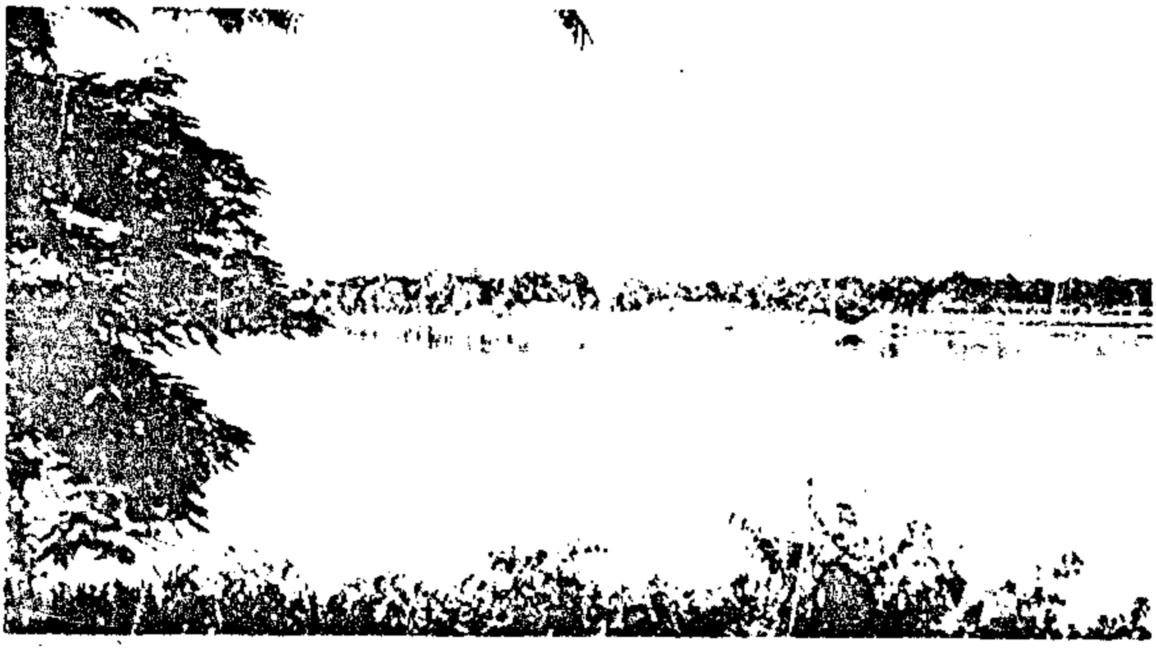

Figure 85.-The Mekong River at Nakhon Phanom, with the mountains around Thakhek, western Laos in background. Dec. 1963.

Figure 86.-Dipterocarp forest with rice paddies, planted by Lua hill tribe, mostly in valley bottom. Between Mae Hongson and Mae Sariang, northwest Thailand. Jan. 1965.

Figure 87.-Dry Dipterocarp forest between Mae Hongson and Mae Sariang, northwest Thailand. Jan. 1965.

Figure 88.-Dry Dipterocarp forest at Borabue, northeastern Thailand. This forest type is usually burned over annually. Dec. 1963.

Figure 89.-Open Mixed Forest, Including *Shorea obtusa* and *Dipterocarpus tuberculatus*, with bamboo. On slopes north of Chantaburi, southeastern Thailand. Nov. 1963.

Figure 90.-Dry Dipterocarp forest along highway east of Phibun Mangsahan, eastern Thailand, near border of southern Laos. Jan. 1964.

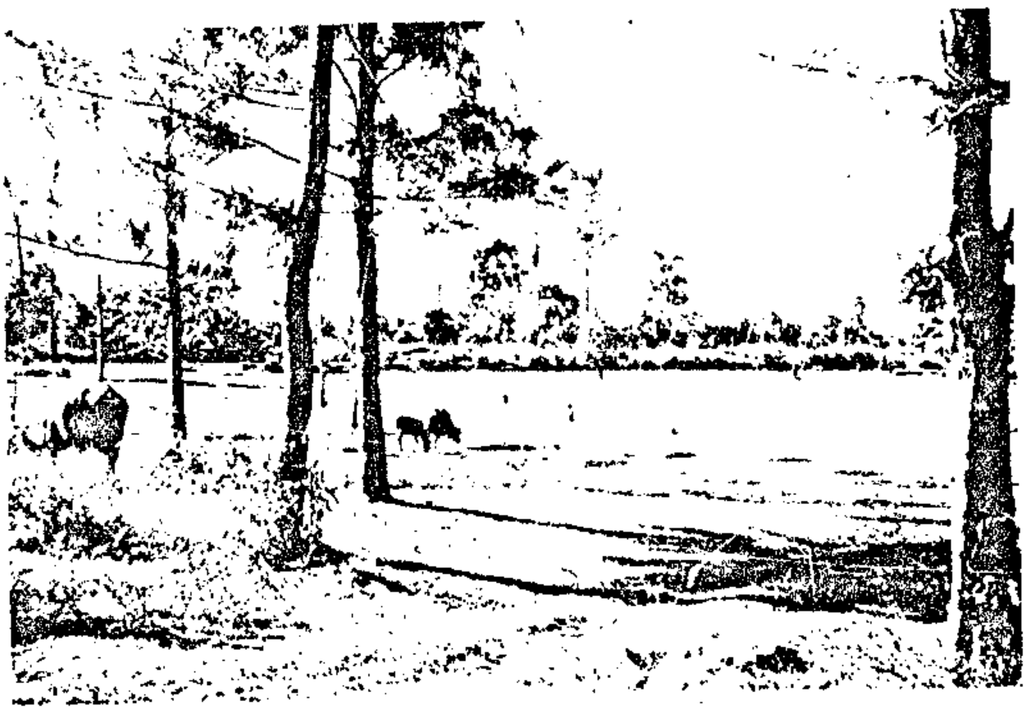

Figure 91-Type of open vegetation east of Phibun Mangsahan, near border between Thailand and southern Laos. Casuarina trees in foreground. Dec. 1963.

Figure 92.-Fairly open Ditperocarp forest, on plateau of Quirirom, Cambodia. (Photo by Aubreville.).

Figure 93.-Dry Dipterocarp forest as it appears after being burned over. Cambodia. (Photo by Allouard.)

Figure 94.-Forest road on heavy, red volcanic clay as it appeared after 2 years of use by light vehicles during all seasons, and heavy trucks in dry season. Between Sala Dar and Sopheas, Cambodia.

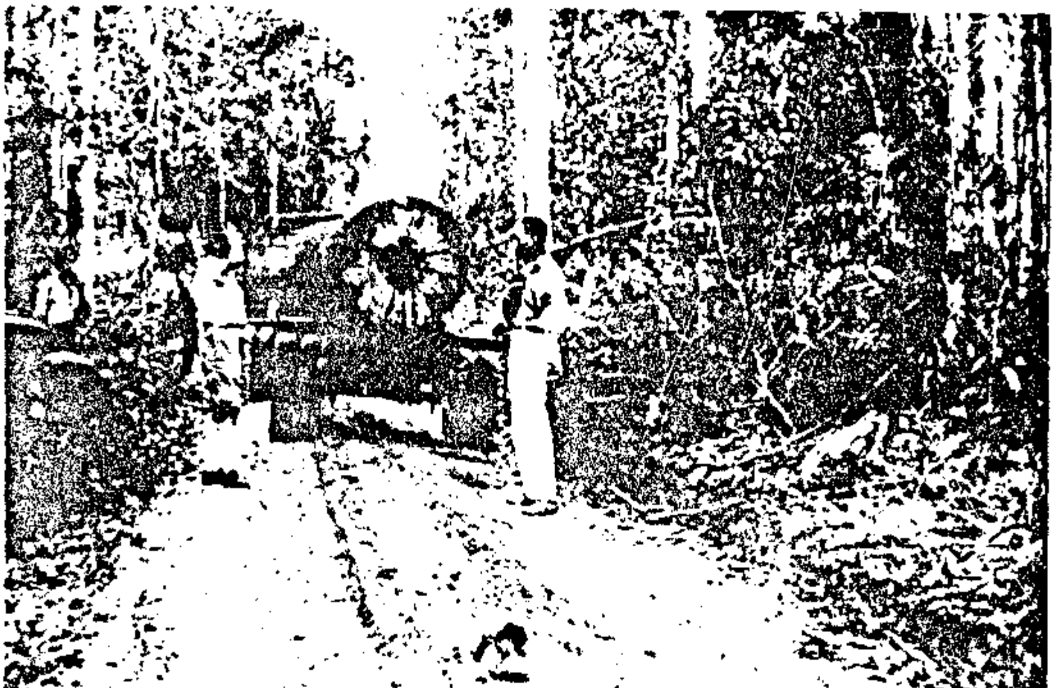

Figure 95.-Road from Sala Dar to Sopheas, Cambodia, tested for use by heavy trucks. (Photo by Allouard.)

Figure 96.-Thorn forest in northeastern Thailand. This type usually develops when the original vegetation is cleared for agriculture and the land later abandoned. Nakhon Phanom, close to the Mekong River. Dec. 1963.

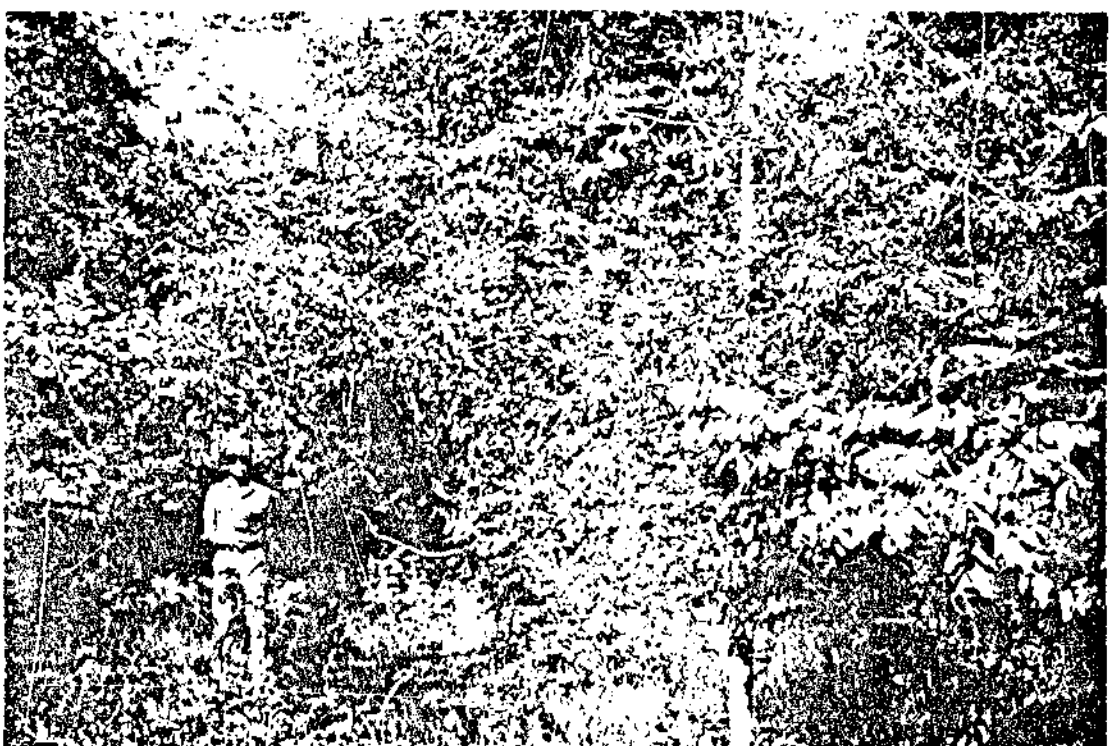

Figure 97.-Thorn forest of small armed trees and shrubs, mixed with bamboos, especially the slender Thyrsostachys siamensis, is widespread in central Thailand. Kanchanaburi, western Thailand. Dec. 1963.

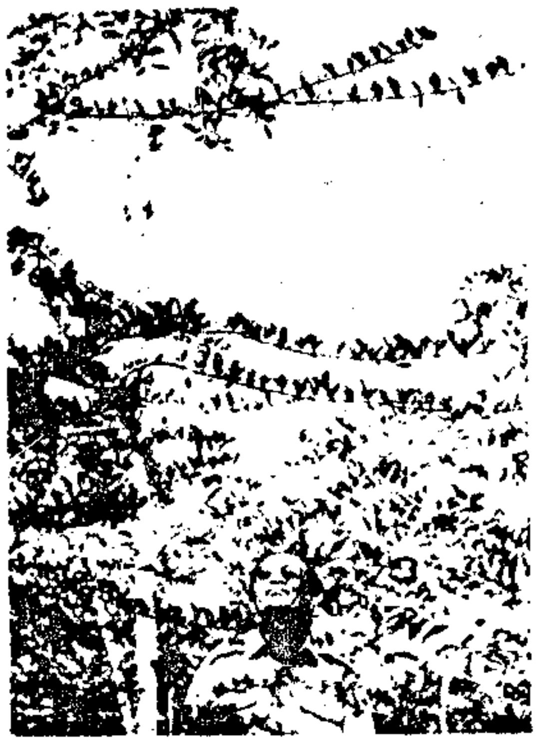

Figure 98.-Close-up of branches of 'k'let' (_Randia dumetorum_), a frequent shrub or small tree in thorn forest, showing the long, sharp spines present on the trunk and branches. Kanchanaburi, western Thailand. Dec. 1963.

Figure 99.-Beach forest of medium stature, at Huay Yang, central peninsular Thailand. Jan. 1965.

Figure 100.-Casuarina trees are characteristic along beaches, and are often planted for windbreak and to prevent soil erosion. Huay Yang, central peninsular Thailand. Feb. 1965.

Figure 101.-Bamboo brakes, especially the tall, armed Bambusa arundinacea, and stands of soft-wooded 'ngiu' tree (Bombax malabaricum) are frequent in clearings and along the banks of rivers and streams. Middle Khwae Noi River, western Thailand. Dec. 1963.

Figure 102.-Bamboo brake (Dendrocalamus strictus). Mobility in this type of vegetation is somewhat difficult. Forest Station near Tak, northwestern Thailand. Jan. 1964.

Figure 103.-Rice paddies northeast of Bangkok. Part of crop (light colored) has already been harvested. Hamlets and farm-houses are surrounded by bamboos, especially Bambusa blumenea and Thyrsostachys siamensis, for windbreak, and fruit trees. Moving objects can readily be detected from the air, whether in harvested or unharvested rice patches, and craft traveling on the 'khlongs' (man-made canals). Near Saraburi, central plain. Nov. 1963.

Figure 104.-Floating raft of bamboo (Bambusa arundinacea) to Kanchanaburi, for the manufacture of paper pulp or for house construction. Low tree, in dense stands, along waterline is Homonoia riparia. Khwae Noi River, western Thailand. Dec. 1963.

Figure 105.-Ground fire passing through a bamboo brake in flower. Most bamboos in Thailand are deciduous, and fire frequently sweeps over the litter in the dry season, but rarely damages living shoots. Mae Sod, northwest Thailand.

Figure 106.-Wooded savanna with a ground cover of rough grasses. Trees, mostly of the Dipterocarp family, measure from 10 to 30 feet (3-10 m.) in height, and are usually widely spaced. West of Nakhon Phanom, northeastern Thailand. Dec. 19[illegible]3.

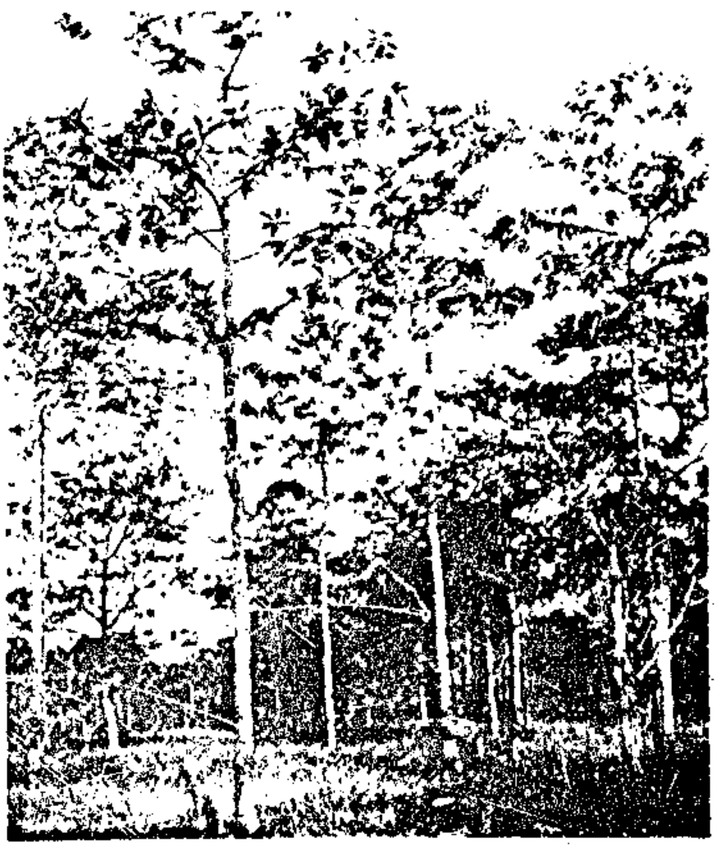

Figure 107.-A wooded savanna, mostly with deciduous trees, in Vietnam. (Photo by Institut des Recherches Agronomiques et Forestières de l'Indochine.)

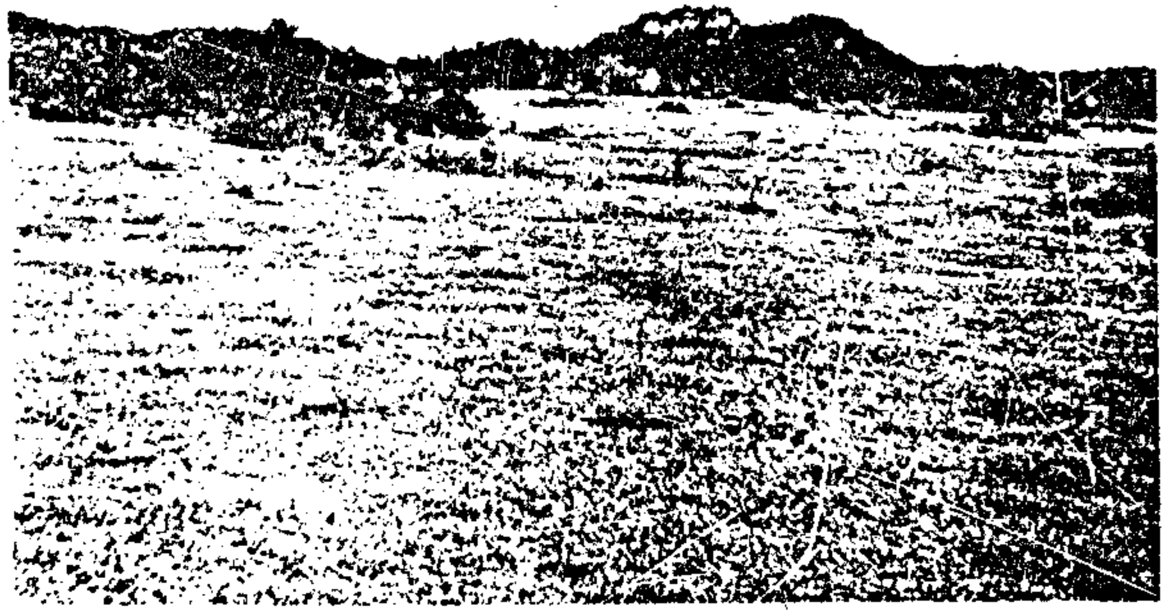

Figure 108.-Open grass savanna, south of Ranong, southwest Peninsula. Feb. 1965.

Figure 109.-Wooded savanna with ground cover composed of an herbaceous species (Themeda) and a shrub (Lagerstroemia macrocarpa). Thakhek, Mekong basin, central Laos. (Photo by Vidal.)

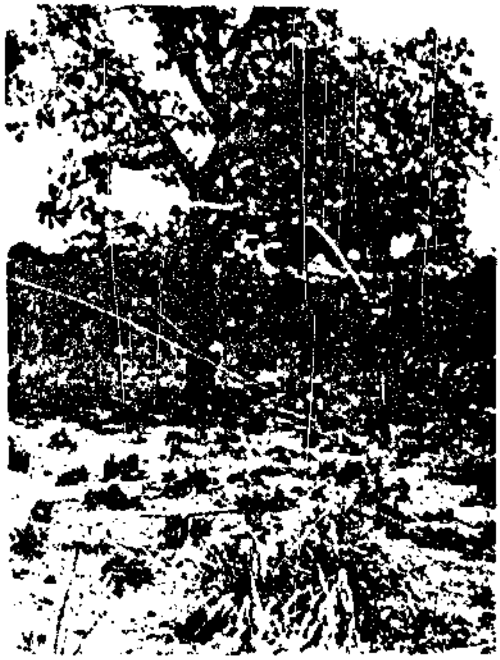

Figure 110.-Wooded pseudo-steppe with a dominant herb, a species of _Themeda_, and _Careya sphaerica_ tree. Region of Thakhek, Mekong basin, central Laos. (Photo by Vidal.)

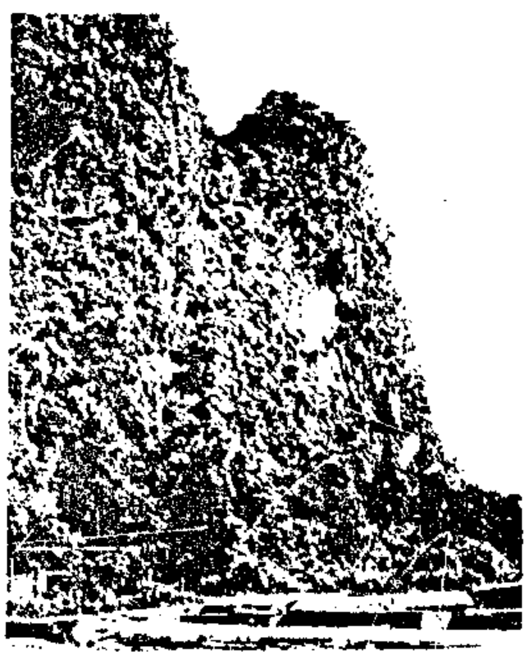

Figure 111.-Limestone buttes are a characteristic feature of the southern Peninsula, suggesting the 'mogotes' of northern Puerto Rico. The vegetation covering these perpendicular cliffs is characteristic and differs from other types. Krabi, Peninsular Thailand. Jan. 1964.

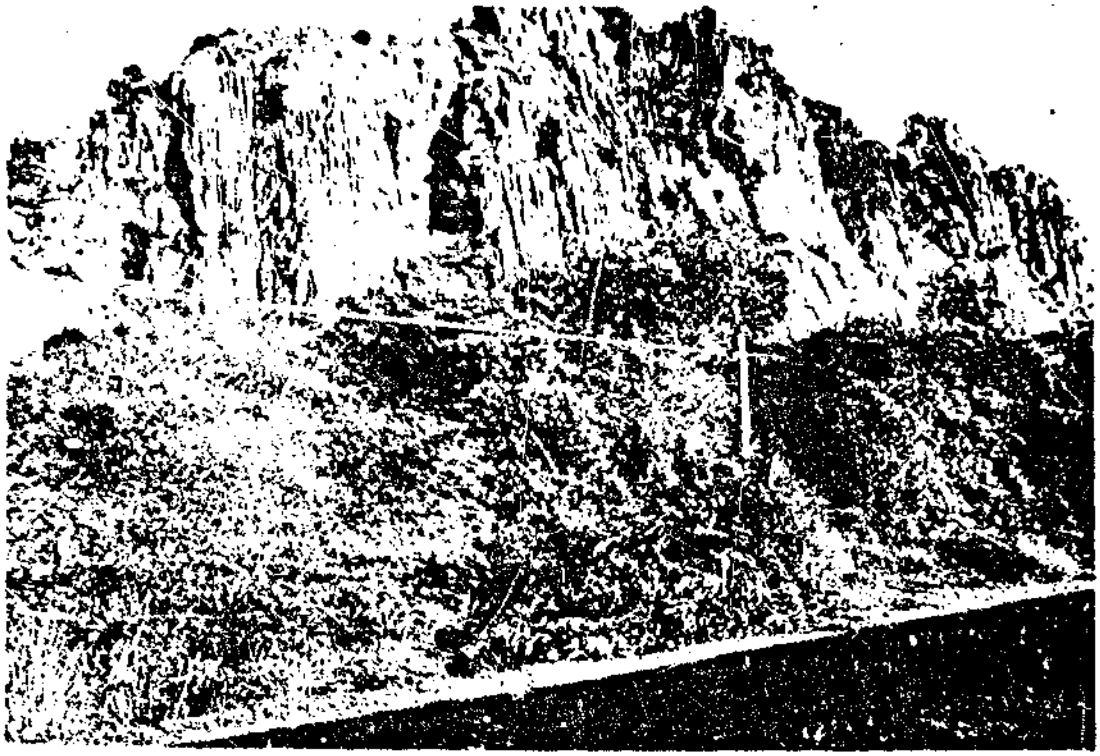

Figure 112.-Limestone bluffs are frequent throughout Thailand. Vegetation around the base of these xeric cliffs is composed of small trees and shrubs, many of them thorny, and bamboos (Bambusa arundinacea and Thyrsostachys siamensis). Near Khampaeng Phet, northwest Thailand. Jan. 1964.

Figure 113.-This area near the test-site, for defoliants, was covered at one time with forest. With destruction of the original forest, 'kha-luang' (Imperata cylindrica) and other grasses and such weeds as Eupatorium odoratum soon develop. Near Pranburi, upper peninsula, Thailand. Nov. 1963.

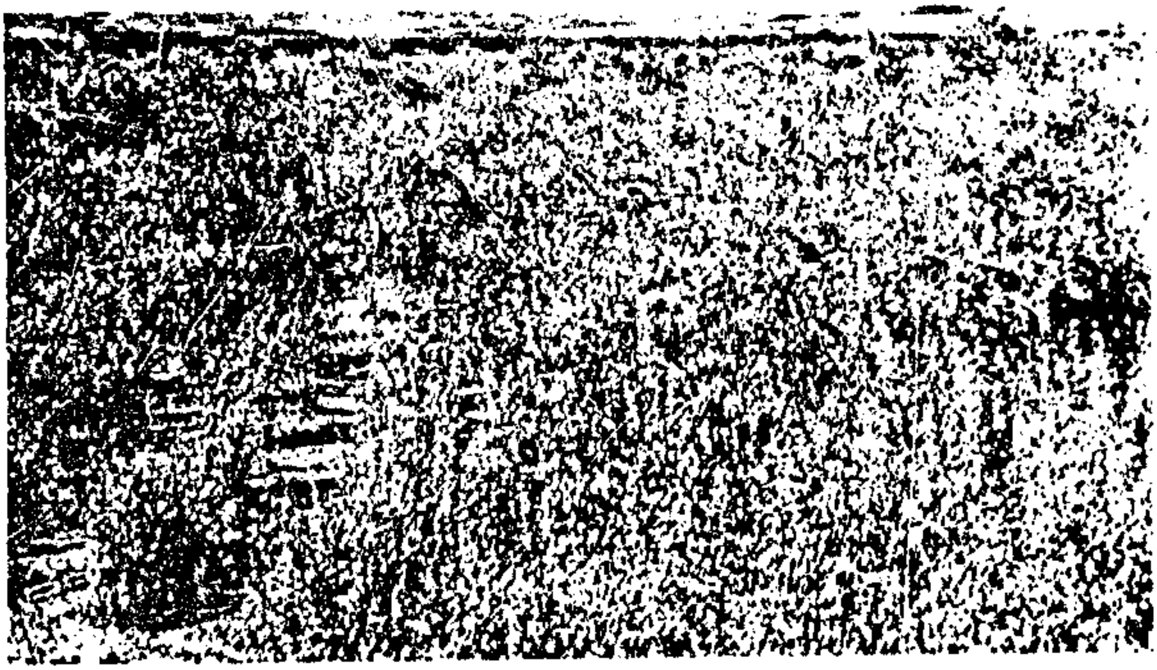

Figure 114.-In deforested areas, abandoned tilled land, or along roadsides an exotic weed, Eupatorium odoratum, develops rapidly, and is a serious weed pest throughout Thailand as in other parts of Southeast Asia. It is also considered hazardous, because it provides sites for ambush.

Figure 115.-A tall cane-grass, 'phong' (Saccharum spontaneum), up to 6 feet (2 m) high, is common throughout Thailand, along roadsides and in clearings; provides potential sites for ambush. Pranburi, upper Peninsula. Jan. 1965.

Figure 116.-Calotropis gigantea, known in Thailand as 'rak-dok'; a weed common along roadsides. Nakhon Sawan, central Thailand. Feb. 1965.

Figure 117.-Dense herbaceous ground cover, especially of Eupatorium odoratum and Imperata cylindrica, that develops in exposed clearings and along roadsides. Such vegetation is considered ideal for ambush. Phibun Mangsahan, eastern Thailand. Dec. 1963.

Figure 118.-Deforested land, foreground, cleared for shifting cultivation; denuded slopes, in background, covered mostly with 'lalang' grass (Imperata cylindrica). Around Tranninh (alt. 1,200 m), northern Laos. (Photo by Vidal.)

Figure 119.-Hill tribe, Map, village in Yankar mountain range, in uplands of South Vietnam.

Figure 120.-Pará rubber (Hevea brasiliensis) plantation. When the ground cover is not cleared or kept low, as shown above, such plantations provide ideal sites for ambush, as well as a staging area. Chantaburi, southeast Thailand. Dec. 1963.

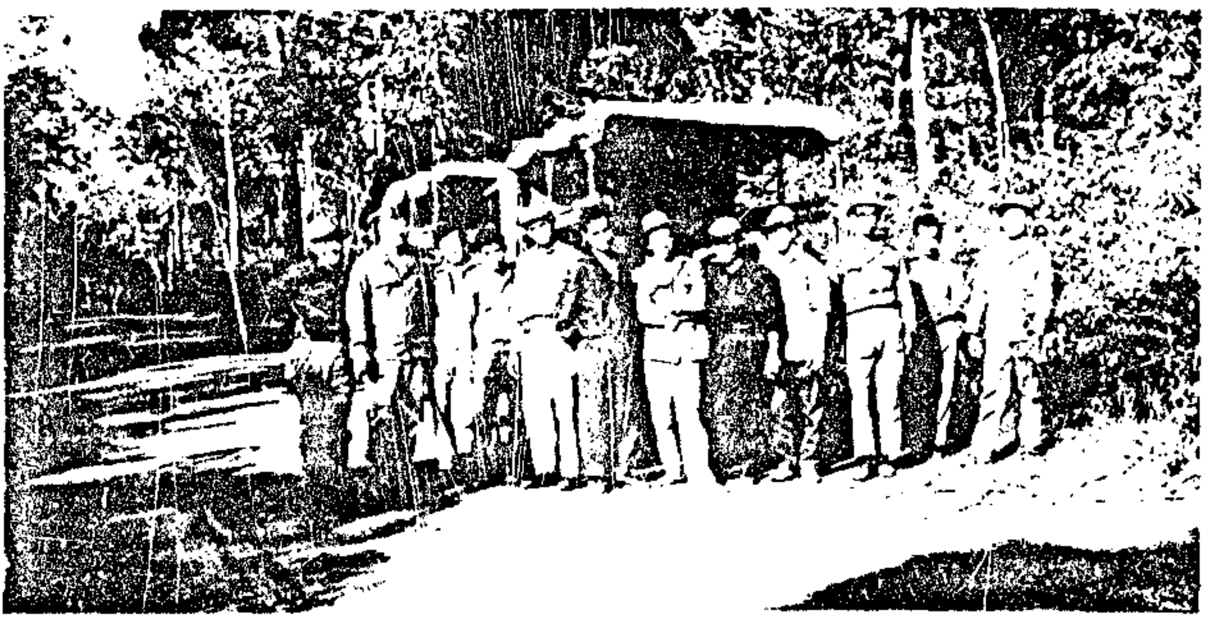

Figure 121.-Thai field team, of forest rangers and soil technicians, conducting studies and preparing profiles of forest types. Near Mukdahan, northeast Thailand. Dec. 1963.

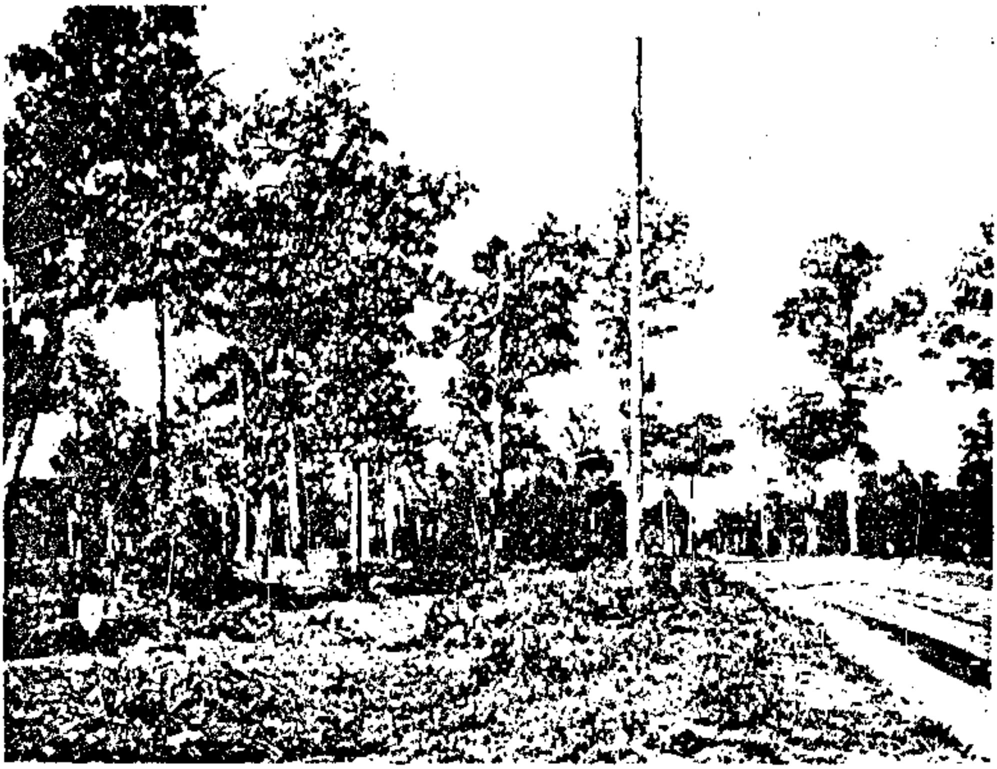

Figure 122.-Open Dipterocarp forest, equivalent to the 'fôret claire' of French ecologists, between Konkaen and Kalasin, northeast Thailand. Dec. 1963.

Figure 123.-Members of Thai field team identifying plants in Dipterocarp forest. Phu Phan, northeast Thailand. Dec. 1963.

Figure 124.-Technicians taking soil samples in Dipterocarp forest. Phu Phan, northeast Thailand. Dec. 1963.

Figure 125.-Section of large Dry Mixed Deciduous forest, covering hill slopes and valleys, in Phu Phan Forest Reserve, northeast Thailand. Jan. 1965.

Figure 126.-Secondary growth in Dry Mixed Deciduous forest. Phu Phan Forest Reserve, northeast Thailand. Jan. 1965.

Figure 127.-Rice paddies, in impoverished soil and subject to flash floods, at Borabue. Typical of northeast Thailand. Dec. 1963.

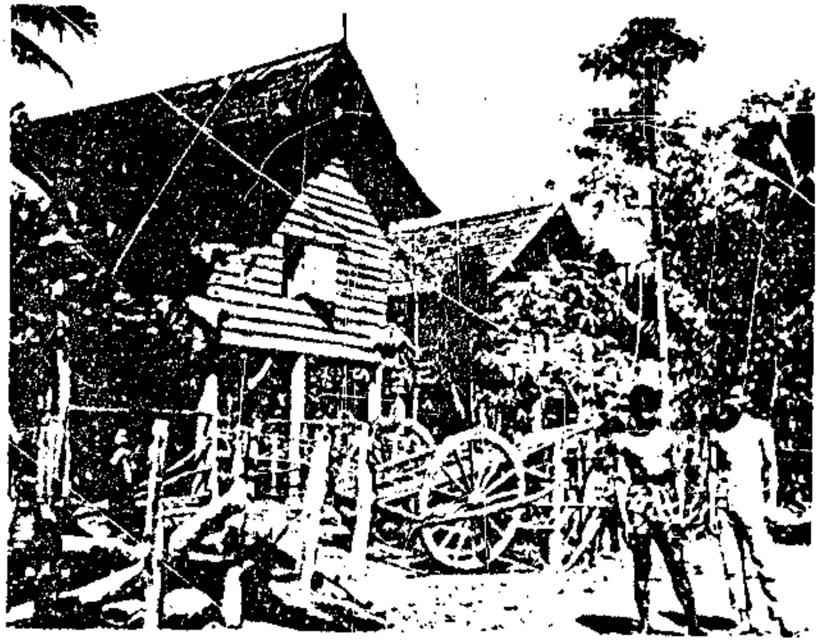

Figure 128.-Rice growing and cattle raising are the main occupations in northeastern Thailand. A typical farmhouse in a hamlet near Sakhon Nakhon. Jan. 1965.

Figure 129.-Dry Evergreen forest. Undergrowth is fairly sparse; woody vines, or lianes, are frequent; and several trees and shrubs bear thorny spines. Section of site near Pranburi, upper Peninsula, before tests with chemical application commenced. Nov. 1963.

Figure 130.-Dr. Robert A. Darrow, Biological Laboratory at Fort Detrick, Maryland, on inspection trail at test site near Pranburi, upper Peninsula. Feb. 1965.

Figure 131.-One of a series of trails opened in test site to set up cameras, to record penetration of defoliants and to determine reaction of plants to chemicals after repeated spraying. Pranburi, Peninsula. Feb. 1965.

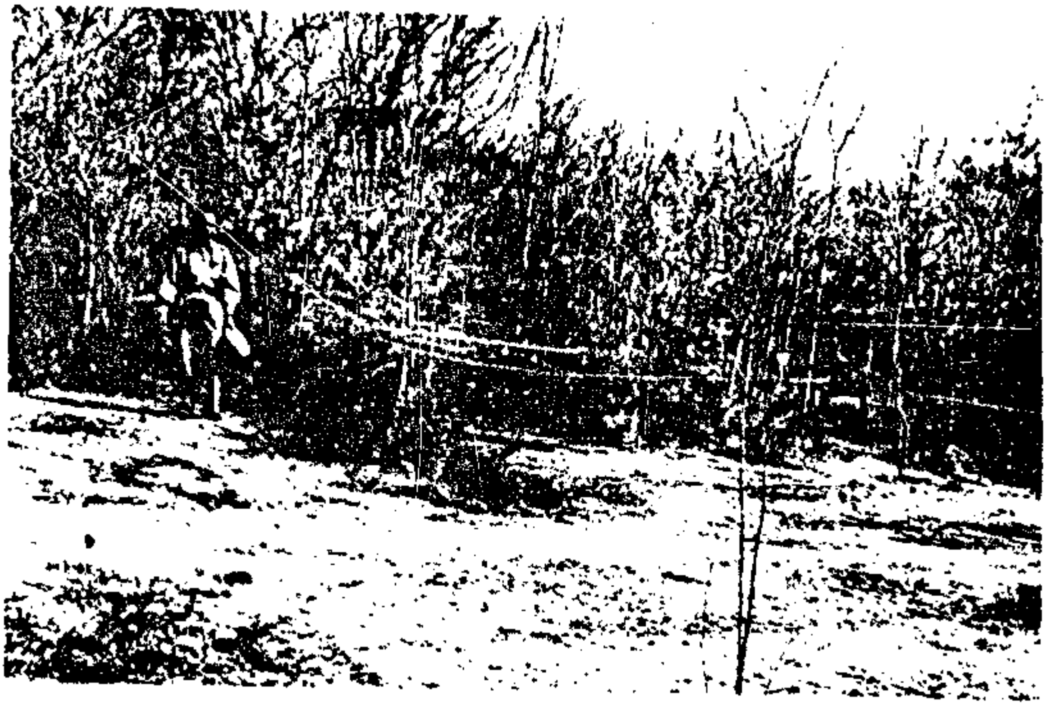

Figure 132.-Section of test site, showing desiccating effect of aerial spraying on vegetation. Pranburi, Peninsula. Feb. 1965.

Figure 133.-'Ma-kok' trees (<u>Spondias</u> <u>pinnata</u>) defoliated as a result of aerial spraying with chemicals. Pranburi, upper Peninsula. Feb. 1965.

Figure 134.-Some plants in the ground cover, notably 'khao lang' grass (Imperata cylindrica) in foreground, are able to withstand chemicals and reappear several weeks after being sprayed. Test site, Pranburi, upper Peninsula. Feb. 1965.

Figure 135.-A Japanese botanist, member of Joint Kyoto University - Chulalonkorn University Expedition, to study soil productivity, gathering plant materials and recording data in Rain forest at Kachawng, south Peninsula, Thailand. Dec. 1963.

Figure 136.- Member of Joint Kyoto University - Chulalonkorn University weighing litter in Rain forest at Kachawng, south Peninsula, Thailand. Dec. 1963.

PART III

ANNOTATED BIBLIOGRAPHY

OF

SOUTHEAST ASIA

CONTRIBUTION TOWARD

A BIBLIOGRAPHY OF SOUTHEAST ASIA

This annotated Bibliography contains 768 titles that have been reviewed in the course of this Project. It covers a wide range of subjects, from forest types, major and minor forest products, agricultural crops, aerial photography and photo sampling as applied to forest surveys and evaluation, to subjects of a general nature. These references include many of minor importance that were found during search for the major publications. This should not be regarded as a complete bibliography of Southeast Asia. Additional literature citations are included in a majority of the references listed, as well as in published materials on subjects, other than vegetation, relating to Southeast Asia.

I am grateful to the National Agricultural Library, including the Branch at the Plant Industry Station, for cooperation extended in the preparation of this Bibliography. Its invaluable card catalog, arranged by author and subject, contains references and periodical articles from a very wide range of sources.

An important supplemental source is the Library of Congress. Additional references on the vegetation of Thailand, and of Southeast Asia in general, are also available in the Departments of Botany of the Royal Forest Department, Kasetsart and Chulalonkorn Universities in Bangkok, as well as in other scientific institutions.

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The forests of Cochinchina, now a part of South Vietnam, may be divided into dryland forests, to the East, and periodically flooded forests, to the West.
The forests of Cambodia, cover an area of 4,000,000 hectares (15,444 sq. mi.); are separated into three major types: (a) inundated forest, (b) open forest, and (c) dense forest.
Laos, although rich in forest types, had not been thoroughly studied up to 1929 like those of Annam and Cambodia. As a result of shifting agriculture, extensive areas had been cleared of forest, and these zones in part had been invaded by palms, and other plants of secondary growth. Valuable teak forests, in the northwest, were also severely overcut. Laos has long been considered a vast potential source of forest products but a program of forest management and reforestation still remained to be organized in 1929.

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The vernacular names of these trees in Tonkin, Annam, Cambodia and Laos is given. Descriptions are given of the habitat of the respective trees; and their wood structure.
The second part of the article deals with the industrial and commercial phases of these woods: their esthetic features; physical, mechanical and technological characters; and their use in the European market.
One plate contains line diagrams, drawn to scale, of a twig with needles of P. merkusii; the needles of the two species; cones; and seed. The second plate shows the microscopic structure of the wood on the transverse, tangential and radial surfaces.

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Rice and fish are two inseparable items in the diet of the Thai people.

______. Presenting Vietnam. 20 pp. Spec. ed. Published by the Review Horizons, Saigon-Vietnam. 1960.
Situated between latitudes 8°33 and 23°22 North, Vietnam covers a total area of 330,000 sq. kilometers and is 1,200 kilometers (750 miles) from north to south. The elongation of its territory over 15 degrees of latitude gives Vietnam an extremely varied climate. The south is almost entirely an alluvial plain, in the center of which the Mekong flows like a wide open hand. In the center, on the contrary, a thin tongue of land, sparsely irrigated by small water-courses, separates the seashore from the long mountain range of Truong-Son running from north to south, with peaks often exceeding 8,000 ft. (2,600 m.). In the north mountain and plain achieve a harmonious balance. Skirting the immense delta of the Red River, the high region swings capriciously along the frontier of China, a chalky massif lying roughly Northwest to Southeast.
On this territory lives a population which can only be estimated at approximately 23 millions. The separation brought about by the negotiations in Geneva prevents the taking of any general census of the whole country.

An ethnographical map of Vietnam shows clearly the great diversity of its people. The area inhabited by the Vietnamese is limited mostly to the Mekong Delta, the Red River Delta, and a very narrow coastal strip. A distinctly larger area in the interior is criss-crossed by a multitude of ethnic groups, remnants of human migrations which, in prehistoric periods, succeeded one another on the soil of what is now Vietnam. According to their origin, the ethnic minorities may be classified into six main groups: the Khmers in the South; the Chams in the area of Phanrang and Phanri and who are related to the Malays; the Mois of Indo-Malayan origin who inhabit the entire hinterland of the center and the plateaux north of Saigon; and the Thai, the Man and the Meo who inhabit the high mountains of the North. Each of these groups is divided into an infinity of tribes, many of them quite distinct from the others. This is so, for example, in the case of the Man, and is even more so evident with the mountain people of the South, whom ethnologists group under the convenient name of 'Pemsiens'. This term is derived from the initials PMSI - 'Populations Montagnardes du Sud de l'Indochine'. These varied elements are numerically only a small proportion of the population, contributing only 3 to 4 percent of the total.

As for the Vietnamese, styled a 'pure race' for convenience of language, their origin is still uncertain. It is generally held that they came from the southern provinces of China. If the principle of a permanence as national heredity is admitted, one is obliged to put aside the theory that they are distant ancestors of the mountain peoples who came down from the high summits to cultivate the delta of the Red River, in view of the fact that they congregated solely in the coastal regions and in the swampy plains of the north and south. Whatever the truth may be, it is certain that the Vietnamese race, as it is today with its own peculiar characteristics, forms a homogeneous whole, the product of long-past mingling of peoples. It may not be possible to make a precise scientific analysis of each constituent element - Mongol, Indonesian, Indo-Maley, Melanesian and others - but it is undeniable that the mixture of these elements through the course of centuries has resulted in a product which has ethnic originality. On that basis it has just claims to authentic nationalism.

______. La Culture du Tabac. Gouvernement Générale de l'Indochine Série Saigon. Bulletin No. 6. 11 pp. Saigon. 1918.

Discusses the cultivation of tobacco in Indochina.

______. Pinus khasya Royle. Caractères sylvicoles et méthodes de plantation. Bois et Forêts des Tropiques. No. 69: 27-32. Jan.-Feb. 1960.

A description is given of the morphology of this tree, occurring in the mountainous areas of tropical Asia, where it grows spontaneously. There is also a treatment of its botanical and anatomical characters; mechanical properties and utilization of the wood; its ecology; and plantation methods.

One diagram and 3 photographs are included, in addition to 11 references.

_____. East Meets West in Thailand. 17 pp. illustr. Mutual Security Agency, Washington, D. C.

This pamphlet, written in popular style, treats briefly with the economy of Thailand, a program for health, rice production, new agricultural resources, transportation and industry, development of hydroelectric resources, and Thailand's contribution to mutual security.

_____. Le Cambodge moderne. 46 pp. Bar de Presse du Palais Royal. 1950.

_____. Direction de la Statistique et des Etudes Economiques (Cambodia). Bulletin mensuel de statistique. Phnom-Penh. 1954.

Archaruak, T. Papaya culture. Kasikorn 26 (3): 273-282. 1953.

Aubreville, A. Au pays des eaux et des forêts - Impressions du Cambodge forestier. Bois et Forêts des Tropiques. 52: 49-56. illustr. 1 map. March-April 1957.

Written in non-technical style, this article presents the author's impressions of the forests of Cambodia. He describes in brief the inundated forest around Tonlé Sap and the basin of the Mekong River; and the trees lining the avenues in Phnom Penh, the capital, such as kokis (*Hopea odorata*), tamarind (*Tarmarindus indica*), cailcedrat (*Khaya senegalensis*) and mahogany (*Swietenia macrophylla*).

The central part of Cambodia is covered with rice-fields, flanked to the northwest and southwest by high ranges of Cardamom and Elephant Mountains, separating Cambodia from Thailand.

On red soils, especially around Kompong Cham, Kompong Thom and elsewhere, a fine dense, moist forest once existed, but this was felled some years ago for the planting of Pará rubber tree (*Hevea brasiliensis*). Moist Evergreen forest is now confined to the mountain region along the border with Thailand, in which dominant trees are: *Tetrameles nudiflora*, *Irvingia* sp., *Dipterocarpus dyeri*, *Hopea odorata* and *Anisoptera cochinchinensis*.

The 2-needled pine (*Pinus merkusii*) is found occasionally in the lowlands. The dense Dipterocarp forest along the Gulf of Thailand and in the Mekong plain, along with pine, resembles the deciduous forests of Africa in general appearance. This forest has long been exploited for commercial timber, especially *Xylia dolabriformis* and *Shorea obtusa*. Teak is not native to Cambodia.

Auriol, R. F. Le riz etyé, sa préparation industrielle et ses sous-produits. Indochina. Insp. Gen. de l'Agric., de l'Elev. et des Forêts. Impr. A. Portail. 41 pp. Saigon. 1937.

A study of rice culture, its industrial processing and subproducts.

Australian Institute of International Affairs. French-Indochina and the French colonies in the Pacific area. A.I.I.A. World Affairs Paper No. 2. 32 pp. 1940.

Avery, G. Evaluating understory plant cover from aerial photographs. In Techniques and Methods of Measuring Understory Vegetation. Proceedings of a Symposium at Tifton, Georgia, Oct. 1958. pp. 79-81.

______. Photographing forests from helicopters. Journal of Forestry 57 (5): 339-342. May 1959.

______. Recent trends in forest photogrammetry. Journal of Forestry 60 (7): 459-460. July 1962.

Bakitin, Y.V., and A. Imamliev. Physiological changes in fruit trees during chemical defoliation. Plant Physiology 6 (2): 202-206. March-April 1959. American Institute of Biological Sciences, Washington, D. C.

Balankura, B. Introducing new insecticides. Kasikorn 23 (2): 94-96. Bangkok. 1950.

Ballard, G. Le problème du riz en Cochinchine. Soc. d'Etudes et d'Inform. Econ. 39 pp. Paris. 1935.

Bamrungpol, K. The cost of growing dent corn at Ban Mai Samrong. Kasikorn 27 (4): 373-379. Bangkok. 1954.

Bandhuvibas, S. Why do we have to increase rubber planting area? Kasikorn 26 (3): 283-290. Bangkok. 1953.

Banerji, J. The Mangrove Forests of the Andamans. Proc. Fourth World Forestry Congress. 3: 425-428; 3 tables. Dehra Dun. 1954.
Discusses in brief the following phases of this specialized forest type: physiognomy of mangrove forest; its general distribution; climate; floristic composition; fuel value of mangrove; mangrove poles; artificial regeneration; silvicultural characters of Bruguiera gymnorrhiza; method of felling; planting; qualities of Bruguiera poles; and classification of poles.

______. The mangrove forests of the Andamans. Tropical Silviculture II, 319-324. FAO. Rome, 1957.

Barnard, R. C. Linear regeneration sampling. Malayan Forester. 13. p. 129. 1950.

______., and G.G.K. Setten. Investigation scheme for growth and increment studies in Johore mangrove forest. Malayan Forester 16 (40). 1953.

Barnett, E. C. The Fagaceae of Thailand and their geographical distribution. Trans. Bot. Soc. (Edinburgh) 33 (3): 327-343. 1 map. 1942.
A systematic treatment with keys to genera and species, but there is no separate treatment of species.

Bates, M. Observations on the Distribution of Diurnal Mosquitoes in a Tropical Forest. Ecology 25: 2: 159-170. 1937.

Workers in Brazil and Colombia have long felt that the mosquito Haemagogus capricornii might be the chief vectór of jungle yellow fever. The Villavicencio area of eastern Colombia is definitely of the rain forest type, with a total precipitation of between 160 to 200 inches (4 or 5 m.) annually. The author gives the average temperatures of the general area and the forest temperatures; a description of the forest areas in which the studies were made; methods of study; distribution of Haemagogus capricornii.

This vector has been found to be relatively more abundant in the forest canopy than at ground level. In captures made at ground level, it appears to be more abundant in open and dry sites. Above the ground level with maximum density of the forest canopy the species is again relatively scarce.

The zonal distribution of this mosquito is most marked during the wet season, and it becomes relatively more abundant at ground level towards midday on a clear day after a succession of clear days, and during the dry season. From these data, it would seem that avoidance of zones of high relative humidity may be the determining factor in the flight orientation of the mosquito.

Thirteen references are included.

Baudesson, H. Indochina and its Primitive People (Transl. by E. Appleby Holt). 328 pp. illustr. E. P. Dutton & Co. New York.

This interesting publication, written in popular style, is divided into two parts. The first part contains 10 chapters, dealing with the Moi, their industries and occupations; family and social life; religious beliefs, rites, and superstitions; art and culture; and intellectual life. The second part, with 5 chapters, treats with the social and family life of the Cham, and their rites and superstitions.

Bauer, P. T. The rubber industry: A study in competition in monopoly. 404 pp. Harvard Univ. Press. 1948.

Bay, J. C. Bibliographies of botany. A contribution toward a bibliotheca bibliographica, compiled and annotated. Progr. Rei Bot. 3: 331-456. 1909.

Issued by the Association Internationale des Botanistes.

Beard, J. S. Climax vegetation in Tropical America. Ecology 25 (2): 127-158. 23 figs. April 1964.

This is aimed at correlating the vegetation of Trinidad with that of mainland tropical America. Only climax communities are considered. The writer classes as 'climax' any community which is apparently stable, mature and integrated, and has relegated to the status of 'seral' any community which is patently in a state of change, development or transition. A climax type is relatively permanent under the given conditions. The writer treats with: floristic; physiognomic; and habitat groups. Beard arranges formations into 5 'Formation Series', summarized in tabular form, within each of which there are

structures and life-forms, expressing every degree of transition from optimum to extreme adversity for a single major type of habitat. The following names are suggested: (a) Seasonal formation; (b) Dry Evergreen formation; (c) Montane formation; (d) Swamp formation; and (e) Marsh or Seasonal-swamp formation.

Detailed descriptions are given of 24 formations of which a summary appears in table 1. Tentative correlations with the nomenclature of Schimper, Shantz and Barbour are given in tables II, III, and IV. An analytical key for the recognition of formations in the field is given in table V. Literature cited contains 43 references.

Beckett, W. R. D., et al. Streblus paper (Streblus asper Lour.). Kew Bull. Misc. Inf. 1888: 81-84. 1888.

Report on its source and manufacture in Thailand.

Becking, R. W. Forest Photo Interpretation. Commission VII on Photo Interpretation. Working Group on Forestry Applications - Annual Report 1960. Selected Bibliography. Photogrammetric Engr. 27 (4): 648-653. Published by the American Society of Photogrammetry. 1961.

Bègué, L. La Première Session de la Sous-Commission du Teck de l'Organisation des Nations-Unies pour l'Alimentation et l'Agriculture a Bangkok (Thailand). Bois et Forêts des Tropiques. 48: 7-19. illustr. 1 map. July-Aug. 1956.

The first session of FAO Teak Commission was held in Bangkok during Feb. 9-18, 1956. Its objective was to promote, on an international scale, the study of the many problems related to silviculture, use, production, and trade of Teak wood.

Papers presented by representatives of several countries made it possible to obtain a first-hand opinion on the position of Teak in the world market. An agenda was prepared for the work so that every section could investigate the various problems.

An excursion organized for the conference, enabled the members to obtain a picture of the forest problems prevailing in Thailand, especially in those areas where stands of Teak predominate.

Beller, S., and P. Bhenchitr. A preliminary list of insect pests and their host plants in Thailand. Tech. Bull. 1: 68 pp. Dept. Agr. and Fish. Thailand. 1936.

The chief aim of this publication is to present a preliminary list of insect pests and their hosts in Thailand, with notes on their injury, miscellaneous foods, and utilization of the host plants. Records were kept of the hosts and their insect pests from 1929 up to the time of publication, and this paper is a summary of that work.

Belshaw, H. I., and J. B. Grant. Mission on community organization and development in South and Southeast Asia. UN Series on Community Organization and Development. New York. 1953.

Bergsmark, D. R. Economic geography of Asia. Prentice-Hall. New York. 618 pp. 1935.

Bernard, H. Pour la compréhension de l'Indochine et de l'Occident. Cathasia. 196 pp. Paris. 1950.

Bernard, P. Le problème economique indochinois. Nouvelles Editions Latines. 424 pp. Paris. 1934.

Bertrand, A. Les produits forestiers de l'Indochine. Au Service de la Défense Nationale. Gouvernement Général de l'Indochine Série Saigon. Bulletin No. 13. 18 pp. Saigon. 1918.
Discusses some of the major timber species and minor forest products of Indochina.

Bertrand, P. Compte-rendu des travaux au Cabodge, 1949. Pt. 2. Station Pilot-Ferms Experimentale de Véal-Trá, Battambang. Archives de l'Office Indochinois du Riz. No. 33. 60 pp. 1951.
Les conditions de la culture du riz dans le Haut-Donnai (Vietnam). L'Agron. Trop. 7: 266-275. 1952.

Bhodisaro, C. A method of rice cultivation in southern Thailand. Kasikorn 23 (1): 32-34. Bangkok. 1950.

Bhojakara, P., and P.C. Kashetra. A compilation of the Results of Experimental Work on Rice. 94 pp. (Mimeographed). Department of Agriculture. July 1947.
This is a summary of the results of experimental work on rice, at Rangsit farm and elsewhere in Thailand.
This preliminary report was submitted to members of the FAO, on the occasion of their visit to Thailand in July 1947.

Bisson, R. Influence de la fumure et de la taille de formation sur la production du théier. L'Agron. Trop. 6: 115-146.

Blanck, E., W. Credner and E.V. Oldershausen. Contributions to the knowledge of chemical weathering and soil formation in Siam. An English translation by Robert L. Pendleton of: Bertrange Zur Chemischen Verwitterung and Bodenbildung in Siam. Chemie der Erde 9, 419-452. 1935. Technical Bulletin No. 2; 60 pp. Department of Agriculture and Fisheries, Bangkok. August 1937.
An interpretation of chemical analysis of the soil samples collected by Credner. The views expressed by Blanck differ from those advanced in 1935 by Credner.

Bloembergen, S. A revision of the genus Alangium. Bull. Jard. Bot. Buitenzorg Ser. III. 16 (2): 139-235. F. 1-10 (Apr.). 1939.
Includes species from Thailand.

Blondel, F. L'erosion en Indochine. Comptes-rendus 13th Inter. Géogr. Congr. (Paris) 2: Travaux de la Section II. Librarie A. Colin. Paris. 659-666 pp. 1931.

Blumenstock, D. I., and C.W. Thornthwaite. Climate and the World Pattern. Yearbook of Agriculture 1941. pp. 98-127. figs. 9. Washington, D. C. 1941.

Three great patterns dominate the earth and are of tremendous importance to man - that of climate, vegetation and the pattern of soils. When the three are laid one upon another, their boundaries coincide to a remarkable degree because climate is the fundamental dynamic force shaping the other two. The relationships between these patterns have been the object of considerable scientific study, and some of the results are broadly outlined by the authors. A fourth pattern, laid upon the three, is that of human culture, or civilization. Although modern man has some freedom to vary this pattern because of his control of the other factors, he too cannot go beyond certain limits set fundamentally by climate.

This article presents a concise discussion of the climate pattern; climate and vegetation; climate and soils; climate and weathering; climate, natural erosion, and minor land forms; climate and accelerated erosion; climate and land utilization; and climate and landscape.

Literature cited contains 26 references.

Boon, D. A. Maatregelen ter verzekering van de productie mogelijkheden der bosschen in de Buitengewesten. Tectona 31. 829-846. English Summary. 1939.

Boonbongkarn, C. A method of marcoting pepper vine. Kasikorn 26 (2): 225-228. Bangkok. 1953.

______. Cultivation and canning of bamboo shoots. Kasikorn 26 (16): 608-612. Bangkok. 1953.

______. Pepper growing in Chantaburi. Kasikorn 23: 183-190, 295-303, 351-357. Bangkok. 1950.

______. Rice variety trials. Kasikorn 23 (4): 295-303. Bangkok. 1950.

Boon-long, N. Improving Thai lac industry. Kasikorn 25 (3): 190-198. Bangkok. 1952.

Boonyaketu, T. The present marketing system of Durian Suan. Kasikorn 25 (1): 16-23. Bangkok. 1952.

Bourke-Borrowes, D. Some miscellaneous notes on big trees in Thailand. Indian For. 53 (6): 315-327. pl. 6,7. (June.) 1927.

Concerns individual trees.

Bourret, R. Etudes géologiques sur le nord-est du Tonkin. Bull. du Service Géologique de l'Indochine 11, pt. 1. 326. pp. 1922.

______. Etudes géologiques dans la region de Pak-lay, Moyen Laos. Bull. du Service Géologique de l'Indochine 14, pt. 2. 178 pp. 1925.

Bouvier, A. Situation des plantations francaises du thé Indochine. Rev. Inter. Produits Colon (Paris). pp. 53-57. Abstr. in L'Agron. Trop. 4: 665. 1949.

Braak, C. Klimakunde von Hinterrindien und Insulinde. In Köppen, W., and Geiger, R., (eds.). Handbüch der Klimatologie 4, pt. R. Transl. by Weather Inform. Branch, Hdqtrs. Army Air Force. March 1943. U. S. Navy reprint. Washington, D. C. 1944.

Braemer, P. Quelques aspects de la riziculture au Tonkin. Proc. 4th Pacific Sci. Congr. 4: 529-559. 1930.

Brandis, D. An enumeration of the Dipterocarpaceae, based chiefly upon the specimens preserved at the Royal Herbarium and Museum, Kew, and the British Museum; with remarks on the genera and species. Journ. Linn. Soc. Bot. 31: 1-148. pl. 1-3. 1895.
Includes eastern Asiatic species.

______. Indian trees; an account of trees, shrubs, woody climbers, bamboos and palms indigenous or commonly cultivated in the British Indian Empire. i-xxiv, 767 pp. 201 figures. 1906.
A comprehensive manual, including many species of neighboring areas.

Brown, G. F., S.Buraves, J. Charaljavanphet, N. Jalichandra, W. D. Johnston, Jr., V. Sresthaputra and G. C. Taylor, Jr. Geological Reconnaissance of the mineral deposits of Thailand. U. S. Geological Survey Bull. 984. 184 pp. 20 pl. 51 figs. 1951.
This publication contains a wealth of useful information. For the general reader, the first 50 pages are the most useful and treat with the geography, physiography, and geology of Thailand. The geological map, plate 5, is almost on the same scale as the widely-used provisional soil and rock map by Pendleton.

Brown, F. G. Forest Trees of Sarawak and Brunei. 370 p. Govt. Printing Office, Kuching. 1955.

Brown, W. H. and A. F. Fischer. Philippine Mangrove Swamps. Dept. of Agric. and Natural Resources, Bureau of Forestry Bull. 17. Manila. 1918.

Brun, W. A., H.A. Cruzado, and T. J. Muzik. The Chemical Defoliation and Desiccation of Tropical Woody Plants. Tropical Agriculture 38 (1): 69-81. Jan. 1961.

Fifty one different formulations were tested for their defoliation or desiccation and discoloration effects on 25 species of tropical woody plants. Thirty-seven of the formulations acted primarily as defoliants and 13 caused dessiccation or discoloration of the leaves to which they were applied.

The most effective defoliant formulations were those containing butyne 1,4-diol, tributyl phosphorotrithioite or mixtures of these two compounds. Mixtures were found to be more effective than either of the components by themselves. One formulation, containing a mixture of these two active ingredients, gave an average of 82 percent defoliation one week after application on 16 trees tested in the Mayaguez area. Although not all formulations were tested in both areas, defoliation appeared to be more easily attained in very dry region on the south coast of Puerto Rico than in mesophytic area around Mayaguez.

Of the 13 formulations showing desiccating activity, tributyl phosphate clearly stands out as the most effective. Within one week after its application, tributyl phosphate caused 100 percent desiccation or discoloration of the leaves of 14 of the 16 trees tested.

Experimental evidence was obtained showing that the primary path of entry of both defoliating and desiccating formulations was through the stomatal openings.

The effect of brief shower falling shortly after the application of defoliants and desiccants was determined. It was found that rain falling 5 minutes after the application of tributyl phosphate did not reduce its effectiveness as a foliar desiccant. Rain falling 5 and 30 minutes after the application of two different defoliant formulations reduced their effectiveness on one of the two species tested.

Bruzon, E., and P. Carton. Le climat de l'Indochine et les typhons de la Mer de Chine. Impr. d'Extreme-Orient. Hanoi. 310 pp. 1930.

______., and A. Romer. Le Climat de l'Indochine. Haut-Commissariat de France ou Indochine. Service Météorologique. Impr. d'Extreme-Orient. 160 pp. Saigon. 1950.

Bulletin Economique de l'Indochine. Nos. 128-139. Hanoi - Haiphong. 1918 - 1919.

These numbers contain a series of articles, by different specialists, on economic crops of Indochina.

Bunpatham, S. Cashew nut. Kasikorn 23 (6): 426-433. Bankgok. 1950.

Buranatep, P. Some aspects of rice cropping. Kasikorn 23 (6): Bangkok. 1950.

Buravas, S. Preliminary notes on the geology of Thailand. Thai Science Bulletin 7 (1): 7-43. Bangkok. June 1952.

The physical features and morphology of the various physiographic regions of Thailand is given, as well as a discussion of the climate and vegetation. There are 19 references.

Burkill, I. H. Begonia hanifii, a small tuberous species of the islands of Lankawi. Journ. Str. Br. Roy. Asiat. Soc. 79: 103-104. 1 fig. 1918.
A new species of Begonia is described.

______. Botanical collectors, collections and collecting areas in the Malay Peninsula. Gard. Bull. Straits Settlem. 4: 113-302. 1 map. 1927.
Includes notes on some collectors in Thailand.

______. A dictionary of the economic products of the Malay Peninsula. 2 volumes. (1, i-xi, 1-1220; 2, 1221-2402). London. 1935.
A comprehensive reference work on economic plants, including many products of Thailand.

______., and F. W. Foxworthy. Notes on Dipterocarps. No. 6. On the genus Pachynocarpus. Journ. Str. Br. Roy. Asiat. Soc. 85-86: 271-280. f. 1-9. 1922.
Cites a few species of Vatica and Pachynocarpus from southern Thailand.

Burma Forest Service. Silviculture and management of mangrove forests of Burma. Paper presented to the Second Session Asia-Pacific Forestry Commission, Singapore. 1952.

Burtt Davy, J. The classification of tropical woody vegetation-types. Institute Paper, No. 13. 85 pp. Imp. For. Inst., Oxford Univ. 1938.

Butarobol, C. Baccaurea leaf-eating caterpillar. Kasikorn 27 (3): 231-235. 1954.

______. Castor oil plant-pest control. Kasikorn 25 (4): 289-294. Bangkok. 1952.

______. Field crabs. Kasikorn 26 (5): 535-541. 1953.

______. Rat control for coconut plantation. Kasikorn 25 (6): 465-467. Bangkok. 1952.

Calder, C.C., V. Narayanaswami, and M.S. Ramaswami. List of species and genera of Indian phanerogams not included in Sir J.D. Hooker's Flora of British India, arranged in alphabetical order. 1906-1924. Rec. Bot. Surv. India 11 (1): 1-157. 1926.
Supplemental to Hooker's fundamental flora of regions adjacent to Thailand on the west.

Calder, R. Men Against the Jungle. 231 pp. George Allen and Unwin, Ltd. 1954.
One chapter is devoted to the work of the World Health Organization and UNICEF in Thailand.

Callard, G. F. L'Indochine: géographie, histoire, mise en valeur. Edition Notre Domaine Colonial. 124 pp. Paris. 1922.

Cambodian Forest Service. Silviculture of the forests of Cambodia - mangrove. Paper presented to the Third Session, Asia-Pacific Forestry Commission, Tokyo. 1955.

Camus, A. Les Chênes. Monographie du genre Quercus. 2 volumes. 1 map. 1: 686 pp. 35 figs. 1934-38; 2: 830 pp. 59 figs. 1938-39. Paris. 1934-39.
Includes Thai species of oaks.

Capus, G. La production du thé en Indochine. Gouv. Gén. de l'Indochina. Publ. de l'Agence Economique No. 26. 26 pp. 1930.

Cardot, J. La culture du caoutchouc en Indochine et la crise mondiale. Gouv. Gén. de l'Indochine. Publ. de l'Agence Economique No. 27. 21 pp. 1931.

Carle, E. L. Le riz en Cochinchine. Etude agricole, commerciale, industrielle, avec diverses notes concernant cette culture dans le monde. 346 pp. 1933.

Carter, A. C. (ed.) The kingdom of Siam. 280 pp. illustr. G. P. Putnam's Sons. 1904.
This publication was prepared by officials in various Departments of the Thai Government. While it is not intended to present a full description of the country and its people, the contents are an accurate review of conditions as they existed 60 years ago. The articles were written during 1903 and the statistics cited refer to the period up to that year. Because of lack of a standard transliteration of Thai characters, each author has followed his own system.
Two of the 19 chapters are devoted to agriculture and forestry.

Catinot, R., and G. Ve Saint-Aubin. Utilisation des photographies aeriénnes sans point au sol en cartographie forestiére. Bois et Forêts des Tropiques. 69: 17-25. illustr. Jan.-Feb. 1960.
The authors discuss a problem with which investigators of tropical forests are much concerned, namely the transformation, without the aid of ground reconnaissance, of aerial photographs into maps utilizable by foresters, lumber operators and others. Methods are outlined, provided at least two astronomical points exist within the zone photographed. The cost of application has been worked out, and does not seem to be prohibitive in consideration of the usefulness of the data which these methods provide.

______., and J. Leroy-Deval. Essai de destruction de la forêt dense par empoisonment au Gabon. Bois et Forêts des Tropiques. 69: 3-25. illustr. Jan.-Feb. 1960.

Tests were made in Gabon, West Africa, on the destruction of dense forests by poisoning. At the time it was considered that phytohormones seemed to be the most practical substances for poisoning trees. The technique of spraying on the bark gave mortality rates of 60 to 65 percent, which was regarded as insufficient. Tests were made also by spraying the phytohormones on blazes, barked strips, and on Malay notches. Mortality exceeded 60 percent with the last two methods. Spraying on Malay notches was preferred as being the easiest and cheapest.

Carton, P. La météorologie agricole en Indochine. Impr. d'Extreme-Orient. 15 pp. Hanoi. 1930.

Castagnol, E. M. Comparaison des differents types de rizières. Bull. Econ. de l'Indochine. 755B-759B. 1932.

______. Le Sol, étude théorique et pratique. Impr. d'Extreme-Orient. 264 pp. Hanoi. 1942.

______., and Ho-Dac-Vy. Etude comparative des principaux types de sols en place du nord de l'Indochine. Gouv. Gén. de l'Indochine. Inst. Recher. Agron. Compte-Rendu des Travaux. pp. 175-212. 1923-33.

______., and Pham-gia-Tu. Etude des textiles du nord de l'Indochine. Archives Inst. Recher. Agron. Indochine. No. 6-35 pp. Abstr. in L'Agron. Trop. 6:537. 1951.

______., and Nguyen Cong Vieu. Etude de la flore macrobienne des sols du Tonkin. Archives Recher. Agron. au Cambodge, au Laos et au Vietnam. No. 11. 55 pp. 1951.

______. Contribution à l'étude des terres rouges basaltiques et dacitiques des hauts-plateaux du sud de l'Indochine. Archives Recher. Agron. au Cambodge, au Laos et au Vietnam. No. 12. 123 pp. 1952.

Cero, M.M. Preliminary studies of certain physical properties of some Siamese Soils. Siam Science Bulletin 1 (2): 1-27. Sept. 1938.
The samples used in this preliminary study were collected in widely scattered parts of Thailand. One table indicates the sticky point, rolling-out-limit, and the non-sticky plastic range of the samples.

______. Preliminary survey of the lands and soils in relation to the cultivation and production of Virginia tobacco in Changwad Chiengrai, Thailand. Thai Science Bulletin 1 (4): 36 pp. 2 maps. illustr. Oct. 1939.
This presentation is a comparative description of the lands and soils of Changwad Chiengrai in relation to the cultivation of Virginia tobacco as covered in the survey of the valley from Chiengmai to northern border in Amphur Mae Sai. The survey was conducted

during April 11 to 18, 1939, in an area of approximately 900,000 'rai', of which about 25 percent was cultivated to Virginia tobacco.

Champion, H. G. The effect of defoliation on the increment of Teak saplings. Forest Bulletin No. 89 (Silviculture Series). 6 pp. 1 table. Delhi. 1934.

Teak is exceptionally liable to defoliation by Lepidepterous larvae, particularly by the skeletonising Hapalia machaeralis and the defoliating Hyblaea puera. Instances are on record of the death of saplings from repeated defoliation, but larger trees respond by producing successive flushes of new leaves and death rarely, if ever, results from the attacks.

The defoliated plantations are a most depressing sight and measures to control the insects appear an urgent necessity. Such control measures have been under trial at Nilambur and other sites for a number of years.

______. A preliminary survey of the forest types of India and Burma. Ind. For. Rec. 1 (1). 1936.

______. The effect of defoliation on the increment of teak saplings. Forest Bulletin No. 89 - Silviculture series. India. 6 pp. 1934.

Champsoloix, R. La Forêt des pays montagnards du Sud Vietnam et ses produits. Bois et Forêts des Trop. 40: 3-12. 1955.

______. Le Pin a 3 feuilles du Langbian (Pinus khasya Royle). Bois et Forêts des Tropiques. 57. 3-11. illustr. Jan.-Feb. 1958.

The Pines (Pinus) are represented in the uplands of South Vietnam by 4 species, including the 2-needled Pinus merkusii and the 3-needled Pinus khasya.

These two species occur over large areas in the highlands of South Vietnam, and are a source of certain forest products of some importance. This article treats almost exclusively with Pinus khasya. It covers a wide area of Langbian Mountain, in South Vietnam, growing at altitudes of between 1,000 and 1,700 m. (3,300 - 5,500 ft.). The properties of its wood make it particularly suitable for paper-making. This was the objective in parceling out the Langbian plantation for the production of billets for the paper industry. The author describes the ecological characteristics of this pine; the climate and soil in the region of its growth; and its behavior in relation to other species.

Chandravekin, P. Hydrogenation of volatile oil distilled from Gurjun balsam. Thai Science Bulletin 7 (1): 1-6. Bangkok. June 1952.

This article deals with Gurjun balsam obtained from the 'yang' tree (Dipterocarpus alatus), a liquid containing volatile oils and resins. Its general properties are given. Nine references are included.

Chapman, V.J. The application of aerial photography to ecology as exemplified by the natural vegetation of Ceylon. Indian Forester 73 (7): 287-314. 1947.

In this paper an attempt is made to give a brief account of some of the different vegetation types of Ceylon as seen from the air and on the ground. Points of interest that arise from air photographs are indicated, especially where they can be of definite ecological value. This study can only be regarded as preliminary in nature because time factor did not permit more detailed work. Some conclusions may have to be modified, but the general interpretation probably will remain valid.

Charoenrat, S. Weeds in floating rice field. Kasikorn 25 (4): 306-311. Bangkok. 1952.

Charuprakorn, S. Papaya latex. Kasikorn 23 (1): 46-55. Bangkok. 1950.

Chatot, J. La culture du café en Indochine. Impr. d'Extreme-Orient. 214 pp. Hanoi. 1939.

Chepsithar, S. Thailand's teak exports. Bangkok Chamber of Commerce Journal 9 (3): 3. 1955.

Chevalier, A. Premier inventaire des bois et autres produits forestiéres du Tonkin. Extrait du Bulletin Economique de l'Indochine, Nouvelle Série, Nos. 131-132, Juillet-Octobre 1918 et No. 137, Juillet-Août 1919. 227 pp. Hanoi-Haiphong. 1919.

The first part is devoted to a discussion of the forests as they existed up to 1919, and those of the future, in relation to their composition, production, conservation, management and exploitation.

The second part contains a brief description of the principal woods of Tonkin, arranged according to family, genus and species, and their respective vernacular names.

The third part is a treatment of such secondary forest products as bamboos; palms; tannin-producing plants; dye sources; resin and turpentine sources; wood-oil and resin from Dipterocarps; lac; oleo-resin and Canarium; liquidambar; benzoin; indigenous rubber sources; forest resources for the manufacture of paper pulp; forest oil seeds; essential oil plants; wood and bark for mucilage; wild tea; and other forest resources.

The report concludes with 2 tables. One indicates the density of selected woods from Tonkin, with their botanical indentification and corresponding Annamite name; and the other, the density of planks cut from logs, 4 years after felling, made at the arsenal in Hanoi in 1918.

Alphabetical lists of the scientific and vernacular names of the woods of Tonkin are included.

_____. Sur un groupe de plantes insecticides; les Stemona d'Indochine.

Rev. Bot. Appl. 17: 136-137. 1937.
Includes references to the occurrence of insecticidal plants in Thailand.

______. La situation de la culture du tabac dans les pays d'Indochine. Rev. Inter. de Bot. App. et d'Agr. Trop. 33: 348-353. 1953.

Cockerell, T.D.A. The flora of Doi Sutep, Thailand. Torreya 29(6): 159-162. 1929.
An account of a botanical trip from Chiengmai up the mountain Sutep.

Collenette, P. A. Physiographic classification of North Borneo. Journ. Trop. Geography. Vol. 17. pp. 28-33. May 1963.
The study of the physiography of North Borneo had not received much consideration until recent years. Only a decade ago Reinhard and Wenk observed that "A student of geomorphology would find North Borneo a most interesting country." A few significant facts have come to light, but the inaccessability of the country, the lack of adequate maps, and perhaps chiefly the fact that the traveller in the jungle of Borneo rarely gets a view of the country to be explored, render morphological studies very difficult. Since 1950, however, most of the country has been mapped geologically, using ground surveys and aerial photographs. The tentative classification suggested in this paper is based on such materials, on verbal accounts by colleagues in the British Borneo Geological Survey, and on ten years of personal experience in the country.
North Borneo is divided into four main physiographic regions: the Western Lowlands; the Western Cordillera; the Central Uplands; and the Eastern Lowlands.
The lowland regions are defined as those areas which are less than 1,000 ft. (300 m.) above sea-level. They include hills, plains, deltas and islands. The western Cordillera consists of a number of sub-parallel mountain ranges and associated inter-mountain plains, resulting from the folding and uplift of the northern part of the tertiary geosyncline of northwest Borneo. The Central Uplands consist of a large complex area of rugged terrain, generally more than 1,000 ft. (300 m.) above sea level. Each region is further subdivided. Some of the sub-regions are single morphological entities, such as the Kaindangan peneplain; some are groups of similar features, such as the Eastern Deltas; and others, such as the Labuk Highlands, are morphologically complex.
The paper contains 1 figure and 7 references.

Colwell, R. N. Use of aerial photographs in forest recreation. Photogrammetric Engineering 16 (1): 21-31. March 1950.
Workers engaged in forest recreation, like those in other fields, have only begun to explore the possibilities for making advantageous use of aerial photographs.

Cooper, F. G. Munsell manual of color. Defining and explaining the fundamental characteristics of color. 35 pp. Published by Munsell Color Company, Inc., Baltimore, Md. Oct. 26, 1938.

This set of student charts contains twenty hues. The colors regularly come in separate small envelopes, one for each chart, and have been pasted on blank charts. The notation is explained in the Manual.

This booklet contains all of the 400 regular colors of the Munsell system. Several series of special colors that do not appear in this book are also available from the Munsell Color Company. To protect the color chips, each chart is covered with thin cellophane. While this changes the appearance slightly, it does not impair the usefulness of the book for library references. If color charts are to be used regularly in matching particular products, the necessary charts may be purchased either separately or in sets.

Corner, E.J.H. Notes on the systematy and distribution of Malayan phanerogams, IV: Ixora. Gard. Bull. Straits Settlement. 11: 177-235. 1941.

A systematic treatment of Ixora with a key; cites specimens from Thailand.

______. Wayside Trees of Malaya, Vol. I. 772 pp. 259 text figs. Govt. Printing Office, Singapore. (2nd Ed.) 1952.

This large reference contains descriptions of about 950 species of trees growing in gardens, orchards, rice-fields, waste ground, along seashores, riverbanks, roadsides and in secondary growth both in the lowlands and in the mountains.

Of approximately 8,000 species of flowering plants in Malay, at least 2,500 are trees growing in the forest at a ratio of 100 genera to the acre. To describe so many accurately is impossible except in hard scientific terms. The author has therefore limited the subject to trees commonly found outside the high forest. Forest trees have been omitted on principle because they are so numerous and cannot be classified without recourse to their detailed botanical structure. The greater part of the book deals with flowering plants. Palms, cycads, bamboo, pandans and tree-ferns have been omitted.

The introductory part outlines the method of arrangement and selection of Malay names; method of giving specific descriptions; how to identify a tree; a key to some common flowering trees; terms used; general remarks about trees; and a succint treatise on Malayan vegetation.

The remarks accompanying the descriptions have been limited to the biological aspect of trees, and only a passing reference is made to their history, cultivation and economic uses, because these have been exhaustively compiled by Burkill.

Drawings are also included of many characteristic fruits. Fallen fruits often supply the only ready means of identifying large trees, such as oaks, chestnuts, dipterocarps, figs, mangosteens, nutmegs, and others.

Couey, M. and Truong-van-Hieu. Etude de quelques charactéres quantitatifs en relation avec le facteur rendement chez le riz. Archives de l'Office Indochinois du Riz. No. 34. 90 pp. 1951.

______. Le riz. Etude botanique, génétique, physiologique, agrologique et technologique appliquée a l'Indochine. Archives de l'Office Indochinois du Riz. No. 30. 312 pp. 1950.

Couffinhal, M. La Situation actuelle des Forets de la Cochinchine. Gouvernement Général de l'Indochine Série Saigon Bulletin No. 8. 30 pp.
Appendix contains a list of the principal timber species growing in the upper altitude of Cochinchina, now part of South Vietnam.

Craib, W. G., and others: Contributions to the flora of Thailand. Kew Bull. Misc. Inf. Additamenta (I) 1912: 144-155. (II) 264-269. (III) 1913: 65-72. (IV) 199-204. (V) 1914: 4-11. (VI) 1915: 122-132. (VII) 279-285. (VIII) 1915: 419-433. (IX) 1916: 259-269. (X) 1918: 362-371. (XI) 1920: 300-305. (XII) 1922: 165-174. (XIII) 225-241. (XIV) 1924: 81-98. (XV) 1925: 7-23. (XVI) 367-394. (XVIII) 1926: 154-174. (XIX) 337-363. (XX) 1927: 56-72. (XXI) 164-174. (XXII) 212-220. (XXIII) 374-395. (XXIV) 1928: 62-72. (XXV) 234-237. (XXVI) 1929: 105-119. (XXVII) 1930: 161-174. (XVIII) 313-327. (XXIX) 405-427. (XXX) 1931: 206-221. (XXXI) 275-280. (XXXII) 441-448. (XXXIII) 1932: 137-149. (XXXIV) 276-289, (XXXV) 330-338, (XXXVI) 425-437, (XXXVII) 475-486. (XXXVIII) 1933: 18-30. (XXXIX) 1935: 326-335. (XL) 1936: 34-47. (XLI) 1937: 26-44, (XLII) 71-75. Figs. 1.2, (XLIII) 87-94, (XLIV) 371-392. (XLV) 505-510. (XLVI) 1938: 24-32. 1 fig., (XLVII) 98-106. (XLVIII) 127-133. (XLIX) 199-209, (L) 445-454. 1 fig. (LI) 1939: 109-150. (LII) 456-465. (LIII) 1940: 180-186. (LIV) 1941: 8-21. 1912-1941.
Critical notes and new species. This is a continuation of contributions by Craib (1911-1912). Parts XVI and XVII are by D. G. Downie and include manuscript descriptions by R. A. Rolfe. Part XXI is by E. T. Geddes. Beginning in 1935 A.F.G. Kerr edited and added descriptions to this series after Craib's death in 1933. H. R. Fletcher contributed much of parts XLI and XLII. J.B. Imlay contributed Part LI. Various others contributed descriptions.

Craib, W. G. a. Pittosporopsis kerrii Craib. Icacinaceae. Tribus Icacineae. Hook. Icon. Pl. 30: pl. 2977.
Cites Kerr 558, 558 A from Chiengmai.

b. Murtonia kerrii Craib. Leguminosae. Tribus Hedysaraae. Hook. Incon. Pl. 30: pl. 2979.
Cites Kerr 1934 from Chiengmai.

c. Styrax benzoides Craib. Styracaceae. Hook. Icon. Pl. 30: pl. 2999.
Cites Kerr specimens from Chiengmai.

______. Orophea polycarpa and Artabotrys burmanicus. Kew Bull. Misc. Inf. 1915: 433-535.
A systematic treatment of these genera, citing Thai specimens.

______. Some new species from Thailand. Gard. Chron III. 72: 363: (Dec. 23). 1922.
Four new horticultural introductions by Kerr: Stephania erecta, Petrocosmea kerrii, Didymocarpus waltiana n. sp., described in Latin, and Barleria siamensis.

______. Six new flowering plants from Siam. Journ. Nat. Hist. Soc. of Siam 6 (1): 43-46. 1909.
Four Annonaceae, 1 Menispermaceae, and 1 Violaceae from collections of Eryl Smith are described.

______. Florae Siamensis enumeratio. A list of the plants known from Thailand with records of their occurrence. 2 vols. Bangkok. 1 (Polypetalae) 1-809, index 1-6, 1 folded map. 1925-31; 2 (Gamopetalae) 1-476, 1932-39 (incomplete). The Bangkok Times Press. 1925-39.
Contains distribution records, critical notes, local names, new varieties, and transfers. As far as completed this was the most complete enumeration of Thailand plants up to that time. Edited by A.F.G. Kerr after Craib's death in 1933. See also Kerr, A.F.G., 1925.

______. a. Some new Thailand Begonias. Gard. Chron. III 83: 66-67. 1928.
Five new species described.

b. Some new Thailand plants. Gard. Chron. III. 83-140. New species of Sonerila and Chirita - new to cultivation. 1928.

______. The Flora and Vegetation of Thailand. Mid-Pacific Mag. 41 (4): 328-335, 1 pl. April 1931.
A popular account of Thai plants, chiefly in the Bangkok region.

______.a. Xylia Kerrii Craib et Hutchinson. Leguminosae, Tribus Adenantherae. Hook. Icon. Pl. 30: pl. 2932. 1911.
Refers to Kerr 547 from Chiengami, at foot of Doi Sutep.

______. b. Phyllanthodendron roseum Craib et Hutchinson. Euphorbiaceae. Tribus Phyllantheae. Hook. Icon. Pl. 30: pl. 2935. 1911.
Refers to Kerr 697 from Chiengmai.

______. Contributions to the flora of Thailand. Dicotyledons, Univ. Aberdeen Studies 57: 1-210. 1912; (Monocotyledons) 61: 41 pp. 1913.
This is a republication, with rewritten introduction; increased or added bibliography; and an index.

Craighead, F. C. Some effects of artificial defoliation on pine and

larch. Journ. of Forestry 38 (11): 885-888. 1940.

Credner, W. Grundzuge einer Gliederung Siams in seiner Teillandschaften. Geog. Zeitschrift 36 (4): 193-211, 273-292. 1930.

______. Siam: das Land der Tai; eine Landeskunde auf Grund eigener Reisen und Forschungen. i-xvi, 1-422. illustr. 1935.
The vegetation is well described in 'Ill. Die Naturlandschaft.' Includes a bibliography.

Dal, C. La forêt vietnamienne. Rev. Inter. des Prod. Colon. et du Materiel Colon. 30: 99-101. 1955.

Danser, B. H. On the taxonomy and the nomenclature of the Loranthaceae of Asia and Australia. Bull. Jard. Bot. (Buitenzorg) Ser. III, 10 (3): 291-373. Nov. 1929.
Consists of new systems with keys to genera for Elytranthinae and Hypheatinae (Loranthinae) and nomenclature; includes many transfers, historical notes, etc.

______. The Loranthaceae of French Indo-China and Thailand. Bull. Jard. Bot. (Buitenzorg) Ser. III, 16: 1-63 pl. 1. f. 1-3. Sept. 1938.
A systematic treatment.

______. Additions to the Loranthaceae of Thailand. Bull. Jard. Bot. (Buitenzorg) Ser. III. 16 (3): 253-267. 1 f. Feb. 1940.
Additions to the preceding title.

Dansereau, P.M. Structural Units of Vegetation in Tropical and Temperate Climates with Specific Reference to Pacific Areas. Seventh Pacific Science Congress. Proceedings Vol. V: pp. 100-112. 4 figs. 2 tables. 1953.
The living environment may be approached in many ways, according to the difference in point of view, method and technique. The conclusions reflect the differences in purpose. In fact, the geographer, ecologist, taxonomist, pathologist, geneticist, and others interested in encompassing the living beings within their habitat, apply various kinds of classifications.
A brief discussion is given of floristic systems; life-forms; ecological systems; and structural or physiognomic classifications. The author discusses a new system based on structure, accompanied by diagrams of profiles of plant communities. There is also a table indicating six categories of criteria to be applied in a constructional definition of vegetation types, according to this new system.
The Bibliography lists 25 references.

Davis, J.H., Jr. The Ecology and Geologic Role of Mangroves in Florida. Carnegie Inst. Wash. Publ. Biol. Abstr. 15 (1). 1941.

Deignan, H. G. Siam--land of free men. Smithsonian Institution War Background Study No. 8. Washington, D. C. 1943.

______. The Birds of northern Thailand. Smithsonian Institution Mus. Bull. 186. Washington, D. C. 1945.

______. Checklist of the Birds of Thailand. Smithsonian Institution United States National Museum Bulletin 226. I-X: 3-263. 1 map. Washington, D. C. 1963.

This publication includes the scientific names and range of 1,173 birds of Thailand, and is complete so far as the avifauna of that country was known up to 1962.

Dept. of Agr. and Fisheries. Thailand. Annual reports of the Cotton Experiment Station at Klongtan. 1936-37, 1937-38. Bangkok. 1939.

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Dept. of Publicity (Thailand). Present-day Siam. Bangkok. 1949.

deYoung, J. E. Demographic trends in Thailand. Report of the 8th Pacific Congress. pp. 394-395. 1953.

______. Village life in modern Thailand. Univ. of Calif. Press. Berkeley and Los Angeles. 1955.

This is a synoptic account of the daily activities in a Thai village, designed to give the lay reader a picture of how a Thai peasant and his family live and work in present-day Thailand. It is also intended to show how the life of the peasant has changed in the last century, and points out some of the possibilities for the immediate future.

A bibliography and an index are included.

Dhibayakalin, L. A peculiar method of growing rice in Amphur Bang Pakong. Kasikorn 23 (2): 86-93. Bangkok. 1950.

Diels, L. Agapetes hosseanus Diels, n. sp. Repert. sp. Nov. Fedde 1: 16. 1905.

______.a. Rhododendron thailandii Diels, nov. spec. Repert. Sp. Nov. Fedde 4: 289. 1907.

Based on Hosseus 507.

b. Prunus hosseusii Diels, nov. spec., aus Thailand. Repert. Sp. Nov. Fedde 4: 289-290. 1907.

Based on Hosseus 260.

______. Heliciae novae descriptae. Repert. Sp. Nov. Fedde 13: 527-528. 1915.
Includes Helicia stricta, a new species from Thailand and China.

Dilock, P. von S. Die Landwirtschaft in Siam. 215 pp. Leipzig. 1908.
A general description of the physiographic regions of Thailand. Includes some data on economic botany.

Dixon, H. N. On the moss flora of Thailand. Journ. Thailand Soc. Nat. Hist. Suppl. 9 (1): 1-51. 1933.
A systematic treatment of new species and varieties.

______. Further contributions to the moss flora of Thailand. Journ. Thailand Soc. Nat. Hist. Suppl. 10 (1): 1-30. 1935.
An enumeration of recent collections, largely by Kerr, with 20 new species.

______. Mosses of Kaw Tao. Journ. Thailand Soc. Nat. Hist. Suppl. 8 (1): 19-21. 1934.
A systematic enumeration of a collection by A.F.G. Kerr.

Doan, K.V. Le problème des engrais dans la riziculture du Sud Vietnam. Archives de l'Office Indochinois du Riz. No. 36. 38 pp. 1952.

Dobby, E. H. G. Southeast Asia. Univ. London Press, Ltd. 415 pp. 118 maps and diagrams. London. 1950.
The purpose of this publication is to present a picture of environmental conditions and human adaptations in Southeast Asia. It provides a basic text for the student, as well as general information of interest to the sociologist, administrator, politician and businessman. It discusses the physical, environmental and social aspects of geography applicable to Southeast Asia and its people.

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Douglas, W.O. North from Malaya. Doubleday. 352 pp. New York. 1953.

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Dunn, S.T. A revision of the genus Millettia Wight et Arn. Journ. Linn. Soc. Bot. 41 (280): 123-243. Nov. 13, 1912.
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DuPasquier, R. Amelioration des plantes de grandes cultures. Proc. Fourth Pacific Sci. Congr. 4: 483-505. 1929.

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Durant, C.C.L. Growth of mangrove species in Malaya. Malayan Forester 10 (1): 3-15. 1941.

Earle, F.M. Geography of the Southeast Tropics. The Annals of the American Academy of Political and Social Science. 226. 1-8. March 1943.

A brief discussion of the geography of Southeast Asia, treated according to countries, with comments on agriculture.

Edwards, J.P. Growth of Malayan forest trees, as shown by sample plot records, 1915-28. Mal. For. Rec. No. 9. pp. 1-151. 1930.

Egler, F.E. The dispersal and establishment of red mangrove, Rhizophora mangle, in Florida. Carib. For. 9 (4): 299-310. 1948.

Evans, G.C., T.C. Whitmore and Y.K. Wong. The distribution of light reaching the ground vegetation in a tropical rain forest. The Journ. of Ecol. 48 (1): 193-204. 4 text-figs. Feb. 1960.

In March 1957 a study of light reaching the undergrowth of a Tropical Rain Forest was made in Bukit Timah Nature Reserve, Singapore. A survey of lighting conditions in this forest provides data on the occurrence of sunflecks, also on lighting conditions when the sun was shining and when obscured by cloud. These data were used to determine the pattern of light on sample plots on the forest floor under cloudy conditions. It was shown that this pattern does not vary appreciably from day to day.

The daily march of light intensity under cloudy conditions is shown to be affected by two factors - a steadily increasing maximal intensity as noon approaches and at the same time an increasing number of periods of very low intensity, because of the accumulation of dense clouds near midday on the days of observation.

The pattern on the forest floor under sunny conditions, without sunflecks, when compared with that under cloudy conditions is shown to be substantially different.

The problem of taking readings under hazy conditions, when thin wisp clouds partly obscure the sun, is considered. These are shown to approximate very closely an average to those made when the sun was shining but with no sunflecks.

The distribution of light reaching the forest floor between the three categories of cloudy conditions, hazy conditions and sunny excluding sunflecks, and the sunflecks themselves was studied for 4 hours in the middle of the day. The large contribution of sunflecks

was thus made evident, together with appreciable decrease in intensity during cloudy and rainy period at around noon.

Finally, a comparison was made between lighting conditions on two separate sample plots, showing that in the absence of sunflecks, substantially more light reached the ground vegetation on one plot than on the other, whether under cloudy or sunny conditions. The bulk of the sunflecks contributed roughly equal quantities of light to the two plots, with sufficient evidence to generalize about the incidence of very bright sunflecks, which were of rare occurrence.

Six references are cited.

Fair, A.D. No Place to Hide: How defoliants expose the Viet-Cong. Armed Forces Chemical Journal 18 (1): 5-6. March 1964.

This article reviews the use in Vietnam of commercial chemicals to defoliate, in the expectation that removal of leaves from vegetation will improve vertical and horizontal visibility, for ground detection. There is a brief review of the proposals made to defoliate areas paralleling roads which the VC harass; for the improvement of local security at field installations, strategic hamlets, and outposts.

Defoliation tests were made in an area of 8,000 acres in the Camau Peninsula of mangrove forest, mixed with coconut and nipa palm. The chemical used was a specific combination of 2,4-D and 2,4,5-T, which was coded 'Purple'. Nipa palm was the most abundant of the resistant vegetation. Approximately 60 days were required for the full effects of the herbicide to develop. Mangrove trees, however, are very sensitive to Purple, and almost complete defoliation took place within less than one week.

Fall, B.B. The Viet-Minh regime. Cornell Univ. Data Paper No. 14. Southeast Asia Program. Dept. Far Eastern Studies. 143 pp. 1954.

Fayette, S. Government works aid small rice farmers in Indochina. Far Eastern Survey 9: 143-150 pp. 1940.

Fischer, W. A. Investigations in the use of color photography for geologic purposes. 10 pages. Presented at the Third Regional Cartographic Conference of the United Nations for Asia and the Far East. Bangkok, 27 Oct.-10 Nov. 1961.

Subtle color differences in color photographs can be enhanced by printing specially designed black-and-white copies and employing image enhancement techniques for viewing black-and-white duplicates. Parts of the original photographs having similar color characteristics can be outlined electronically.

Flacourt, M. de. Possibilités du Cambodge au Point de Vue Cotonnier. Gouvernement Général de l'Indochine. Série Saigon No. 5. 29 pp. 1918.

Discusses the possibilities of growing cotton in Cambodia.

Fletcher, H.R. The Siamese Verbenaceae. Kew Bull. Misc. Inf. 1938. (10): 401-445. 1 map. 1938.
A systematic treatment, including keys and a bibliography.

______. Keys to the Siamese Species of Myrsinaceae. Notes from the Royal Botanic Garden, Edinburgh. 20 (98): 106-120. 1948.
Keys to the following Thai genera: Maesa, Aegiceras, Ardisia, Labisia, Embelia, Myrsine and Rapanea.

Food and Agriculture Organization of the United Nations. Report of the FAO mission to Siam. Washington, D.C. 1948.

______. International Rice Commission. Report of the second meeting of the Working Party on Rice Breeding: Bogor, Indonesia, April. 1951. FAO Developmental Paper No. 14. 82 pp. Rome. 1951.

______. Conference de Nuwara Eliya (Ceylan) sur l'utilisation des sols tropicaux, du 17 au septembre 1951. L'Agron. Trop. 7: 170-176. 1952.

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______. Report of the Special Technical Meeting on the Economic Aspects of the Rice Industry. Rangoon. Nov. 11-18. Rome. 1954.

______. Report of the Fourth Meeting of the Working Party on Fertilizers. Tokyo, Oct. 1954. FAO Agr. Development Paper No. 48. 1955.

______. Timber Trends and Prospects in the Asia-Pacific Region. The Role of Bamboo. pp. 91-100. Geneva. 1961.
This study was prepared jointly by the Secretariats of the Food and Agricultural Organization of the United Nations and the United Nations Economic Commission for Asia and the Far East. Bamboo calls for special attention for two reasons. It is an important component of several of the principal forest types in the Asia-Pacific region; and secondly, it serves as an alternative to other forest products in a wide range of end uses. There are between 600 and 700 species of bamboo, belonging to 60 genera of the grass family (Gramineae). The widespread use of bamboo in some countries is in fact one, although by no means the only, reason for the low consumption per head of industrial woods. This article treats with the distribution and extent of bamboos in the Asia-Pacific region; management practices and yields; production and consumption; utilization; trade in bamboo; prospects for bamboo; and conclusions.

Forbin, V. Comment le Tonkin lutte contre les inondations. La Nature. 60: 199-204. Paris. 1932.

Fosberg, R. R. On the possibility of a Rational General Classification of Humid Tropical Vegetation. Proc. Symposium on Humid Tropical Vegetation, Tjiawi (Indonesia). 34-59 pp. Dec. 1958.

In his introductory remarks, the author observes that classification is an orderly arrangement of information designed to facilitate thinking, and to aid in locating, communicating, handling and utilizing the information. While its units may represent real entities the classification itself is a mental construction. Hence there may be more than one equally valid and useful classification built to handle the same information.

Surveying the field, it is obvious that much important progress has been made in this direction, but in some respects we are still groping. Regardless of the magnitude of the task, data of significance in the study and classification of vegetation as such seem to fall readily into about the same general convenient but perhaps artificial categories, subscribed to in one formulation or another by most students of vegetation. A concise review presents the history of classification of vegetation; philosophy of classifaction; general method of classification; information and criteria considered for classification, such as physiognomy, structure, function, composition, dynamics, habitat or environmental relations, history, and degree of generalization. The author lists 25 formations into which tropical vegetation may be segregated. A list of 20 references, followed by a discussion are included.

Foxworthy, F.W. Minor Forest Products of the Malay Peninsula. Malayan Forest Records No. 2. 151-217. 1922.

The term 'minor forest products' or 'jungle produce' includes all products of the forest other than the major products, such as timber and firewood. They include a number of materials with low unit values, but are generally useful, and with an aggregate value often exceeding that of the timber furnished by the forest.

The different minor forest products of the Malayan Peninsula are considered under a series of headings: palms and palm products; gums, oils and resins, including gutta percha; wild rubber; resins, oleo-resins and wood oils; bark oils, fruit or seed oils, and essential oils; incense woods; tanning materials; dye plants and dye woods; fiber plants; poisonous plants; a lengthy list of medicinal plants; food plants from the forest; and miscellaneous products, such as vegetable and animal products.

______. Forest Reconnaissance in Malaya. Empire Forestry Journal. 3 (1): 78-79. July 1924.

Forest work in the Rain forests in the eastern tropics necessitates dealing with a large number of forms or types which are new to foresters experienced with temperate climate.

About 1905, a small coterie of foresters and botanists, working in the Philippine Islands, launched a study to develop a system of forest reconnaissance, suitable for use in the wet tropics. The system, developed by the Forest Department in the Federated Malay States, was the Strip Valuation Survey, which involved careful recording and evaluation of map notes. It was found that a one percent evaluation gave a very fair notion of the average composition of large areas. More detailed examination was necessary of areas less than 10,000 acres, or where very elaborate and expensive systems of exploration were contemplated. The author described the method used in mapping; in recording evaluation of trees; detailed plan of work in the field; and progress made in Malaya up to 1924 on the survey.

A summary is given of reconnaissance work carried out in British North Borneo and in the Malay Peninsula and the conclusions arrived at. Four tables are included, showing method of recording topographical notes; tree measurements; and statistics from block reconnaissance.

______. Commercial Timber Trees of the Malay Peninsula. Malayan Forest Records No. 3. 195 pp. illustr. 1 map. 1927.

The timber trees of the Malay Peninsula are represented by many and imperfectly known species. The need for a manual for use by forest officers and others, as an aid to identify the more important trees in the field, had long been felt. The purpose of this manual is to present in simple language, the distinguishing features for each tree-species. A concise summary is given of the characters of each commercially useful tree.

To accomplish this the author stressed the initial importance of becoming acquainted with the species furnishing timbers. Herbarium material made it possible to work out the botanical status of the respective species, as well as providing a great deal of information about their natural distribution and habitat. The relative and actual abundance of the different species was also determined. A comprehensive chart was prepared to show the known occurrence of the different commercial timbers in the various districts.

Before treating with the general characteristics of individual tree species, the author furnished a brief discussion of the geography of the region, its climate, soil and topography; also a treatment of the types of forests of the Malay Peninsula and their specific composition. The forests of Malay may be roughly grouped into: littoral, lowland, and mountain or hill forests, each of which may be separated into a series of sub-divisions.

There is a short list of references, particularly those furnishing descriptions of leaves, flowers and forests. A key is given to the principal timber trees of the Malayan Peninsula for use in the forest, with emphasis on features most apparent in the field.

Description of individual species follows a definite order of arrangement according to families, based on abundance as indicated by the enumeration survey. In each instance the common name most generally used, and alternate vernacular names, are given;

distribution; description as an aid to identify the tree in the field, based on its habit, and such characters as the bark, leaves, flowers and fruit; seedlings, whenever available; products; sylviculture; illustrations of trees, and in some instances close-up photographs of the bark, leaves, fruit and/or flowers.

A general index of family, and botanical and vernacular names of the trees described completes the manual.

______. Forest reconnaissance in Malaya. Emp. For. Journ. 22 pp. 1924.

______. Commercial timber trees of the Malay Peninsula. Mal. For. Rec., No. 3. pp. 78-86. 1927.

______., and D. M. Matthews. Mangrove and Nipa Swamps of British North Borneo. Govt. of Br. Borneo Dept. For. Bull. 3. 195 pp. 1917.

Fromaget, J. Etudes géologique de l'Indochine 16 (2): 368 pp. 1927.

______. Etudes géologiques sur le nor-ouest du Tonkin et le nord du Haut-Laos. Bull. du Service Géologique de l'Indochine 23 (1): 153 pp. 1937.

Frontou, G. Travaux sur la culture de la canne ásucre au Vietnam. L'Agron. Trop. 5: 115-137. 1950.

Furtado, C. X. Palmae Malesicae: VIII. - The Genus Licuala in the Malay Peninsula. Gard. Bull. Straits Settlement 11: 31-73. 9 figs. 1940.

Includes Thailand species with mention of range.

Gagnepain, F. J. B. Louis Pierre (1833-1905). Notice necrologique. Nouv. Arch. Mus. Hist. Nat. (Paris) 4 (8): 19-21. 1906.

Includes a bibliography of the writings of this pioneer plant explorer who worked in Thailand and Indochina.

______. Un genre meconnu: classification des Cissus et Cayratia. Not. Syst. (Paris) 1: 339-362. 1911.

Cites a few Thailand specimens.

______. Aracées nouvelles Indochinoises. Not. Syst. (Paris) 9: 116-140.

Describes many new species from Thailand.

______. Introduction. In: H. Lecomte, Flore gènèrale de l'Indochine. Tome préliminaire. pp. 13-19.1944.

Contains a discussion of vegetation and forests of Indochina.

Gaide, L. Les Stations climatiques en Indochine. Impr. d'Extreme-Orient. 49 pp. 1930.

Gairdner, K. G. Notes on the fauna and flora of Ratburi and Petchaburi districts. Journ. Nat. His. Soc. Thailand 1 (1): 27-40. 1914; 1 (2): 131-156. 1915.
A floristic description of peninsular Thailand, southwest of Bangkok.

Garabedian, S. A revision of Emilia. Kew Bull. Misc. Inf. 1924: 137-144. 1924.
Includes Thai species.

Garrett, H.B.G. On hills northeast of Chiengmai. Journ. Thailand Res. Soc. 32 (1): 37-40. 2 pl. 1940.
Geographical notes and comment on an illustration of Rhododendron microphyton.

Garry, R. J. The changing fortunes and future of pepper growing in Cambodia. 17: 133-142 pp. 7 tables. 4 figs. May 1963.
The author traces the history of the growing of pepper (Piper nigrum) in Cambodia. A brief review is given of the efforts made to grow this crop in new areas of Cambodia, especially in the western section.

Gauchou, M. Le machinisme agricole in Indochine. Machinisme Agric. (May) 6-10 pp. Abstr. L'Agron. Trop. 4: 334. 1949.

Gerini, G.E. (Compiler). Thailand and its productions, arts, manufactures. A descriptive catalogue of the Siamese section at the International Exhibition of Industry and Labour held in Turin April 29-Nov. 19, 1911.
Supplemented with historical, technical, commercial and statistical summaries on each subject. English edition was revised and brought up to date, with the addition of an appendix. 339 pp. 1912.
Pages 332-339 contain an index of Thai plant names arranged alphabetically according to their botanical and vernacular names, and page references.

Gimon, M. L'économie forestiére au Vietnam. Rev. Internatl. du Bois. 27-28. Feb. 1954.

Gould, F. W. Texas Plants. A Checklist and Ecological Summary. The Agricultural and Mechanical College of Texas, Texas Agric. Experiment Station. MP - 585. 112 pp. 11 figs. June 1962.
This is the most recent contribution on the plant ecology of Texas. It treats with environmental factors and vegetation areas. A checklist of Texas plants is included; also a bibliography of 85 references; and a general index to plant names.

Gould, J.S. Thailand, A Developing Economy. India Quarterly 8 (3): 311-334. July-Sept. 1952.

The author, Economic Adviser to the government of Thailand and the National Economic Council, discusses the general background of Thai economy; agriculture, fisheries and forestry; industry; and the financial structure of the Thai government.

Gourgand, E. La situation forestiére du Cambodge en 1918. Governement Général de l'Indochine. Série Saigon Bulletin No. 10. 34 pp. Saigon. 1918.
A descriptive summary of the forests and forest products of Cambodia.

Gourou, P. Les paysans du delta tonkinois; étude de géographie humaine. Publications de l'Ecole francaise d'Extreme-Orient. Vol. 27. 666 pp. 1936.

______. L'utilization du sol en Indochine francaise. 466 pp. illustr. 1940.
Contains a discussion of the vegetation of Indochina. English translation issued as land utilization in French Indochina (Inst. of Pacific Relations. New York.) 1945. 3 volumes. 1940.

Gouvernement Général de l'Indochine. Congres d'Agriculture Coloniale. Série, Saigon.
Bulletins issued by this organization in 1918 contain a series of articles, by French specialists, on agricultural and forest products of the colony.
Bulletin No. 1, by M. P. Quesnel, treats with native agriculture in Cochinchina (South Vietnam), with reference to the question of labor and possibilities of introducing new crops. Bulletin No. 2 is devoted to the problems of colonizing unused lands. Bulletin No. 5, by M. de Flacourt, treats with the possibility of growing cotton in Cambodia. Bulletin No. 6 discusses the cultivation of tobacco in Indochina. Bulletin No. 7, prepared by Aug. Chevalier and others, deals with the cultivation of Pará rubber (Hevea brasiliensis) in Indochina. In Bulletin No. 8, Couffinhal discusses the forests and natural forest formations of Cochinchina (now part of South Vietnam) 50 years ago; exploitable products; exportation; forest regeneration; and organization of the Forest Service in Cochinchina. Included, as an appendix, is a list of the principal tree species in the forests of Cochinchina, with their Annamitic names, dimensions and other features, and their uses.

Graham, W. A. Siam. A Handbook of Practical, Commercial, and Political Information. 591 pp. 1 map. 99 illustrations. Alexander Moring, Ltd. London. 1912.
This comprehensive publication is divided into 7 parts. Part I treats with geography and natural resources - flora, fauna, geology and minerals; Part II, races of Siam, Part III, history, social organization, education and government; Part IV, industries, commerce, trade and treaties, communications and transport; Part V,

arts, archaelogy and architecture; Part VI, religion; Part VII, language and literature.

The appendices contain a list of animals, plants, minerals, trade statistics, tables of currency, weights and measures. A bibliography and a general index are also included.

Groff, G. W. Culture and varieties of Siamese pummelos as related to introductions in other countries. Lingnan Science Journal 5 (3): 188-247 pp. 10 pl. 4 tables. Dec. 1927.

The special aims carried out in these investigations were to study types and varieties of Siamese pummelos; to obtain data regarding their comparative vigor and resistance to citrus canker, and other diseases or insect pests; to determine local cultural methods, and possible influences which might account for the seedless character of some varieties, including the effect of saline or tidal waters; and finally to secure plants or authentic bud wood of the best varieties.

Guhler, U. Studies of precious stones in Siam. Siam Science Bulletin 4(1): 1-39. Bangkok. 1947.

A short description is given of the crystal forms, the physical, and optical and chemical properties of the various gems occurring in Thailand. The second part contains relevant historical and modern references to the occurrence of gems in Thailand. The third part deals with the special conditions under which gems are treated, cut and traded in Thailand. A special chapter deals with synthetic corundum.

Guibier, J.F.H. Situation des Forêts de l'Annam. Gouvernement Général de l'Indochine. Série Saigon Bulletin No. 9. 114 pp. Saigon. 1918.

A discussion of the forests and forest products of Annam, with a descriptive list of woods of potential value suitable for export to France.

Guillain E. The Kingdom of Laos. Eastern World 7(6): 28-29. 1953.

Haas, F. Some Non-marine Mollusks from Northwest and Southeast Siam. Nat. Hist. Bull. Siam Society. 15(1): 21-25. Sept. 1952.

While mainly devoted to collecting mammals, the Rush Watkins Zoological Expedition to Siam in 1949 also gathered a series of mollusks. Although not new to science, these are of considerable interest as being either rare or extend our knowledge of their geographical distribution. An annotated list of mollusk species collected is included.

Haden-Guest, S., and J.K. Wright and E.M. Teclaff (Editors). A World Geography of Forest Resources. 736 pp. illustr. 58 maps and diagrams. American Geographical Society. Special publication No.33. 1956.

This deals in large part with the world's forests as yielding materials that man cannot do without. It also considers forests as part of the land, as features of the landscape, and indicating the relationship of forests to rainfall and temperature, relief and soils.

Six chapters are devoted to forests and wood products in their worldwide aspects, and 25 chapters to the forest situation and the problems of particular regions. Chapter 23 is devoted to Southeast Asia, with sections treating with the forests and forest products of Thailand and Indochina.

A selected bibliography is included, with a limited list of references to forestry according to continent and country. This is followed by selected subject bibliographies, including dictionaries and glossaries pertaining to forestry, and references to atlases and maps. There is a botanical index to tree species mentioned in the text, and a general index.

Haig, I.T., M.A. Huberman and M.Aung Din. Tropical Silviculture. FAO Forestry and Forest Products Studies. 1(13). 190 pp., illustr. 1958.

The proper development and use of tropical forests, covering an area slightly less than one half of the world's forest land, have concerned the Forestry Division of the Food and Agriculture Organization (FAO) since its inception. These forests not only contain an enormous quantity of unused or little used raw materials but their proper management also poses some of the most difficult problems in silvicultural techniques as well as in the formulation of a sound forest policy.

This study sums up the status of tropical silviculture with particular regard to natural regeneration, as a guide to future efforts in developing silvicultural practices.

The first four pages present a general review of tropical forests, their classification, and a table listing investigations undertaken during the past 150 years on climatic-vegetation relationships. This is accompanied by a fairly extensive bibliography.

There is a treatment of Silvics and Silviculture of Major Forest Communities, with a comprehensive discussion of Wet Evergreen (Rain) forest. A bibliography is also included.

Major forest types discussed are: Moist Deciduous forest, accompanied by a list of references: Dry Deciduous forest and its occurrence, physical factors, silvical factors, silvicultural practices, and a bibliography; the occurrence, physical and silvical factors of the Mangrove forest; and some pertinent data on the occurrence of Bamboo and Coniferous forests.

The final chapter is a discussion of proposed program relating to the physical and silvical features of major climatic forest formations, indicating the most important fields of definite value and promise for consideration in future programs.

Hammer, E. J. The struggle for Indochina continues: Geneva to Bandung. Stanford Univ. Press. 40 pp. 1955.

Harvard University Library. Indochina: selected list of references. Harvard Univ. 108 pp. 1940.

Heinsdijk, D. Forest type mapping with the help of aerial photographs in the tropics. Tropical Woods. 102: 27-46 pp. 17 figs. 3 tables. Oct. 15, 1955.

Technically, the construction of topographical maps only by ground survey in tropics, covered with dense forests, has become definitely obsolete. Aerial survey has largely replaced ground survey in these regions. Nevertheless the necessity of making forest inventories of small area without the aid of aerial photographs is still common practice in the tropics. The study of the possibilities of replacing forest inventories, at least in part, by pure photo-interpretation is still in its infancy.

The Forest Service of Guiana has adopted the following systems. Detailed topographical maps are first prepared from aerial pictures. These are used as basis for forest type maps made by photo-interpretation and ground reconnaissance sampling. The forest type maps are then used to carry out such detailed inventory as may be necessary.

The Supterintendent do Plano de Valorizacao Economica da Amazonia initiated the inventory and forest research work of the Amazonian forests. In this work they are assisted by the Food and Agriculture Organization of the United Nations with a team of technicians. The team has at its disposition numerous trimetrogon-aerial-photographs, taken by flyers from the United States of America. By using these pictures to advantage, an attempt is being made to locate valuable forests, where better (vertical) aerial survey work is most needed, and what kind of inventories should next be done. Owing to the very simple topography and the large areas where forest types are more or less constant in composition, the results of this work are very promising.

Literature cited contains 6 references.

Heller, R.C., G.E. Doverspike and R.C. Aldrich. Indentification of Tree Species on large-scale Panchromatic and Color Aerial Photographs. Agriculture Handbook No. 261. 17 pp. illustr. Forest Service, U. S. Department of Agriculture. July 1964.

This report describes results of research conducted near Ely, Minn., in July 1960, and indicates the best type of film and scale combination to identify tree species. These results should be applicable not only to inventories of timber but also to other projects, such as to assess damage to forests by destructive enemies, to appraise forest wildlife habitat, or to expedite forest management.

Data are given on study area and species; methods of obtaining data, by gathering ground and aerial information; office procedures and photo interpretation: and results obtained. A discussion and conclusions are included.

The authors maintain that color film is superior to panchromatic film for use in identifying individual tree species. People are accustomed to seeing and identifying objects not only by shape and form but also by color. A forester trained to recognize trees by morphological features also associates a color with that tree. The cost of using color film at large scales should be little more than that required for panchromatic film. While color film costs five times as much as panchromatic film, the important point is that film cost is only a small fraction of the total cost of aerial photography. When we consider equal aircraft costs, the same standby time for the flight crew, elimination of the need for prints, and reduction of photo handling by interpreting color film in rolls, the extra cost of color film is minor. Increased interpretation obtained from color film would counterbalance the slight increase in cost.

Tree species were identified accurately enough on color film at large scales to suggest the possibility of using it in actual inventory problems. Further study, especially to associate crown and foliage characteristics of trees with age and physiographic features, should be helpful in improving identification of woody species.

Literature cited contains 9 references. A list of species, arranged according to the most frequently identified features on color photographs (1:1584 scale), is also included.

Hemsley, W. B. a. Achilus siamensis Hemsl. Hook. Icon. Pl. 24: pl. 2370. 1895.

A new species from Thailand.

______. Thailand Plants. Kew Bull. Misc. Inf. 1895 (98): 38-39. 1895.

Notes on collection by F.H. Smiles and description of Achilus n. gen. (Zingiberaceae), with A. siamensis n. sp.

______. Phyllanthodendron mirabilis Hemsl. Hook. Icon. Pl. 26: pl. 2563 and 2564. 1899.

New genus and species from Thailand.

Henderson, M.R. The genus Eugenia (Myrtaceae) in Malaya. Gard. Bull. Singapore 12: (1): 292. figs. April 1949.

A systematic treatment, including the Thai species.

Henry, T. A. The treatment of leprosy by vegetable oils. Kew Bull. Misc. Inf. 1926: 17-23. pl. 3,4. 1926.

Includes references to the botanical origin of the oils used, mostly from Hydnocarpus from Thailand.

Hesse-Hartegg, E. von. Urwulder und Nutzbaume der hinterindischen. Tropen. Oesterr. Forst.- & Jagdz. 16: 193-195. 1938.

Hill, A.W. The genus Strychnos in India and the East. Kew Bull. Misc. Inf. 1917: 121-210, pp. 20 figs. 1917.

A revision, including Thai species.

______. New species of Strychnos from Thailand. Kew. Bull. Misc. Inf. 1925 (10):423-426. 1925.
Four new species from Kerr's collections.

Hillis, W. E. Production of mangrove extract in delta region of Papua. Emp. For. Rev. 35 (4): 420-436. 1956.

Hoffet, J. H. Etude géologique sur le centre de l'Indochine entre Tourane et le Mékong (Annam central et Bas-Laos). Bull. du Service Géologique de l'Indochine 20 (2): 154 pp. 1933.

Hoffet, J.J. Note sur la géologie du Bas-Laos. Bull. du Service Géologique de l'Indochine 24(2): 22 pp. 1937.

Hofman, W. Thailand-benzoe. Neue Untersuchungen and Versuch einer pharmakognostischen Monographie. 121 pp. 1 text map. Zurich. 1920.
Contains historical and botanical data on gum benzoin from a species of Styrax.

Holmes, E.M. The trees yielding benzoin. Pharm. Journ. (London) Ser. III, 14: 354-355. 1883.
Concerns identity of the trees; Thai benzoin is Styrax benzoin.

Holland, J.H. Overseas plant products. 279 pp. London. 1937.
An annotated alphabetical list of products imported into England with notes on their botanical origin, uses, and place of origin, including many from Thailand.

Holttum, R.E. The fern genus Diplazium in the Malay Peninsula. Gard. Bull. Straits Settlement. 11: 74-103. figs 6. 1940.
Cites specimens from Thailand.

______. The Zingiberaceae of the Malay Peninsula. Gard. Bull. Singapore. 13: 1-249. figs. 33. 1950.
A systematic treatment, including Thai species. Figures are on unnumbered pages.

Hooker, J.D. On some species of Impatiens from Indo-China and the Malayan Peninsula. Kew Bull. Misc. Inf. 1909: 1-12. 1909.
Includes I. macrosepala from southern Thailand.

______. The flora of British India. 7 volumes. London. 1, i-xi, 1-740. 1872-75; 2, 1-792. 1876-79; 3, 1-712. 1880-82; 4, 1-780. 1883-85; 5, 1-910. 1886-90; 6, 1-792. 1890-94; 7, 1-842. 1897.
A general descriptive flora, including a few species based on Thailand records. This is the most comprehensive flora on the area west of Thailand.

Hosseus, C.C. Kurzer Bericht von Dr. K. Hosseus Uber den Verlauf zweier in das Innere von Thailand ausgefuhrten Studienreise. Zeitschr. Ges. Erdkunde Berlin 1906 (3): 190-196. 1906.
A general account, with botanical observations.

______. Das Teakholz in Thailand. Beih. Tropenpflanz. 8: 378-391. 3 figs. 1907.
Notes largely of economic nature.

______. Die aus Thailand bekannten Acanthaceen. Bot. Jahrb. Engler 41 (1): 62-73. 1907.
A systematic enumeration of Acanthaceae, including many new species from Thailand.

______. Eine neue Rafflesiaceen Gattung aus Thailand. Bot. Jahrb. Engler 41 (2): 55-61. 2 plates. 1907.
Richthofenia n. gen., with R. siamensis n. sp.

______. Die Gewinnung des Teakholzes in Thailand und seine Bedeutung auf dem Weltmarkte. Jahresb. Verein. Angew. Bot. 4: 40-50. 1907.
Observations mainly of economic value.

______. Von Bankok nach der Nordgrenze Thailand. Mitt. Geogr. Ges. Hamburg 22: 222-224. 1907.
A summary of a travel lecture with general botanical observations.

______. Zwei interessante Neuheiten aus Thailand in Kgl. Bot. Garten zu Dahlem. Notizbl. Bot. Gart. Berlin 4: 314-318. Oct. 10, 1907.
Cites new species from Thailand - Aeschynanthus macrocalyx and Hoya engleriana.

______. Leguminosae novae Thailand. Repert. Sp. Nov. Fedde 4: 290-291. 1907.
Bauhinia harmsiana, Indigofera siamensis and Rhynchosia longipetiolata, and new species from the author's collections.

______. Eine neue Gesneracee (Didymocarpus aureoglandulosa C.B. Clarke), aus Thailand. Repert. Sp. Nov. Fedde 4: 291-292. 1907.
Based on Hosseus 220.

______. Beitrage zur Flora des Doi-Sutap unter vergleichen. Beruchsichtigung einiger anderer Hohenzuge Nord-Saims. Bot. Jahrb. Engler 40: Beibl. 93: 92-99. 1908.
A general floristic description.

______. Vegetationsbilder auf Thailand. Aus sinem Vortrag im Verein für Naturkunde in Munchen. Globus 96 (10): 149-152. figs. 4. 167-170. figs. 7. 1909.
A general description of the vegetation.

______. Beitrage zur Flora Thailand. Beih. Bot. Centralbl. II. Abt. 27 (3): 455-507. 1910.
A systematic enumeration, based on the author's and Lindhardt's collections; and includes species listed in Williams, F.N. 1904-05.

______. Die Vegetation und die Nutzholzer Thailand. Oesterr. Forst.- & Jagdz. 30 & 36. 1910.

______. Die Bedeutung der Bambusstande auf Grund eigener Studien in Thailand. Arch. Anthropol. 38 (n. ser. 10): 55-73. 1910.

______. Die botanischen Ergebnisse meiner Expedition nach Thailand. Beih. Bot. Centralbl. II Abt. 28 (3): 357-457. 1911.
A systematic enumeration of 1904-05 collections including bryophytes, ferns, and seed plants; several described as new.

______. Beitrage zur Flora von Wang Djao am Ma Ping in Mittle-Thailand. Bot. Jahrb. Engler 45 (3): 360-374. 1911.
A floristic description with list of species of various habitats.

______. Eine neue Gentiana (G. hesseliana Hoss.) vom Pahombukgebirge (2300 m. u d. m.) auf der siamenisch-birmanischen Grenze. Repert. Sp. Nov. Fedde 9: 465-466. 1911.
Based on Hosseus 609.

______. Einige neue Arten meiner Thailand-Expedition. Repert. Sp. Nov. Fedde 10: 61-64. 1911.
New species: Polygonum damrongiana, Mussaenda sutepensis, Swertia dielsiana, and Croton hutchinsonianus.

______. Durch konig Tachulalongkorns Reich. Eine deutsche Thailand-Expedition. i-xii, 1-219 pp. 125 figs. 1 map. 1912.
Includes data on the vegetation and agriculture of Thailand.

______. Botanische und kolonial wirtschaftliche Studien uber die Bambusstande. Beih. Bot. Centralbl. II. Abt. 31 (1): 1-69. illustr. 1913.
Contains references to the uses of bamboo in Thailand.

Howes, F. N. The banana in some tropical eastern countries -- its forms and variations. Kew bull. Misc. Inf. 1928: 305-332. pl. 3-9. 1928.
Includes Thai varieties; an index of varietal names; and an extensive bibliography.

______. Observations on bananas in Thailand. Journ. Thailand Soc. Nat. Hist. Suppl. 9 (1): 41-48. 1929.
A general discussion of varieties used.

Hubbard, C.E. Eremochloa eriopoda E. C. Hubbard. Hook. Icon. Pl. 34 (4): pl. 3376. 1939.
A new species from Thailand and Indochina.

Huberman, M.A. Bamboo Silviculture. Unasylva 13 (1): 36-43. 3 figs. 1959.

Throughout wide areas of the world, bamboos serve a multitude of purposes. Rural housing largely depends on them. Pulp and paper manufacture from bamboos is expanding. This article deals with the occurrence of bamboos; physical factors of climate and soil; silvical factors, growth habits, and silvicultural practices, as developed largely in Asia and to a lesser extent in Latin America and Africa. The author also reviews the research requirements for consideration in future programs.

Selected references on the subject contain 36 titles.

______. Mangrove Silviculture. Unasylva 13 (4): 188-195. 1959.

The mangrove forest is a community controlled primarily by edaphic factors. Such edaphic communities are of varying importance throughout the tropics as successional stages in the development of, or in retrogression from, the major climax formation communities. Although the development of these communities involves such factors as soil, structure, composition, aeration, mineral contents of surface and soil water and water movement, including changes in water levels, probably the most important is the extreme water regime. As a consequence, a number of forest communities have been recognized as riparian, gallery, varzea, riverain, periodic or seasonal swamp, freshwater swamp, peaty swamp, beach, tidal, and mangrove forests.

In many areas, mangrove forests have greater importance economically than other edaphic communities, forming in wide areas an important source of timber, fuel, charcoal, posts, poles, tannin and other minor forest products. The effects of commercial exploitation of mangrove woodland are so marked that, as a result, these coastal forests are often better known than other forest types.

The composition of mangrove forest in both Southeast Asia and Puerto Rico, as well as in other regions of the eastern and western hemispheres, is essentially similar. All the genera of the western mangrove are found in the eastern area, although the species are different. In southeastern and southern Thailand, for example, the following species have been reported: _Rhizophora mucronata_, _R. apiculata_, _Bruguiera conjugata_, _B. parviflora_, _B. sexangula_, _Avicennia officinalis_, _A. marina_, _Ceriops tagal_, and others. In Puerto Rico, the four principal species are: _Rhizophora mangle_, _Laguncularia racemosa_, _Conocarpus erecta_ and _Avicennia nitida_.

Huet, J. Tarif de cubage approximatif des pins sur pied pour les bois d'industrie seulement. Réserve de Kirirom, Cambodge. Non publié. 9 pages. Service des Eaux et Forets du Cambodge. 1950.

Humbert, H., and F. Gagnepain. Supplement a la Flore Générale de l'Indochine. 1:700 pp. illustr. 1938-46.

Consists of additions and corrections to, and replacement of, parts of contributions by Lecomte and others.

Hutchinson, J. Revision of Aspidopterys. Kew Bull. Misc. Inf. 91-103. 1 fig. 1917.

A systematic treatment, including species from Thailand.

Implay, J. B. New and re-named Siamese Acanthaceae. In W.B. Craib's and other - Contributions to the flora of Thailand. Additamentum LI. Kew Bull. Misc. Inf. 1939 (3): 109-150. 1939.

Indonesian Forest Service. Problems of silviculture and management of mangrove forests in Indonesia. Paper presented to the Second Session Asia-Pacific Forestry Commission, Singapore. 1952.

Ingram, J. C. Economic change in Thailand since 1850. 251 pp. 1 map. Stanford Univ. Press. 1955.

This publication contains chapters on: the economy of Siam in 1850; the growth of rice exports; the role of government in the rice industry; the growth of other exports; imports and home-market industries; currency and exchange; sources of government revenue; government expenditures; the development of an exchange economy; and recent developments up to 1954.

A large selected bibliography, and a general index are included.

International Bank for Reconstruction and Development. Thailand. Press Release No. 224. Washington, D. C. 1950.

International Rice Yearbook. World rice production less in 1954-55. In Foreign Crops & Markets. Nov. 1954.

Isarasena, M.L.Y. Mechanical rice cultivation. Kasikorn 25 (1): 44-55. 1952.

Jalavicharana, K. The phosphate insecticides. Kasikorn 25 (4): 295-300. 1952.

Jewesson, R. Some applications of aerial photographs. Technical Notes. Forestry Chronicle 35 (1): 67-71. Serial No. 142. 1959.

The use of aerial photography for photogrammetric purposes has become a standard technique in many phases of forestry. In the search for more elaborate uses, however, some of the simpler, yet equally useful, purposes have been overlooked or by-passed. Up-to-date, low elevation photography taken from light aircraft with relatively inexpensive aerial camera equipment can be invaluable in providing management with current information on many phases of their operations.

Johnson, E. W. Aerial photographic site evaluation for long-leaf pine. Agricultural Experiment Station Bulletin No. 339: pp. 24-26. April 1962.

Kaempfer, E. Amoenitatum exoticarum politico-physico-medicarum fascicli V, quibus continentur variae relationes, observationes et descriptiones rarum persicarum et ulterioris Asiae, multa attentione, in peregrinationibus per universum Crientem collectae. 912 pp. 16 plates. 75 figs. 1712.
Contains observations(in Latin) on Thailand with a few references to plants.

______. The History of Japan; giving an account of the ancient and present state of government of that empire---of its metals, minerals, trees, plants, animals, birds, and fishes. 2 volumes. I: 392 pp. 20 plates; 2: 383-612; appendix 75 pp. pl. 21-45. 1728.
Contains a few notes on the vegetation of Thailand.

Kanchananaga, T. (Ed.). The commercial and economic progress of Thailand, 1949. Thai Commercial Development Bureau. 191 pp. Bangkok. 1949.
This publication contains a section on forests and forest products of Thailand. Additional data cover geography, climate, communications and transport, and the cooperative movement in Thailand.

Karam'yshev, V.P. Agriculture in the Democratic Republic of Vietnam. 106 pp. U.S. Joint Publications Research Service, Washington, D.C. Jan. 1961. (Mimeographed.)
This is a translation of a Russian publication entitled 'Sel'skve Khozyastvo Demokraticheskov Respubliki V'etnam' published by State Publishing House of Agricultural Literature, Moscow, 1959. The author visited North Vietnam as a member of a group of Soviet specialists, and bases his report on personal observations.
There is a discussion of the agricultural economy of the country, its structure and divisions of specialization during the years following the dissolution of Indochina as a colony. The author decribes in detail the reorganization that has taken place in village life; the organization and development of labor brigades; cooperative and state farms; and the Three Year Plan for the development and reconstruction of the economy during 1956-60. A description is given of the methods used in cultivating basic agricultural crops, with particular emphasis on rice and cotton, in North Vietnam.
Comments regarding this publication should be directed to: Moskva, B-66, Passmannyv per. d.3, Sel'khozgiz. Photocopies of the translation may be purchased from: Photoduplication Service, Library of Congress, Washington 25, D. D.

Katikarn, B. Onion growing. Kasikorn 25 (5): 396-402. 1952.

Keith, A. Notes on the Thailand provinces of Koowi, Bangtopan, Pateeo and Champoon. Journ. Str. Br. Roy. Asiat. Soc. 24: 63-78. 1 folded map. 1891.
Deals with peninsular Thailand north of the isthmus of Kra, with

observations on 'The jungle covering' and 'The grass country of Pateeo'.

Kemavanit, C., and F. Sasisonti. Bat guano from Patalung. Kasikorn 25(3): 267-272. 1953.

Kendall, R.H., and L. Sayn-Wittgenstein. A test of the effectiveness of air-photo stratification. The Forestry Chronicle 37 (3): 338, 350-355. Dec. 1961.

A test of the efficiency of different systems of air photo stratification was conducted in an area near the Petawawa Forest Experiment Station. While stratification, particularly according to cover type, height and canopy density, increased the precision of the estimated total volume and mean annual increment, this increase was not as large as had been expected. The main value of air photo stratification may be in furnishing a forest type map for management purposes.

No attempt was made to generalize from the results obtained. They are applicable only to the particular forest where the test was carried out.

Kending, H. and B. Sa-ard. Vegetative Propagation of Teak. Unasylva 14 (4) 193-194. 3 figs. 1960.

The authors describe the so-called 'forkert budding' method, used extensively for budding rubber (Hevea brasiliensis). The budding test on rubber was conducted at the Huey Tak teak plantation in northern Thailand. It was assumed that this method might also be suitable for teak. Approximately 200 successful bud-grafts were made during the initial investigation. They were watched closely during the first growth season and measured each month, and the last record was made in December at the end of the rainy season. Three buddings died owing to termites, but the rest had reached an average height of 1.78 m. Some clones measured 2.68 m., and were almost as high as the seedlings growing spontaneously in the area surrounding the experimental plots.

Kernan, H.S. The forests of Vietnam. American Forests 70 (6): 31, 53-57. June 1964.

The Vietnamese are primarily a coastal and delta people, catchers of fish and growers of rice. Their homes are among endless lagoons and tidewater flats and dark, sluggish rivers, between whose meaderings they lay out and till their paddies of rice with the intensity and precision which that pampered crop demands. In historical times, as their driftings can be traced along the western rim of the South China Sea, they preferred to settle near the coast and avoided the forbidding highland jungles of the interior. While rice paddies are troublesome to construct, they respond to attention by producing some of the heaviest crops known to man. They demand hard, monotonous physical labor. The lowland rice-growers have no acquaintance with forests. Bamboo, earth and straw meet their needs

for housing, and village and roadside trees provide fuel. There are mangrove stands, but these scarcely give an idea of the uses and appearance of a forest. At high tide they resemble floating gardens; and at low tide they look like a convention of spiders perched on stilt-like legs.

In the highlands of the interior live tribes of Malayan origin, quite distinct from their fellow citizens, the Vietnamese, in language, appearance and culture. Their habitual surroundings are mountains and torrents; wildlife and roadless forests. The highlander's life requires neither permanent field nor persevering labor. He catches fish and game, and roves about looking for ground to clear and burn. In the rainy season, he plants his fields to upland rice and corn. These crops use up the richness deposited by a generation of forest growth. When they are harvested the forest again begins the slow, patient task of building up the soil. Lowland rice-growers have other ways of keeping their fields green and they often condemn this cycle as wasteful and destructive. But the mountain people know the restorative power of the forest and make use of this power to the fullest extent.

About the turn of this century Europeans began to arrive in these remote highlands with demands for food and industrial products, demands which the traditional cycle of field and forest proved utterly incapable of meeting. Thereupon began a series of changes that are still in the process of working themselves out to some stable and happy conclusion.

The French colonial administrators recognized no private ownership of forest land. To them all land was public domain. They did, however, reserve some areas for permanent management, while leaving others open for cutting and settlement as need of the developing community dictated. Their principal concern was to make the forest a source of revenue for the colonial administration. In this policy they were successful, and forests of Vietnam helped to pay for many of the roads, harbors and municipal works which are yet valuable assets to the country. Such financing is certainly a legitimate function of the forest in a developing economy. However, the temptation to exploit the forest and to neglect research, training and forest management was almost overwhelming. The colonial administration made some modest bows toward forestry, but not enough to compensate for the removal of highgrade timber by a concurrent program of replacement.

The present (1960) Directorate of Forestry operates very largely in the same capacity as did that of the colonial administration. First of all, this agency functions to supervise the sale of timber from public domain and to collect the revenue from such sales. Each year the Directorate auctions off about 70 million board feet of timber for about $1,800,000. One-half of this money finances the forest administration, and the other half becomes available to the national treasury for counter-insurgency effort. In 1962 the government took a very significant step to aid forestry by adding a 25 percent severance tax to the stumpage price. These extra revenues are reserved entirely for protection and reforestation. With them the Directorate began to grow seedlings at/a rate that was expected to reach sixty million a year. In carrying out this program, the government grants land to those who successfully plant trees thereon. This policy is creating private forest ownership.

Kerr, A.F.G. Notes on the pollination of certain species of Dendrobium. Sci. Proc. Roy. Dublin Soc. n. ser. 12 (5): 47-53. pl. 5,6, Apr. 1909.
Based on native orchids of northern Thailand.

______. Contributions to the flora of Thailand.II. Sketch of the vegetation of Chiengmai. Kew Bull. 1911 (1): 1-6. 2 plates 1911.

______. Contributions to the flora of Thailand. Notes on Dischidia rafflesiana Wall, and Dischidia nummularia Br. Sci. Proc. Roy. Dublin Soc. n. ser. 13 (24): 293-309. pl. 26-31. 1912.
Morphological and physiological data on Asclepiadaceae of Thailand.

______. Recent advances in our knowledge of the flora of Thailand. Journ. Siam Soc. 10 (1): 13-15. 1913.
Historical; concerning collectors and publications.

______. A hybrid Dipterocarpus. Journ. Siam Soc. 11 (1): 9-12. 1 plate. 1914.
D. obtusifolius and D. costatus on Doi Sutep.

______. Local plant names. In W.G. Craib, Florae Siamensis enumeratio. Part I: 9-14. 1925.
A discussion of the selection and transliteration of the names contributed by Kerr.

______. A little known orchid (Dendrobium friedricksianum). Journ. Siam. Soc. Nat. Hist. Suppl. 7 (1): 65-66.
A general note.

______. Carl Roebelen. Journ. Siam. Soc. Nat. Hist. Suppl. 7 (2): 132-134. 1927.
An obituary of this orchid hunter of Thailand.

______. Kaw Tao, its physical features and vegetation. Journ. Siam Soc. Nat. Hist. Suppl. 7:137-149. pl. 8-12. 1 map, plus 1 folded map. 1928.
A floristic account.

______. Fruit and seeds in the drift of Kaw Tao. Journ. Siam Soc. Nat. Hist. Suppl. 8 (2): 103-117. 1930.

A study in plant dispersal with a list of 50 species found and a bibliography.

______. Dispersal of fruit by wind. Journ. Siam Soc. Nat. Hist. Suppl. 8 (3): 216. 1931.
Notes on Hopea odorata and Pterocarpus sp.

______. Notes on introduced plants in Thailand. Journ. Siam Soc. Nat. Hist. Suppl. 8 (3): 197. 212. 1931. 8 (4): 334-335. 1932.
Notes on various species.

______. A reputed rejuvenator. Journ. Siam Soc. Nat. Hist. Suppl. 8 (4): 336-338. 1932.
A drug from Butea superba.

______. The genus Parnassia in Thailand. Journ. Siam Soc. Nat. Hist. Suppl. 9 (3): 327-328. 1 fig. 1934.
A note on the occurrence of P. mysorensis in northern Thailand; new to the country.

______. An interesting aromatic herb (Artemesia pallens). Journ. Siam Soc. Nat. Hist. Suppl. 10 (1): 61-62. 1935.
A rarely cultivated plant in Thailand.

______. Cleistogamous flower in Ruellia tuberosa. Journ. Siam Soc. Nat. Hist. Suppl. 10 (1): 66-67. 1935.
Observations on the occurrence of this common wayside plant in Thailand.

______. Psilobium siamense, Kerr. Hook Icon. Pl. 34 (2): pl. 3332.
A new species from Thailand.

______. Composition of the dry evergreen forest on Kaw Tao. Journ. Siam. Soc. Nat. Hist. Suppl. 10 (3): 35-38. 1937.
Quantitative studies with a tabular count of a sample plot. This issue was erroneously distributed as Vol. 11, No. 1, but corrected later.

______. Early botanists in Thailand. Journ. Thailand Res. Soc. Nat. Hist. Suppl. 12: 1-27. 1 pl. 1939.
Historical data. The plate is a portrait of the author.

______. Hoya mitrata Kerr. Hook. Icon. Pl. 35 (1): pl. 3406. 1940.
A new species from Thailand.

______. Hoya flagellata Kerr. Hook. Icon. Pl. 35: pl. 3407. 1940.
A new species from Thailand.

______. Notes on the scented woods of Thailand. Nat. Hist. Bull. Thailand Res. Soc. 13: 35-41. 1942.
Botanical, economic and historical data on 11 species.

______. Remirema bracteata A.F.G. Kerr. Hook. Icon. Pl. 35: pl. 3435.
Occurs in Thailand.

______. The genera Hydnocarpus and Taraktogenos in Siam. The Record (Thailand) Techn. & Sci. Suppl 7: 1-16. 5 pl.
Contains an introduction and a review of species, including T. clavipetala and T. ilicifolia transferred from Hydnocarpus, with keys. Also includes notes on the chemistry of Hydnocarpus and Taraktogenos oils by A. Marcan; and notes on clinical benefits from the use of oil of Hydnocarpus anthelminthica by J.W. McKean.

______. Between 1923 and 1933 A.F.G. Kerr, the well-known investigator of Thai botany, published anonymously reports of field trips undertaken by himself and his party through many important regions of Thailand. About 18 such reports appeared in The Record, published by the Ministry of Commerce, Bangkok. Notes on the flora and on landuse of the regions investigated are of much interest, but there is seldom any mention of the nature of the soil.

Kew, Royal Botanic Garden. Decades Kewenses Plantarum novarum in Herbario Horti Regii conservatorum Decades XV - XIX. Kew Bull. Misc. Inf. 102-120. 1895. 357-362. 1909. 19-24; LVIII 275-280; 381-386. 1910. 188-193; 343-348. 1911; 113-118. 1913. 216-221. 1921; 75-81. 1927; 153-161. 6 plates. 2 figs. 1930; 99-107. 1934; 490-496. 1936.
Parts listed contain descriptions of new species from Thailand.

Khambanonda, I. Bangkhen pop-corn. Kasikorn 23 (3): 205-208. 1950.

______. Fertilizer experiments on rice. Kasikorn 23 (3): 157-159. 1950.

______. Tomato production in the dry season. Kasikorn 23 (2): 113-117. 1950.

Kiet, Le-Cong. La vegetation psamophile de la presqu'ile de Cam-Ranh. Ann. Fac. Sci. Saigon. 367-434. 3 maps. diagrams. 16 illustr. 1962.
This is a dissertation submitted to the Faculty of Sciences of Saigon in candidature for the Diploma of Higher Studies in Natural Sciences. The field study, made during June 1960 to September 1961, involved: (a) the topography and flora of the peninsula of Cam-Ranh; (b) investigation of each plant formation; and (c) the preparation of a map of the vegetation on a scale of 1:50,000 (Ann. Fac. Sci. Saigon 1961). Transects were made along the length of the Peninsula.
The thesis is divided into 3 parts. Part one treats with the geography, geology, climate and prevailing winds in the area. The second part deals with the vegetation. A. Vegetative formations of changing sand dunes: (a) dunes with Spinifex littoreus Merr. and Vitex trifolia var. simplicifolia Chem.; (b) carpet of Fimbristylis sericea R. Br., Chrysopogon orientale A. Camus, and Sideroxylon maritimum Pierre; (c) littoral thicket at Longanier; and (d) transition

formation between littoral thicket at Lagonier and Vatica forest. B. Vegetative formations of fixed dunes: (a) Vatica forest; (b) Secondary forest of Vatica tonkinensis Aug. Chev. and Eugenia rubicunda Gagn.; (c) dense and open scrub of Sindora cochinchinensis H. Ball. and Scolopia buxifolia Gagne.; (d) dense and open thicket of Rhodamnia trinervia Bl. and Eurya turfosa Gagn.; and (e) Steppe (grass) of Chrysopogon orientale A. Camus and Eremochloa ciliaris Merr.; the distribution of Oldenlandia pinifolia O. Ktze., Polycarpa arenaria Gagn. and Fimbristylis sericea R. Br. C. Vegetation formations of moist dunes: (a) Dune formations subject to constant inundation; (b) formations subject to daily inundations, such as mangrove, sandy beaches with Zoysia pungens Willd., Sesuvium portulacastrum L. and Suseda australis Miq.; (c) swamp meadows of Nepenthes mirabilis (Lour.) Druce and Nepenthes annamensis Macf.; (d) vegetative formations on sand exposed to seasonal inundations, such as stands of Melaleuca leucadendron L., and periodically inundated carpet of Leptocarpus disjunctus Mast.

The third part is devoted to general conclusions and a summary of the studies. This is followed by an alphabetically arranged list of most of the spontaneous plants found on the peninsula of Cam-ranh. About 40 species remained to be identified at the National Museum of Natural History. A list of 26 references, mostly French, is included. This is followed by a series of 18 tables, showing the chemical analysis of sand specimens; ratio of association of Spinifex littoreus and Vitex trifolia var. simplicifolia with local dominance of Pandanus reversispiralis at the northern end of the peninsula; and other associations in the area under study, including a comparison between the floristic composition of the mangrove forest of Cam-ranh with that of Ca-Mau and Cap St. Jacques.

Killip, E. P. List of sedges (Cyperaceae) collected in Thailand by Dr. Hugh M. Smith. Journ. Siam Soc. Nat. Hist. Suppl. 7 (1): 55-57.

A systematic enumeration, but none described as new.

King, G. The species of Ficus of the Indo-Malayan and Chinese countries. Ann. Bot. Gard. Calcutta 1: 1-185. 6 plates. 1887-88.

Kira, T., and T. Umesas (Ed). Nature and Life in Southeast Asia: A preliminary survey on the vegetation of Thailand. Vol. I: 21-157. 26 tables. 54 illustr. Biological Department, Osaka City University, Osaka, Japan. 1961.

This paper presents the results of the preliminary ecological study on the vegetation of Thailand, especially of the northwestern regions, carried out by the Osaka City University, Bioological Expedition to Southeast Asia.

The field study was made during the four months of travel through Thailand during the dry season of 1957-58. Observations were made while traveling, chiefly by automobile, from Bangkok to the northwestern boundary of Thailand, several brief excursions to the northwest highlands, including the ascent of mountain Inthanon, the highest

peak in Thailand, and from Bangkok to Ankor Wat in western Cambodia. The authors recognize five principal forest types in northwestern Thailand. Structure of forest communities was analyzed with special reference to stratification and dispersal of individuals and species.
Literature cited contains 84 titles.

Klayanasuta, W. Banana, var. Kluey Hom Thong. Kasikorn 26 (3): 301-306. 1953.

Koenig, J.G. Journal of a voyage from India to Siam and Malacca in 1779. Journ. Str. Br. Roy. Asiat. Soc. 26: 58-201; 27: 57-103. 1894.
Includes many botanical observations. This is translated from his manuscripts in the British Museum, with a biographical introduction.

______. Voyage to Siam, 1778-79. Koenig's manuscripts at Nat. Hist. Mus. London. 3: 59-113; 13: 1-42.

______. Autograph journal of Koenig's voyages, with lists and descriptions of East Indian (including Siam and Malacca) plants, animals and a few minerals. 21 vols. German & Latin. 1769-85.
This title is taken from the Catalogue of the Books, Manuscripts, Maps and Drawings in the British Museum (Natural History) 2: 1014. 1904.

______. Descriptions plantarum et animalium in itinere Siam. Koenig's manuscripts in Nat. Hist. Mus. London 4: 1-54. 1779.

Kranzlin, F. Einige neue Orchidaceen. Repert. Sp. Nov. Fedde 7: 38-41. 1909.
Includes Cleistoma fuerstenbergianum n. sp, from Siam.

______. Eine neue Calantha (C. hosseusiana) aus Siam. Repert. Sp. Nov. Fedde 7: 82-83. 1909.
Based on Hosseus' collection.

______. Cyrtandreae quaedam novae. Repert Sp. Nov. Fedde 24: 214-223. 1928.
Includes Aeschynanthus hosseusiana (n. sp.) from Siam.

Kridakara, M.C.S. Peanut at Bang Bird Farm. Kasikorn 23 (5): 358-371. 1950.

Krishnaswamy, V.S. Problems of silviculture and management of mangrove forests of India. Paper presented to the Second Session. Asia-Pacific Forestry Commission, Singapore. 1952.

______. Silviculture - Natural regeneration including artificial supplementation - Tropical. Paper presented to the Sixth British Commonwealth Forestry Conference, Canada. 10 pp. 1952.

Kulthongkuam, S. Preliminary report on use of 2,4-D in preventing shedding of cotton bolls. Kasikorn 23 (4): 258-262. 1950.

_____., and S. Thongpanchang. Rate of seeding green gram (Mungo bean). Kasikorn 23 (3): 160-163. 1950.

Kurz, S. 1874-77. Contributions toward a knowledge of the Burmese flora. Journ. Asiat. Soc. Bengal. Part I. 42 (2): 39-141. 1874. Part II. 44 (2): 128-190. 1875; 45 (2): 204-310. 1876: 46 (2): 49-258. 1877.
A critical treatment without species descriptions.

_____. Forest flora of British Burma. 2 volumes. Calcutta. 1; i-xxx. 1-549; 2: 1-613. Calcutta. 1877.
A basic flora of Burma.

Ladejinsky, W. I. Thailand's Agricultural Economy. Foreign Agriculture. 6 (5): 165-184. U.S.D.A. May 1942.
The economy of practically all the countries in the Far East and in Southeast Asia is essentially agricultural. Thailand is no exception. Whereas the agricultural economy of a great number of them is diversified, that of Thailand is not. Thailand is essentially a one-crop country, and rice is the crop. More than 90 percent of all the cultivated acreage is under rice, which is also the country's principal export product. The large rice output insures the people sufficient food, since rice is the principal item in the diet. It must be noted, however, that while in Asia the absence of famine is often an indication of a fair standard of living, it is not so in Thailand. The technique of farming there, the disposition of the output, and conditions under which many natives cultivate the land are characterized by features that spell a low standard of living.
A brief review is given of the physical background of Thailand; its people; population density; agriculture; living standards; taxation and income; land ownership and tenancy; land utilization; with a summary and conclusions.

Lam, H. J. The Sapotaceae, Sarcospermaceae and Boerlagellaceae of the Dutch East Indies and surrounding countries (Malay Peninsula and Philippine Islands). Bull. Jard. Bot. (Buitenzorg) Ser. III, 7 (1-2): 1-289. f. 1-65. 1920.
Includes Thai species.

_____. Further studies on Malayan Sapotaceae, I. Bull. Jard. Bot. (Buitenzorg) Ser. III, 8 (4): 381-494. 29 figs. 1 table. June 1927.
Includes citation of Thai specimens. This is a concise revision of an earlier paper that did not mention collections from Thailand.

_____. The Burseraceae of the Malay Archipelago and Peninsula, with annotations concerning extra-Malayan species especially of <u>Dacryodes</u>,

Santiria and Canarium. Bull. Jard. Bot. (Buitenzorg) Ser. III, 12 (3/4): 281-651. pl. 1-14. 1932.
Includes many Thai species.

______., and R. C. Bakhuizen van den Brink. Revision of the Verbenaceae of the Dutch East Indies and surrounding countries. Bull. Jard. Bot. (Buitenzorg) Ser. III. 3 (1): 1-116. Jan. 1921.
A systematic treatment, including keys and citation of Thai species.

Lamarck, J.B.A.P.M. de. Encyclopedie méthodique. Botanique. 1:648. 1783.
Includes Cassia siamea, and possibly others.

Lamington, C.W.A.N.C.L. Journey through the Trans-Salwin Shan States to Tong-King. Proc. Roy. Geogr. Soc. (London) 13: 701-722. 2 text maps. 1891.
An account of the author's journey beginning in Siam, with incidental botanical observations.

Landon, F. H. Planting in mangrove forests. Malayan Forester 2 (2): 131-133. 1933.

______. Compilation of volume tables. Malayan Forester 9 (1): 33-36. 1940.

______. Mangrove volume tables. Malayan Forester 11 (3): 117-120. 1948.

______. Tropical rain forest of Malaya. Preceedings of the Fourth World Forestry Congress. pp. 106-118. 1954.
Situated between 1° and 7° north of the Equator, Malaya has a typical equatorial climate, with extremes in the lowland from 65° to 100° F. Rainfall averages about 100 inches annually and is well distributed.
The soils of Malaya in general are intrinsically poor, and soon loose their accumulated fertility when the forest is felled. They are mostly derived from granite or from quartzite and schist.
The Tropical rain forest covers about 30,000 sq. miles, or approximately 60 percent of the country. It includes all the forests of the Malay Peninsula from sea-level up to about 2,500 feet (800 m.) elevation, except for certain edaphic forests, such as mangrove swamp forest, beach forest and peat-swamp forest.
Of the principal timber species, the dominants are Dipterocarps. They include such heavy hardwoods as Balanocarpus heimii, species of Shorea, Hopea, Dryobalanops, and Dipterocarpus. Associated species are represented by 30 emergent and approximately 300 main story species that also yield timber. Among these are species of Eugenia, Calophyllum, Dillenia and Durian, and species of the families

Lauraceae, Sapotaceae, Burseraceae, and Myristicaceae.
There is a brief discussion of natural succession and ecological development following disturbance; also the seeding and growth habits of the principal species.

Landon, K.P. Siam in transition. ix: 328 pp. map. Univ. Chicago Press. 1939.
A survey of cultural trends in the five years since the revolution of 1932.

______. The Chinese in Thailand. 310 pp. Oxford University Press. 1941.
The author lived in Thailand from 1927 to 1937. He was at various times a missionary, school teacher, and editor of a monthly magazine which was published in Thai and Chinese. He returned to the United States to become assistant professor philosophy at Earlham College, Indiana.
This publication contains 12 chapters, dealing with such topics as: the status of Chinese in Thailand; Chinese family life; Chinese health in Thailand; Chinese and religion; general trade situation; planned economic development and the Chinese; government control of immigration, discrimination against Chinese in minor and major industries; government control of education; and Chinese in politics.
Included also are 4 appendixes, a bibliography and an index.

______. Thailand. The Annals of the American Academy of Political and Social Science. 226: 112-128. March 1943.
A treatment of Thailand with reference to races, government, social services, communications, agriculture and business, finance, military, and foreign policy.

Lecomte, H. (Ed.) Flore Générale de l'Indochine. 7 volumes. Paris, incomplete in 1951. 1: 1-1070. illustr. 1907-12. 1-1212. illustr. 1908-21. 3: 1-1279. illustr. 1922-23. 4: 1-1091. illustr. 1912-36. 5: 1106. illustr. 1910-31. 6: 1-1244. illustr. 1908-42. 7: 1-650. illustr. 1912-23. 7(2): fasc. 6-9, 1-544. illustr. 1939-41 (incomplete).
The most comprehensive flora of Indochina, including some of the areas covered by Craib's Thai flora and fundamental to the botany of Thailand. 1907-42. Supplements by H. Humbert and F. Gagnepain, 1938-46.

Leveillé, H. Decades plantarum novarum Ci-Ciii. Repert. Sp. Nov. Fedde 11: 492-496. 1913.
Includes Persicaria hosseussi n. sp. and P. chinensis var. siamense; A new variety from Hosseus' Siam collections.

Lee, W. Reconnaissance geological report of the districts of Payap and Maharashtra, northern Siam. Thailand Dept. of State Railways. 1923.

Le May, R. The Economic Conditions of Northeastern Siam. 172 pp. 25 tables. 5 illustr., and a sketch-map of northeastern Siam. Issued by the Ministry of Commerce and Communications, Bangkok. June 1932.

This is a report on the economic conditions in the two north-eastern circles of Nakon Rajasima and Udon.

Up to about 1932 the northeast of Thailand, owing to its remote position and difficulties of communication, was still little known to the general public. This part of the Kingdom covers about 63,444 sq. miles, or 31.7 percent of the total area of the country. It had a population in 1932 of nearly 4 millions, or more than one-third of the entire population.

Various resources, chiefly agricultural and forest products, are found in the area, and large tracts of land are suitable for rice cultivation, plantations and cattle raising. It is only within recent years that this region has begun to develop, with the advent of railroads and the construction of highways, providing quicker and cheaper transportation, with the result that the general economic conditions are showing some improvement.

There is a discussion of the principal industries, namely rice growing and cattle raising; and the trade and production of each of the 15 provinces within the two circles. A series of tables indicate population density; monthly and annual rainfall; crops under cultivation; live stock; trade; etc.

Lew, G. T. Observations on citrus culture in Thailand. Kasikorn 27 (4): 381-395. 1954.

Loetsch, F. The effects of shifting cultivation on the Composition of Tropical Forest, and the Regime of Rivers - A study of Northern Thailand (Title in German). Erdkund 12 (3). Sept. 1958.

This report treats with factors relating to the long established system of shifting agriculture, known as rai in Thailand and Vietnam and chancar in Cambodia, and which is widely practiced in Southeast Asia and other tropical regions. These include observations on:

(1) Areas covered by two types of forest: Mixed Deciduous Monsoon forest; and Semi-evergreen Broadleaf forest. Of this forested area 55 percent is considered unproductive.

(2) In some areas Teak slowly colonizes cutover areas; elsewhere it does not colonize cleared sites. Secondary growth is usually without Teak. This tree occurs in island-like stands. Under shifting cultivation valuable timber land is destroyed. The present area of Monsoon forest, with Teak, is about 45 percent of the original stand.

(3) Of areas above 1,000 m. in altitude, only one-third are unimpaired Broadleaf or Coniferous forests; two-fifths are clearings (nomadic); and one-fourth are savannas, resulting from earlier shifting cultivation. The practice of shifting cultivation has been on the increase during the last 25 years.

Shifting cultivation is of two types: (a) 1-year cultivation; and (b) no established cycle, which is destructive to the soil. This primitive system also causes extensive damage to valuable timber.

The author recommends the elimination of shifting cultivation from teak forest areas; and that teak planting should be increased.

Love, H. H. Methods used in making and testing a large number of rice selections in Thailand. Intl. Rice Comm. News Letter 7: 1-6. Sept. 1953.

______. Rice Improvement in Thailand. Foreign Agriculture 18 (2): 25-28. illustr. U. S. Dept. Agric. Washington, D. C. Feb. 1954.

Dr. Love was engaged from March 1950 as Rice Breeding Advisor, on the Special Technical and Economic Mission to Thailand.

Thailand, about the size of Texas, is ideally suited to rice production. Its fertile central flood plain, generally available water supplies, favorable climate, stable government, and lack of population pressure on land measures are factors that make possible a potentially significant increase in rice exports.

One of the problems investigated was the evaluation of rice varieties in Thailand for early, medium, and late-maturing; for upland, paddy, and deep-water rice; and for glutinous and non-glutinous varieties.

Line selection, for hybridization, was another phase of the program. Variety evaluation and selection were continued along with hybridization.

Mabesa, C. The Philippine Forests, with Special Reference to Dipterocarp Forests. Tropical Silviculture 3: 57-87. 8 tables. Foreign Agricultural Organization. 1958.

Although the forests of the Philippines are composed of diverse timber species, about 75 percent of the volume is represented by members of the Dipterocarp or wood-oil family. Influenced by ecological factors, such as altitude, relative humidity, soil moisture, exposure to wind and climate and other factors, Philippine forests are classified into different types.

A brief description is given of the occurrence of the following forest types: mangrove; littoral or beach; dipterocarp; molave; midmountain and mossy; and pine. In the discussion of the composition of the Dipterocarp forests, consideration is given to the principal timber species and associated woody plants.

The third section of the publication is devoted to site factors, such as: soil; climate; natural succession; ecological development following cutting, fire or other disturbance; and animal ecology. Under silvics, there is a brief discussion of the seeding and growth habits of the principal species. The fifth section treats with silviculture, under the heading of harvest cuttings and management of stands.

Section six discusses injuries and protection, in which consideration is given to: insect pests, diseases, damage caused by fire, and necessary control measures.

In section seven, there is a brief account of volume and yield. Section eight summarizes progress in current research, as well as a review of future planning.

The bibliography contains 12 titles. A list of 231 woody species cited in the text is also included.

Macmillan, H. F. Tropical planting and gardening with special reference to Ceylon. Ed. 4. i-x, 1-560. illustr. 1935.
A manual containing useful information on economic plants of the tropics, many of which occur in Thailand.

Macnae, W. Mangrove Swamps in South Africa. J. Ecol. 51: 1-25. Feb. 1963.
The fauna and certain elements of the flora of the coast of Natal have been shown to have affinities with the tropical Indo-West Pacific. Studies at Inhaca island, off Lourenço Marques have indicated that the fauna and flora of the sheltered shores of this island are more tropical in affinity than those of the open ocean shores. This account of the mangrove swamps in estuaries along the shores of Natal and the areas of the eastern Cap Province north of East London proves that tropical elements in the fauna can live in the sheltered water of estuaries at latitudes where the fauna of the open shores is a distinctly temperate one.
From a study of aerial photographs of the shores of South Africa it becomes clear that mangrove swamps are more rare than one might expect. Extensive mangroves occur only at the following places: at Kosi Bay close to the Moçambique border, where they extend alongside the channels about 1 mile from the mouth; at St. Lucia, close to the old mouth of the Umbolosi river and alongside the bridge over the St. Lucia river; at Richard's Bay and the mouth of the Umlalazi river, also in Zululand; on a backwater of the estuary of the Umgeni river, Durban North; in Durban Bay, on Salisbury island and the adjacent mainland they were formerly much more extensive, at Isipingo; at the mouth of the Umngazana river to the south of Port St. Johns and at the Umtata river mouth. Smaller areas of some significance occur at Sordinana Bay and at various localities in Pondoland. To the south of the Umtata river mouth there are only isolated clumps of trees at the Bashee and Nxanxo river mouths and a stand of occasional trees in a few estuaries to the southward.
Descriptions are given of several mangrove swamps in Natal and Pondoland.
It is demonstrated that in many ways the southernmost of these are more typically zoned than the northern and that the atypical zonation is due to the presence of sand which appears to restrict the growth of certain species, notably *Bruguiera*, *Rhizophora* and *Ceriops*. Under conditions where freshwater influence is strong, *Bruguiera* predominates and grows to 20 m; where the soil is well drained *Lumnitzera* may reach low intertidal levels.
It is clearly shown that where mangroves develop into a typical mangrove swamp they are accompanied by the same assemblage of animals, and that these animals with few exceptions do not extend to the south of the southernmost mangrove swamps. Most of these exceptions are only loosely associated with the mangroves. The

mangrove fauna, as such, is in fact a fauna of very sheltered marine shores and not an estuarine one, i.e. it is not a fauna characteristic of regions with salinity gradients but of regions with a variable salinity.

The article is accompanied by 4 figures, 2 tables and 16 references.

Macnae, W., and M. Kalk. The Ecology of the Mangrove Swamps at Inhaca Island, Moçambique. J. Ecol. 50: 19-34. Feb. 1962.

This paper discusses the mangrove swamps of Inhaca island, Moçambique. These mangroves are among the southernmost in the world. Two types of mangrove are recognized, a zoned mangrove focused on a creek or channel and a longshore mangrove with no zonation. Suggested reasons for this lack of zonation are postulated. The zonation of animals is related to that of the plants and trees but it is deduced that the animals are only fortuitously associated with the mangrove trees and that their distribution as well as that of the trees is controlled by (a) level of water table; (b) resistance to water loss; and (c) correlated with this, the demand for protection from the sun; (d) the degree of consolidation of the substratum, and in addition the animals may be limited by (e) the availability in the upper layers of the substratum of a microflora, a microfauna and of organic debris suitable for food.

Four illustrations and 2 sketch maps of the mangrove swamp at the northern and southern end of the island, and 33 references are included.

Mahaphol, S. Teak in Thailand. Thailand Royal Forest Dept. Bangkok. 1954.

Maliwan, P. Pretreatment of rice seedlings in Chandaburi. Kasikorn 27(2). 157-159. 1954.

Manjikul, A. Plant fibres (jute and others) of Thailand. Jour. Thailand Res. Soc. Nat. Hist. Suppl. 12(2): 261-268. pl. 1-5. 1940.

Largely economic data.

______. Manures and manuring of pepper. The Natural History Bulletin of the Siam Society 14 (2): 41-49. May 1947.

Discusses the results obtained by applying different types of manures.

______. Control of rice army worm. Kasikorn 26 (4): 421-429. 1953.

______. Tobacco and derris insecticides. Kasikorn 27 (4): 323-327. 1954.

Marcan, A. The story of drugs with special reference to Siamese medicinal plants. Journ. Siam. Soc. Nat. Hist. Suppl. 7(2): 107-117. 1927.

Markgraf, F. Monographie der Gattung Gnetum. Bull. Jard. Bot. (Buitenzorg) Ser. III, 10(4): 407-511. pl. 1-14. maps 1-8. May 1930.
Includes species from Thailand.

Marquand, C.V.B. Revision of the Old World species of Buddleja. Kew Bull. Misc. Inf. 1930: 177-208. 1930.

Marshall, C. Sustained yield management of the mangrove salt-water swamp forests of Fiji. Govt. Press. Suva. 1951.

Marshall, J.G.F. The Maihongson forests in Siam. Indian For. 27: 476-484. 1 folded map. 1901.
A general description of the Me Lan forest in the Maihongson and Muang Heng subdistricts, Chiengmai.

Maruyama, S. A peace corridor in Indo-China - A proposal. Japan Quarterly 10: 166-174. 1 map. April-June 1963.

Maurand, P. Une Richesse Ignorée: Les Forêts de Pins a 2 feuilles du Lang-Bian (Pinus merkusii): leur exploitation, leur reconstitution, leurs produits. Conservateur des Forêts, Chef de la Section de Sylviculture du Sud-Indochinois de L'Institut des Recherches Agronomiques et Forestièrs. Imprimerie d'Extreme-Orient. Hanoi. 1938.

______. L'Indochine forestière. Rapport au VIIe Congrès International d'agriculture tropicale et subtropicale. Paris 1937. [illegible] pp. illustr. 1 map. Hanoi. 1938.
This useful contribution, divided into [illegible] chapters, deals with: the forests of Indochina; forest exploitation; clearings - permanent, ray system, forest and brush fires; forest management; forest regeneration; wood utilization; minor forest products; and mangrove woodland.
The publication contains a series of tables; 41 photographs; 1 map on a scale of 1:2,000,000; and an alphabetical list of the most frequently used vernacular names of plants, mostly trees, of Indochina of economical value, with their corresponding botanical name, and Annamite, Cambodian and [illegible] names whenever available.

______. L'Indochine forestière. Inst. Rech. Agric. et For. de l'Indochine. 150 p. Hanoi. [illegible]
Mangrove is discussed on pages 137 to [illegible].

______. L'Indochine forestière. Institut des Recherches agronomiques et forestières de l'Indochine. 252 pp. illustr. 1 map. Hanoi. 1943.
This is a revision of the first publication, published in 1938, by Maurand on the forests of Indochina. As in the original edition, this issue contains chapters on the forests of Indochina; their exploitation; clearings for agricultural purpose, as well as damage

caused by forest fires; forest management; reforestation; timber utilization; minor forest products; and an appendix treating with mangrove and post-mangrove formations; muong (Cassia siamea); and tapping of pine for turpentine.

A map, on a scale of 1:2,200,000, is included; also an alphabetical list of vernacular and corresponding botanicalnames of species of commercial value, cited in the text; as well as their Annamite, Cambodian or Laotian names when known.

McClure, F.A. Bamboo culture in the South Pacific. Unasylva (10)3: 115-116. 1956.

Bamboo occupies an important part in the human economy of some regions, particularly in Southeast Asia and adjacent islands. The majority of the people would be utterly destitute without it. In vast areas bamboo is the one material that is sufficiently cheap and plentiful to fill the tremendous local needs. The author reviews several factors related to bamboo culture and uses, including the utilization of the leaves as a supplementary source of fodder and bedding for livestock.

McFarland, G. B. Thai-English dictionary. Bangkok Times Press, Ltd., Bangkok i-xxi, 1-1019, 1-39, 1941.

A separate alphabetical list of Latin names of plants with their Thai equivalents is given in the Addenda, on pages 14-39.

McNeil, Gomer T. Machinery for the photo interpreter. Photogrammetric Engineering 19(1): 121-124. Published by the American Society of Photogrammetry. March 1953.

Merrill, E. D. An enumeration of Hainan Plants. Lingnan Science Journal (Lingnan Agricultural Review) 5 (1&2): 1-186. Nov. 1927.

Hainan lies just within the tropics between 17° 52° and 20°8' north; its latitude being approximately that of Hawaii and of Cuba. It is separated from the Luichow Peninsula on the mainland of southeastern China by the shallow Hainan strait, which has a width of about 15 miles (24 kms.). The island is about 100 miles (160 kms.) long and 90 miles (24 kms.). wide. Its area is approximately 14,000 square miles, or nearly twice the size of the state of New Jersey, and almost exactly that of the island of Formosa.

The northern half of the island is a comparatively level plain broken by occasional low peaks, sloping gradually up toward the ranges of the interior. The southern half is rough and mountainous, the various ranges culminating in the Five Finger Mountains (Ng Chi Leng), which attain an altitude of about 6,000 feet (1,900 m.). An enumeration of the known plants from the island of Hainan is included.

______. Plant life of the Pacific World. 295 pp. 256 figs. The Macmillan Company, New York. 1945.

This publication, aimed mainly at the needs of the lay reader,

is one of a series describing the natural history and peoples of the Pacific Ocean and of its innumerable islands, large and small. Although more than 50,000 different species, representing 2,500 genera, of higher plants are now known in the Pacific area, the author believes that many thousands still await discovery and study. Many regions are characterized by strictly limited and relatively few types of plant life, such as the small low islands in the Pacific Ocean, and those in the extreme north. Others, such as the larger islands in Melanesia, Papuasia and Malaysia, support an extraordinarily rich plant life. While many parts of the area have been extensively and intensively explored from a botanical standpoint, few have been covered by exhaustive descriptive manuals or even by published lists of the known species.

Subjects discussed in the respective chapters are: the safe forest and jungle of the tropics; general principles of botanical classification; plants of the seashore; mangrove forest; secondary forests and open grasslands; primary forest; noteworthy plants of special interest; weeds and their significance; cultivated plants; jungle foods; problems of Malaysian plant distribution; problems of Polynesian plant distribution; the significance of certain local plant names; data on specific islands and island groups: and notes on botanical history, exploration and bibliography.

______., and E. H. Walker. A bibliography of eastern Asiatic botany. i, 719 pp. 2 maps. Published by the Arnold Arboretum of Harvard University, Cambridge, Mass. 1938.

A comprehensive work including the principal references on Siam, Indo-China, Burma and India.

Meslier, A. Les Forêts du Tonkin. Série Hanoi. No. 13. Congres D'Agriculture Coloniale. Gouvernement Général de l'Indochine. Hanoi-Haiphong. 1918.

Metcalfe, C. R. The structure and botanical identity of some scented woods from the East. Kew Bull. Misc. Inf. 1933 (1): 3-15. pl. 1-4. 1933.

Includes some species native to Thailand.

Meyer, A. Ueber einige Zusammenhaenge zwischen Klima und Boeden in Europa. Chemie der Erde., 2, 209-347. 1926.

Meyners d'Estrey, H. Chronique de Siam. Bull. Soc. Nat. Acclim. 35: 666-671. 1888.

A general account of plant products of economic value.

Mills, L.A., and Associates. The New World of Southeast Asia. 445 pp. 1 map. The University of Minnesota Press. 1949.

This publication contains a chapter on French Indochina by Charles A. Micaud; and a chapter on Thailand by K.P. Landon.

Ministry of Agriculture (Thailand). Thailand and her agricultural problems. 116 pp., illustr. Bangkok. 1949.
This booklet was compiled by members of the National FAO Committee at the suggestion of the Ministry of Agriculture of Thailand, as a source of information for those interested in FAO and other international organizations. Divided into 12 chapters, it contains data on rice culture and rice pests; veterinary work and biologics; irrigation in Thailand, aquatic resources and fisheries; the forest resources of Thailand and their economic importance; the cooperative movement in Thailand; Agricultural Institution at Kasetsart University; nutrition activities before and after the war; malaria and agriculture in Thailand; supplementary study on the trend of rice consumption; and the rice trade of Thailand.

______. Thailand and her agricultural problems 159 pp. Bangkok. Nov. 1950.
This booklet was written and compiled by members of National FAO Committee, Ministry of Agriculture, and originally issued in March 1949. It was reprinted in Nov. 1950, and the data brought up to date.

______. Annual reports for the years 1948 and 1950 to the Food and Agriculture Organization of the United Nations. Bangkok. 1951.

______. (Thailand) Annual report for 1948 to the Food and Agriculture Organization. 36 pp. Bangkok. 1948.
Divided into 3 sections, with 7 appendixes. Discusses the prevailing food and agriculture situation and prospects; per capita consumption; imports and exports; principal crops; and livestock products.

______. Annual report of the Government of Thailand for the year 1951-52 to the Food and Agriculture Organization of the United Nations. 52 pp. Bangkok. (Mimeographed). Bangkok. 1952.
This report contains information on progress and development in agriculture, fisheries, forestry, nutrition, cooperative movement, marketing, and a general review of economic situation of Thailand.

______. Thailand economic farm survey. 269 pp. (Mimeographed). Bangkok. 1953.

______. Some agricultural statistics of the Ministry of Agriculture, 1947-54. Bangkok. July, 1955.

______. A statistical review of Thai agriculture, 1954. Bangkok, 1956.

______. Unpublished phenological data for various crops. Dept. of Rice and Dept. of Agr. Exper. Sta. Bangkok. 1956.

______. Agriculture in Thailand. 231 pp. illustr., with maps. Bangkok. Sept. 1961.

In 1949 the Ministry of Agriculture issued 'Thailand and her Agriculture Problems', which was the forerunner of this contribution. The objective was to provide information on agriculture in Thailand, and to establish a foundation for technical improvement on various phases of agriculture within the country.

This publication, containing 11 chapters, treats with: agriculture; rice production and export; other economic crops, such as corn, cassava, fiber crops, sugarcane and rubber; aquatic resources and fisheries; livestock development and veterinary service; irrigation; forest and forestry program; agricultural education; health and agricultural development; agricultural cooperatives; and rice export of Thailand after World War II.

Ministry of Commerce and Communications, Thailand. The rice industry of Siam. 16 pp. Bangkok. 1926.

A brief treatment of rice and its significance to Thailand; also the methods, period of planting, harvesting and marketing of this important crop.

______. Lac cultivation and trade in Siam. 12 pp. Oct. 1926.

Lac is a product obtained from the lac insect, and contains a dye and a resin. Formerly, the lac-dye was utilized as a substitute for cochineal. After the discovery of analine, lac-dye became of little value, but when a method of using the resin was discovered, the latter became an important article of international trade. The most important lac-producing countries are: Thailand, India, and the former French Indochina. Thailand supplies sticklac or raw lac only, and has been an important source of this cultivated product for many years. Despite competition from synthetic products, it continues to be a steady article of export from Thailand.

______. The Record. Vol. 6. July 1926-April 1927. Bangkok. 1928.

Contains statistics on trade, passenger traffic, rice crop and export trade, timber market and tin output.

______. Siam, nature and industry. 1930.

Chapter ten deals with Flora.

Mitchell, B.A. Ornamental, roadside, and shade trees. The Malayan Forester. 96-144. April 1964.

The subject matter of this article is intentionally limited to the lowlands of Malaysia and no consideration is given to species suitable for use in the highlands (ca. 3,500 feet and upward), or to fruit trees. Cursory discussion is given to: collecting seed; planting and raising seedlings; transplanting larger trees; care and maintenance; availability of seed or seedlings; and suitability for particular sites or purposes. There is a descriptive list of selected species; also an index to vernacular and common names; and a list of plants sold in Penang and Singapore.

Mohr, E.C.J. Soils of equatorial regions, with special reference to the Netherland East Indies. Translated from the Dutch by Robert L. Pendleton. Edwards Brothers, Ann Arbor, Michigan. 1944.

Moldenke, H.N. The known geographic distribution of the members of the Verbenaceae and Avicenniaceae. 1-104. New York. March 12, 1942.
Includes plants of Thailand.

______. An alphabetized list of citations: Part I. A. to H.: 1-326. 1948; Part II. H. to L.: 327-652. 1949?; Part III. L. to S.: 653-978. 1949?; Part IV. S. to Z.: 979-1304. 1948-49.
The author's determinations of specimens by collectors, including institutions, some from eastern Thailand; covers Verbenaceae, Avicenniaceae, and Eriocaulaceae.

______. The known geographic distribution of the members of the Verbenaceae, Avicenniaceae, Stilbaceae, Symphoremaceae, and Eriocaulaceae. 1-215. 1949.
Determinations of specimens arranged geographically, including eastern Asiatic localities.

Moodie, A. W. Working plan for Delta Forest Division, Maymyo, Burma. Supterintendent Gov. Printing. Rangoon. 1924.

Morange, P. Culture de l'Hevea et du Colónies. Gouvernement Général de l'Indochine. Série Saigon Bulletin No. 11. 23 pp. Saigon. 1918.
Discusses the planting of rubber and coconut palm in Cochinchina (now part of South Vietnam).

Moseman, A.H. (Ed.). Agricultural Sciences for the Developing Nations. AAAS Symposium. Vol. 76, 232 pp. illustr., ref. index. Amer. Assoc. for the Adv. of Science. Washington, D.C. Oct. 1964.
This is based on a symposium presented at the Cleveland AAAS meeting, December 1963, to discuss the role of agricultural science and technology in the acceleration of economic progress in newly developing nations. The 12 chapters present an informed summary of the problems and opportunities of technical, economic and educational assistance in agriculture, characteristics of agricultural systems in emerging nations; research to devise and adapt innovations; education and development of human resources; and establishing indigenous institutions to serve advancing agriculture. This book should be helpful in furnishing background experience for the use of agricultural planners in newly emerging countries.
Contributors include officers of the Agency for International Development, the U. S. Department of Agriculture, Purdue University, The Ford Foundation, Ohio State University, Cornell University, The University of Chicago, and the Rockefeller Foundation.

Munsell, A.E.O. Munsell Book of Color. Defining, explaining and illustrating the fundamental characteristics of color. A revision and extension of 'The Atlas of the Munsell Color System.' Published by Munsell Color Company, Inc., Baltimore, Md. 42 pp., charts. 1929.

______. A color notation. An illustrated system defining all colors and their relations by measured scales of hue, value, and chroma. 74 pp. Tenth edition. 1946.

Muschler, R. Labiatae siamenses novae. Repert. Sp. Nov. Fedde 4: 268-270. 1907.
Based on Hosseus' collection.

Narkswaski, M. Farm Management Problems in Thailand. World Crops. Pages 455-459. illustr. Dec. 1963.
Thailand is an agricultural country, with about 85 percent of the population engaged in farming. A large proportion of the natural income comes from agricultural production and 90 percent of exports consists of agricultural commodities. However, an economic survey conducted in 1953 reported that the average net income of a farming family was only about U.S. $150.00, and that about 45 percent of this was derived directly from farming. The average family size was about 5 persons, and consequently the average income <u>per capita</u> was very small.
There is a need in Thailand for well-trained workers in farm management. Although many present-day workers have years of experience in the service, relatively few have sufficient basic knowledge of farm management. There is a need to provide training for these workers if they are to have a proper approach to scientific farm management. At present only Kasetsart University offers courses in this field. Thailand still has many problems in farm management, but progress is gradually being made in solving them.

National Economic Council (Thailand). Monthly Bulletin of Statistics. Bangkok. June 1952. (Mimeographed).
This Bulletin was prepared under the supervision of M.C. Athipurn P. Ksemsri, Director of the Government Statistical Service.
It contains data on population and other vital statistics; agriculture and fishery; foreign trade; price and cost of living; manufacturing production; mining; electricity power; and labor force.

Neang, S. Contribution à l'étude des forêts claires des Trois-Frontières. 71 pp. 1952.

Nelmes, E. Notes on <u>Carex.</u> Kew Bull. Misc. Inf. 1939: 657-659. 1939.
Three new Thai species are cited.

Nessel, H. Die Barlappgewachse (Lycopodiaceae). Eine beschreibende Zusammenstellung mit besonderer Bertucksichtigung ihrer varietatin und formen. 404 pp. 1 pl., 87 figs. Jena; Gustav Fischer. 1939.
Includes species from Thailand.

Nguyen, Van C. La Forêt vietnamienne et la politique forestiére nationale. 17 pp. Secretariat d'Etat á l'Agriculture. Sept.-Oct. 1959.
This paper traces briefly the history of the forests of Vietnam, conceding that little was known up to the Colonial period. It was known, however, that up to that time about three-fourths of the country was covered by forests. But by 1935 only about 42 percent of the country was covered by forest growth.
The author makes a comparison, from the standpoint of economics, between forests in temperate and tropical areas.

Noakes, D.S.P. A yield table for meranti. Malayan Forester 6: 204. 1937.

______. Mangrove. Proc. Fourth World Forestry Congress 3: 415-419. 1954.
This contribution refers to Mangrove woodland subject to tidal inundation, with particular reference to Malaya. It treats with its occurrence; composition; site factors, such as soil and climate; natural succession, ecological development after cutting and other disturbance, and animal ecology; silvics, including seeding and growth habits of principal species; and silviculture.

______. Mangrove. Tropical Silviculture 2: 309-318. FAO. Rome. 1957.

Noyon, F. Regeneration naturelle en forêt tropicale. Le 'Dipterocarpus deyrei' (Dau) sur le versant cambodgien du Golfe de Siam. Bois et Forêts des Tropiques 8(4): 368-378. 1948.
Notes on natural regeneration in tropical forest, with emphasis on Dipterocarpus deyeri (vernacular name 'dau') growing on the Cambodian side of the Gulf of Thailand.

Nuttonson, M.Y. The physical environment and agriculture of Vietnam, Laos and Cambodia. 137 pp. 73 figs. with appendix. American Institute of Crop Ecology, Washington, D.C. 1963. (Mimeographed).
This is a compilation of data extracted from field surveys, publications and reports covering a wide range of sources. It contains chapters on forestry, climate and soils, agricultural crops and livestock.
The appendix includes 73 tables with data on temperatures and precipitation recorded at 94 meteorological and climatological stations.

______. The physical environment and agriculture of Thailand. 256 pp. 1 map. 65 tables. 4 figs. American Institute of Crop Ecology, Washington, D.C. 1963. (Mimeographed).

This is a compilation of survey data, published materials and field reports on Thailand. It contains a discussion of the general and comparative geography of Thailand; climate; variations in rainfall; floods; droughts; water control systems; climatic classification of the natural vegetation of Thailand; economic classification of the forests of Thailand; soils and farm-land use of Thailand; economic background and principal agricultural products of Thailand; agricultural experiment stations and studies of varieties; phenology and yield of rice; distribution and production of farm crops; local field practices; control of crop pests, crop diseases; and weeds of Thailand.

Nyyssonen, A. Aerial photographs of tropical forests. Unasylva 16 (1). No. 64. pp. 3-12, 5 figs. 1962.

The sum of the factors of the environment that influence tree growth is measurable on aerial photographs to the extent that the key features of the environment can be recognized. Tree growth reflects thelocal climate and soil. Local climate and soil moisture, in turn, are apt to be closely related to the topography. Topographical data can be classified accurately from the stereoscopic image.

The following factors are described at some length: tree species identification; classification of forest cover types; and quantitive estimation of growing stock. Depending upon the quality of photographs, such information makes it possible to assess the value of aerial photographs as a source of practical information for use in forest survey.

In some cases identification of tree species from aerial photographs was remarkably successful, but on the whole the results were not adequate. Several successful experiments, however, showed that important forest types can be detected from aerial photographs, although checking and supplementation from the ground is also often necessary.

Photo-interpretation alone seems adequate for a survey of certain forest types. Sometimes this can be accomplished by aircraft or helicopter reconnaissance without photography. But it should be emphasized that ground work can not be dispensed with in tropical forest surveys.

The use of aerial photographs has important advantages in forest surveys. Above all, aerial photographs enable a study of stratification and arrangement of the ground work to be made in the most efficient manner, and are an excellent tool in surface area assessment. Photographs are also useful in practical survey work, in delineating roads, drainage, major topographical features and forest boundaries. Consequently, combined aerial and ground surveys seem to be the best procedure to make forest inventories.

A list of references is included.

Ogawa, H., K. Yoda and T. Kira. Nature and Life in Southeast Asia.

Vol I. A preliminary survey on the vegetation of Thailand. pp. 21-157. 25 tables. 71 figs. illustr. Osaka City University, Osaka, Japan. March 1961.

This publication represents the results of a preliminary ecological study on the natural vegetation of Thailand, especially of the northwestern region, made by the Osaka City University Biological Expedition to Southeast Asia during 1957-58.

Observations were made during four months of travel in the dry season. Five principal types of forest vegetation were recognized in the northwestern region: 1) Savanna forest - Dipterocarp savanna and Mixed savanna forest; 2) Tall deciduous or monsoon forest; 3) Evergreen gallery forest; 4) Subtropical semi-evergreen forest ecotone; and 5) Temperate evergreen forest.

Description of the forests of Burma given by Stamp reveals the close resemblance between Thailand and Burma with respect to forest types and their distribution according to climate. Four sample stands of forests and three of grassland vegetation were selected for intensive studies of their floristic composition, community structure, standing crop and soil organic matter. The floristic composition of the four forest stands are described in detail, based on a census of all trees taller than breast high. Structure of the forest communities was analyzed with special reference to stratification and dispersion of individuals and species over the plots. Eleven sample trees were felled in selected stands, and allometric relations between DBH, stem height, D^2H, leaf amount, total leaf area, amount of stem and branches, etc., were examined.

Total leaf area on unit ground surface or leaf area index (LAI) in the forest plots was estimated. Leaves, stems and branches of the sample trees, specimens of grasses and shrub shoots, leaf and branch litter and half-decomposed organic materials on the ground were analyzed separately for their carbon and total nitrogen content.

The literature cited contains 84 titles. A series of 55 photographs of forest formations supplements the report.

liver, D. Argostemma concinnum Hemsl. Hook. Icon. Pl. 24: pl. 2380. 1895.

A new species from Thailand.

_____. Lysimachia grandifolia Hemsl. Hook. Icon. Pl. 25: pl. 2405. 1895.

Native of Thailand.

'Neil, L.C. Some effects of artificial defoliation on the growth of Jack Pine (Pinus banksiana Lamb.). Canadian Journ. Bot. 40(2): 273-280. Feb. 1962.

Young jack pine (Pinus banksiana Lamb.) were defoliated manually to measure the effects of defoliation on growth of the species, and to determine the relative efficiency of foliage of different ages with respect to growth. The removal of 2 or 3-year old foliage had no appreciable effect on tree growth, but their joint removal reduced height growth. There was also a reduction in height growth by the removal of 1-year old foliage. Current foliage was found to be essential for the maintenance of normal height, diameter and shoot growth. Its removal induced high bud mortality, the production of profuse adventitious growth, and a reduction in the rate of shoot elongation. Complete defoliation resulted in the death of the tree shortly thereafter. Growth reduction resulting from some of the treatments following defoliation soon showed infestation by the Swaine jack-pine sawfly (Neodiprion swainei Midd.). The results are compared with those obtained by several other workers in the field.

O'Neill, H.T., and W.J. Nagel. The Minythoscope: an instrument for viewing any type of photography in gradually decreasing size (or scale) for many purposes. Part IV. Instrumental aids in Photo-interpretation. Photogrammetric Engineering. 533-535. June 1957.
The minythoscope is an instrument designed to facilitate observation and the comparative study of objects as they become smaller in size, in order to discover what general principles, if any, are involved when details vanish and coalesce into a new but often characteristic configuration.

Orleans, Prince H.d'. Around Tonkin and Siam. i-xii, 426 pp. illustr. 1 folded map. London. 1894.
An English translation by C. B. Putnam of this traveller's account, with botanical observations.

______. From Tonkin to India by the source of the Irawadi, January '95 - January '96. i-xii, 437 pp. illustr. 1898.
Includes, on pages 420-431, a list of plants collected by A. Franchet.

Ostenfeld, C.H. A list of plants collected in the Raheng District, Upper Siam, by Mr. E. Linhard, determined by C.B. Clarke, G. Hieronymus, O. Stapf and published by the Botanical Museum of Copenhagen. Bull. Herb. Boiss. Ser. II. 5 (8): 709-724. July 1905.
A systematic enumeration; includes ferns, seed plants and one fungus, with several new species.

______. Utricularia duae novae Siamenses. Repert. Sp. Nov. Fedde 2: 65-69. 1906.
U. siamensis and U. bosminifera; new species collected by J. Schmidt.

Owens, J.S. Better yields with fertilizers. Intl. Rice Comm. News Letter 7: 7-9. 1953.

Panyalaksana, P. Characteristics of some varieties of rice. Kasikorn 23 (5): 325-332. 1950.

______., and S. Bhakdi. Influence of the time of harvesting on the milling quality of paddy. Kasikorn 26 (3): 317-331. 1953.

Pa[illegible]punna, P. Obstacles in increasing the upland crop production in the northeast. Kasikorn 27 (3): 236-238. 1954.

Pasquier, P. Les colonisation des terres incultes. Gouvernement Général de l'Indochine. Bulletin No. 2. 18 pp. Saigon. 1918.
Treats with the settlement of uncultivated land.

Patrick, R. A taxonomic and distributional study of some diatoms from Siam and the Federated Malay States. Proc. Acad. Philadelphia 88: 367-470. 11 plates. 1937.
Contains an extensive bibliography on pages 448-470.

Paulson, R. Lichens from Kaw Tao, an island in the Gulf of Siam. Journ. Siam. Soc. Nat. Hist. Suppl. 8 (2): 99-101. 1930.
A list of collections by A.F.G. Kerr.

Pelzer, K.J. An economic survey of the Pacific area. Part I: Population and land utilization. 215 pp. 188 tables. Inst. Pacific Relations. New York. 1941.
This is one of a group of monographs designed to bring up to date the Economic Handbook of the Pacific Area, published by the Institute of Pacific Relations in 1934.

Pendleton, R. L. Some interrelations between agriculture and forestry, particularly in Thailand. Jour. Thailand Research Society 12 (1): 33-52. 8 figs. Bangkok. Dec. 1939.
This paper calls attention to some of the less well-known facts and relationship between forests, climate and agriculture. In the humid tropics agriculture and forestry are very closely related, as contrasted with conditions in temperate regions where, in some respects, horticultural, agronomic and forestry methods and practices are relatively distinct. Inasmuch as forestry methods are increasingly important in the conservation and management of the soil in tropical regions, and the methods of producing certain upland crops are not generally understood, it seems worth while to consider some of these methods. Certain misconceptions regarding the interrelationships between forests and climate are mentioned, because of their immediate effect on some agricultural problems. A rather different emphasis regarding these interrelationships is noted, hence some of the statements may seem radical. The purpose of the emphasis is to attempt to discount certain conceptions regarding the effects of forests which, though generally held, are still far from being definitely proved.
Forests, although they transpire much water from the soil, and

may hold back even 20 percent of the rainfall from reaching the soil, nevertheless facilitate, thru the production of organic matter, moisture percolation into the soil. They also retard the run-off of rainwater to such a degree that they render the water which actually flows off more useful, as compared with that from slopes without forest. This is because the forests contribute to the more uniform flow of streams throughout the year, thus preserving the stream channels and other associated benefits.

Pioneers and primitive peoples have always had dendrophobia and have used caingin,shifting method of agriculture. Practiced to the extreme caingin agriculture leads to the extinction of peoples thru the development of grassy deserts, and which persist as a result of annual burning. Such consequent grass lands cannot be cultivated with primitive hand tools, the only kind available to these people. Annual fires also prevent forest regeneration.

The caingin system can be replaced by horticultural or clean culture methods, such as are used in temperate regions with the use of strong plows drawn by draft animals or tractors. Nevertheless, such types of cultivation encourage soil erosion and rapidly deplete the soil. Tropical soils planted to rubber, tea and coffee, for example, have suffered seriously thru the application of these types of cultivation. Tropical soils usually are not nearly as rich as is supposed; the prolific growth of the tropical forest is misleading; and the deterioration of tropical forest soils after clearing is more rapid than that of temperate zone soils. In the case of soils planted to Pará rubber (Hevea), the practice is to use forestry methods, by planting permanent cover crops to prevent erosion and to conserve fertility.

If soil fertility is to be conserved and the interests of the population are to be served, it is necessary to have a balanced development of forests and agriculture. Not only are tree products as well as annual grains and similar crops essential to man, but these crops are dependent upon an extremely thin, easily damaged and slowly repaired soil. While soil erosion, if excessive, is serious and completely destroys the soil, some erosion is necessary, nevertheless, to remove slowly the completely weathered out and impoverished surface material.

______. Soil erosion as related to land utilization in the humid tropics. Proceedings of the Sixth Pacific Science Congress 4: 905-920. 1939.

______. Laterite in Siam and Cambodia. Proceedings of the Sixth Pacific Science Congress 4: 969-971. 1939.

______. Further notes on laterite. Proceedings of the Sixth Pacific Science Congress 4: 973-978. 1939.

______. Soil erosion in the tropics. Journ. Forestry 38 (10): 753-762. Oct. 1940.

Attention is drawn to the fact that training in Soil Science in temperate countries is inadequate for the full appreciation, proper interpretation and management of tropical soils. There is a brief discussion of soil erosion in Thailand.

______. Soils of Thailand. Jour. Thai. Res. Soc. Nat. Hist. Suppl. 12 (2): 235-260. 16 figs. 1940.

______. Impressions of the Philippines and the United States: from the notebook of a soil scientist. Thai. Res. Soc. Bull. (formerly the Nat. Hist. Suppl.) 13 (1): 1-20. 9 plates. 1941.

This is a generalization and comparison of the soils of the Philippines and the United States with those of Thailand.

______. Laterite and its structural uses in Thailand and Cambodia. Geogr. Rev. 31: 177-202. 63 figs. 1941.

______. Some results of termite activity in Thailand soils. Thai Science Bulletin 3 (2): 29-53. illustr. April 1941.

Much has been published about the destructiveness of termites. In many parts of Thailand these ubiquitous insects are of considerable benefit to farmers. Millions of mounds built by termites furnish the farmers with small plots of modified soil which, when utilized properly, are useful for the production of tobacco, cotton, chillies, vegetables, and mulberry leaves.

Large quantities of calcium carbonate, in the form of concretions, resembling kankar, are formed by these insects. The characteristics of the termitorium developed by these insects and the importance of the mounds for agricultural production are described.

______. Laterite, or Sila Laeng, a peculiar soil formation. Thai Science Bulletin 3 (3-4): 61-77. illustr. Dec. 1941.

In gradually-sloping land, around the well-watered rice plains of Thailand and covered by slow-growing, open forest, the soil is light sandy with a layer of 'hardpan' of iron oxides and related compounds known as 'Sila laeng'. This material is laterite which has developed in the soil during the course of many ages.

The author gives a summary and conclusions on the subject, supplemented by 26 references.

______. Importance of termites in modifying certain Thailand soils. Journ. Amer. Soc. Agron. 24 (4): 340-344. 3 figs. 1942.

This is a summary of the more extensive paper published in Bangkok in 1941.

______. Land use in Northeastern Thailand. Geographical Review 23 (1): 15-41. illustr. 1 map. The American Geographical Society of New York. Jan. 1943.

Northeastern Thailand, often known as the Korat Plateau, from an old name of the principal town, Nakorn Rachasima, lies between the great eastward bend of the Mekong River and the Dong Phya Yen Mountains. It comprises 167,000 square kilometers (64,000 square miles), or nearly one-third the area of the entire kingdom. The author discusses briefly the climate of this northeastern region; rocks, soils, and natural vegetation; the people; agriculture; rice and rice fields; shifting agriculture; cattle raising and associated activities; rice milling; hogs and poultry; fruit and other tree crops; benefits of termites; forest utilization; and sources of salt.

The article is well illustrated.

______. The formation, development, and utilization of the soils of the Bangkok Plain. The Nat. Hist. Bull. of the Siam Soc. 14 (2): 1-40. 1 map. 7 illustr. May 1947.

The soils of the Bangkok plain exemplify many stages in the development of laterite from riverborne alluvium. Some stages are: marine clays, young clays producing good padi, mature, less fertile clays, senile unproductive soils and laterite. The rejuvenating effects of river action, salt water and of riverborne silt on mature and senile soils are evident.

Bangkok has long been a large consuming center and, until recent years, transportation from areas with soils naturally adapted to year-round production of fruits and vegetables was not practicable. Therefore Chinese methods of diking, draining, and ridging have been extensively used in the Bangkok area to adapt these heavy, wet clays for the growing of vegetables and fruit trees.

______. Impressions of Doi Pulanka. Jour. of the Siam. Soc. 2: 144-148. 7 figs. 1948.

Some notes on the Yao and Miao villages, and land utilization on this mountain near the border of Laos

______. Improving soil productivity in Southeastern Asia and the Indies. U.N. Scientific Conference on the Conservation and Utilization of Resources. 23 pages. 1949. (Mimeographed.)

Discusses the unique methods used by Chinese farmers to make the most effective use of the limited amounts of organic substances in poor soils in that area. Most of this paper appeared subsequently in the Co-op Grain Quarterly, pages 26-32. 10 figs. Chicago. 1950.

______. Soils and land use in Peninsular Siam. Tech. Bull. No. 3. 178 pp. 33 figs. Thai Department of Agriculture. 1949.

Contains observations on soil profile and land utilization, assembled in the course of various field trips throughout peninsular Thailand.

______. Notes on soils and land utilization in Southeastern Siam; with some comments upon the improvement of the agriculture of this area. Techn. Bull. No. 4. 123 pp. 31 figs. Thai Department of Agriculture. 1950.

This Bulletin summarizes the observations made and presents descriptions of soil profiles gathered in the course of numerous field trips during 1935 to 1941.

_. Agricultural and forestry potentialities of the tropics. Agronomy Journal 42 (3): 115-123. March 1950.

A presentation of facts and comparisons based on extensive travel in the tropical regions of Asia and the New World.

_. Report to accompany the provisional map of the soils and surface rocks of the Kingdom of Siam. 290 pp. 1 map. Mutual Security Agency, United States. Special Technical and Economic Mission to Thailand. Jan. 1953. (Mimeographed.)

This voluminous report complements a soil map printed in color in order to distinguish and separate the several soil bodies or profiles. Seldom does the color of the soil have any relation whatsoever to the color which has been used to distinguish it on the map. Each of the various soil groups and types, in most cases, represents a considerable range of soil characteristics.

Because of a greater or less variability of the map colors and between those on the legend 'sample' blocks, soil identifications are checked on the map by means of numbers, indicated on or close to every soil body and the 'sample' block according to the annotated soil legend in which 23 soil types are cited.

The publication contains a comprehensive discussion of the soils and other pertinent data on the main topographic subdivisions of Thailand: the principal river basins; the northern mountains and valleys; the Central Valley; and the Korat Plateau. To supplement, there are notes of field work undertaken in certain less known parts of northeastern Thailand; the Bangkok Plain; southeastern Thailand; and peninsular Thailand.

A brief annotated list of references is included.

___. Thailand - Aspects of Landscape and Life. 321 pp. 51 photos. 26 maps and charts. Duell, Sloan and Pearce. 1962.

This well illustrated publication, written with the assistance of others and completed after the demise of the author, is one of the best sources of information on Thailand. It contains 10 chapters, covering such subjects as: the history of Thailand; its physiography and geology; soils, natural vegetation and animal life; climate and water economy; the agrarian landscape; irrigation; rice agriculture and farm systems; subsidiary crops; animal husbandry and fishing; utilization of forests; mineral deposits and their development; hydroelectric power, and its industrial potential; and the manufacturing industry, transportation, communications, and trade.

____., and S. Sharasvuana. Analyses and profile notes of some laterite soils and soils with iron concretions of Thailand. Soil Science 54 (1): 1-26. 8 figs. July 1942.

______. Analyses of some Siamese laterites. Soil Science 62 (6): 423-440. Dec. 1946.

These two contributions present certain overall considerations and relationships between laterites and the parent materials from which they have developed. The second paper contains analyses of laterites gathered from ancient buildings. Unfortunately the methods of analysis were not the most suitable to show their relationship to the best advantage.

Pham-Hoang-Ho. Cay-co mien nam Vietnam (Vegetation of Vietnam). Bo Quoc-gia Giao-Duo. 803 pp. figs. Taxonomic treatment with scientific names. Saigon. 1960.

This publication, written in Vietnamese, treats with the plants of Vietnam, arranged according to family, with a key to genera, and a brief description of the species. A line drawing accompanies a large number of the plants described.

A list of vernacular names, arranged in alphabetical order, with corresponding botanical names is included.

Phananuchorn, P. Forests of Siam and their resources. Siam Today, 47-53. 11 figs. July 1937.

A general account, largely concerning the exploitation of Thai forests.

Picharn, P.V. List of common trees, shrubs, etc., in Siam ... for the use of foresters, timber traders and students. 278 pp. Bangkok Times Press. 1923.

Vernacular and Latin names are given. Printed with wide space for insertion of notes. Reviewed by A.F.G. Kerr, with critical notes on vernacular names in Journ. Siam. Soc. 17: 214-215. 1923.

Pierre, L. Flore forestière de la Cochinchine. In volume 1: pl. 1-96. 1879-83. 2: pl. 97-169. 1885-88. 3: pl. 170-256. 1888-91. 4: pl. 257-332. 1892-95. 5: pl. 333-400. 1895-99. Register 1-14. 1907.

A folio-sized publication containing plates with descriptive letterpress, and illustrating forest plants Issued in 26 fascicles.

It includes new species based on Siam collections.

Pilger, R. Zwei neue Bambuseae aus Siam. Repert. Sp. Nov. Fedde 3: 116-117. 1906.

Oxytenanthera hosseusii and Dendrocalamus nudus; new species collected by Hosseus.

Piper, C.V., and S.T. Dunn. A revision of Canavalia. Kew Bull. Misc. Inf. 1922: 129-145. 1 map. 1922.

Includes Thai species.

Pisek, A., and E. Cartellieri. Zur Kenntnis des Wasserhaushaltes der Pflanzen. IV. Jahrb. Wiss. Bot., 88, 22. 1931, 1932, 1939.

Polchart, P. Durian orchards in Dhonburi. Kasikorn 26 (6): 505-514. 1952.

______. Mandarin growing in Dhonburi. Kasikorn 26 (6): 589-594. 1953.

______. Making palm sugar in Bangkok. Kasikorn 27 (4): 353-359. 1954.

Poore, M.E.D. Problems in the classification of tropical rain forest. Journ. of Tropical Geography 17: 12-19. May 1963.

The author points out the many valid systems of classification available for any particular range of phenomena. Each of these may be equally suitable for a particular purpose. For example, leaves can be classified according to their size, shape, color, venation, methods of development and other criteria. There is a tendency in Biology to try to arrive at what is known as 'natural' classification. The taxonomy of plants or animals has been considered, since the time of Darwin, to reflect the relationship of organisms by descent, which is synonymous with a phylogenetic classification. In vegetation it is difficult to establish a classification on the principle of descent. Among various possible classifications the most valuable is probably that which reflects most faithfully the relationship between vegetation and habitat. Therefore, the aim of this article is to discuss vegetation, but not from the standpoint of the ecosystem or with what Sukachev calls the geobiocoenose, which is a combination of the ecosystem with the concomitant environment. This is not due to a failure to appreciate the value of such synthetic concepts, but it is necessary to approach the task with a certain degree of realism. The problems of vegetation are sufficiently vast without including other equally large and possibly more complex fields of research.

The author discusses the criteria - habitat, physiognomy and floristics - proposed for the classification of vegetation; the intrinsic difficulties in the classification and ordination of vegetation; and stages in the classification of vegetation.

This paper deals primarily with problems involved in the classification of vegetation rather than with the result. Knowledge of the Rain forest in Malaya, for example, is more advanced than in many equatorial regions, but basic data on its structure and pattern are inadequate. Consequently it is still too early to develop methods that are satisfactory and economical to classify forest types and to determine their relation to habitat.

No conclusions were drawn from the results, but a number of possibilities emerged which warrant further study. Preliminary results strongly suggested that, at least in the upper stories of the forest, there are a number of tree species which are approximately equivalent in their habitat requirements at all stages. The actual species which reach the canopy in any one plane depends on the chances of establishment at the time the gap is formed. If many species behave in the same manner it is possible that the best means of classifying forest types precisely would be by other vegetational criteria.

A cursory analysis of data gathered in Malaya by the author indicated that there are a number of species in each forest type which occur constantly in areas of half an acre. Although not all of these are emergent or main story species, they may serve as a reliable means of defining and identifying various forest types.
A bibliography of 18 titles is included.

Prain, D. The genus Chrozophora. Kew Bull. Misc. Inf. 49-120. 1918.
Includes Thai species.

______., and I. H. Burkill. Diagnoses specierum novarum generis Dioscoreae. Kew Bull. Misc. Inf. 2: 58-66. 1925.
Includes Dioscorea gracilipes and D. calcicola; species new to Thailand.

______. The genus Dioscorea in Siam. Kew Bull. Misc. Inf. 225-245. 1 fig. 5 maps. 1927.
A critical treatment of 32 species including several new ones.

______. Dioscorea: Section Stenocorea. Kew Bull. Misc. Inf. 88-91. 1 map. 1931.
A systematic treatment, including two Thai species.

______. Dioscoreae novae asiaticae. Kew Bull. Misc. Inf. 1933 (5): 240-246. 1933.
Includes Dioscorea filicaulis and D. depauperata; new species to Thailand.

Prain, D, and I.H. Burkill. Dioscoreae novae asiaticae. Kew Bull. Misc. Inf. 425-427. 1930.
Includes D. craibiana, a species new to Thailand.

Prescott, J.A. and R.L. Pendleton. Laterite and Lateritic Soils. Commonwealth Bureau of Soil Science, Rothamsted Experiment Station, Harpenden. Technical Communication No. 47. 51 pp. illustr. Commonwealth Agricultural Bureaux, Farnham Royal, Bucks., England. 1952.
The term 'laterite' was suggested originally by Buchanan (1807) as a name for a highly ferruginous deposit first observed in Malabar during his journey through the countries of Mysore, Canara and Malabar in 1800-01. In the introduction, the authors trace the indefinite and often inexact uses of the term 'laterite'.
In subsequent chapters there is a treatment of the field characteristics of laterite; geographical distribution of laterite, including its occurrence in Southeast Asia; the origin and nature of laterite; and lateritic soils. The authors conclude that, after a survey of the literature and historical data relating to the origin of 'laterite', the term has been used in two different ways.
An extensive bibliography on the subject is included.

Pugh, M.A. Economic development of Siam. U. S. Department of Commerce Bulletin No. 606. 45 pp. Washington, D. C. 1929.
This bulletin discusses the principal features of the economic and commercial development in Thailand. In its preparation, a review was made of annual reports of the various Thai government departments, records of the official board of commercial development, and a series of pamphlets on Thailand printed by the Bangkok Times Press during Nov. 1926.

Purnariksha, R. The situation of phosphate fertilizer in Thailand. Kasikorn 26 (1): 92-97. 1953.

______. Superphosphate vs. rock phosphate. Kasikorn 26 (6): 627-633. 1953.

______., and P. Thitatarn. Rice fertilizer trial. Kasikorn 25 (2): 158-167. 1952.

Quackenbush, R.S., Jr. The development of photo interpretation. Manual of Photo Interpretation. Chapter I. pp. 1-9. 1960.

Queripel, A.L. Introduced plants. Journal Siam Soc. Nat. Hist. Suppl. 8 (4): 335. 1932.
A brief note on Azadirachtia indica, grapefruit, and lemon.

Quesnel, M.P. L'Agriculture indigéne en Cochinchine. Gouvernement Général de l'Indochine Bulletin No. 2. 47 pp. Saigon. 1918.
A discussion of agriculture among primitive people in Cochin-China, now a part of South Vietnam.

Ramiah, K. Factors affecting Rice production. FAO. Agriculture Development Paper No. 45. 45 pp. 1 table. Food and Agriculture Organization of the United Nations. Rome, Italy. Dec. 1954.
This paper is a compilation of material on general conditions of production in various countries, such as treatment of soil, and climatic, geographic, economic and social factors which affect rice yields, for evaluation by India and other countries to determine how to raise their production.
The data are presented in two forms: first, they are summarized and analyzed in the body of the paper; second, for the purpose of clarity and comparison, they are arranged in tabular form.

______. Fertilizer use for increased rice production. Intl. Rice Comm. News Letter No. 10: 1-9. 1954.

Ratanajan, P. Raising watermelon in dry season. Kasikorn 26 (6): 583-588. 1953.

Ratanaprasidhi, M. Forest Industries and Forestry of Thailand. 31 pp. Royal Forest Department, Ministry of Agriculture. Bangkok. 1963. (Mimeographed.)

The forests of Thailand are the source of raw materials for various industries. They may be classified into two main categories: major and minor forest products.

The first part of the paper is devoted to the major forest products and treats with timber exploration, production of plywood and veneer, chip board, manufacture of furniture, pulp and paper, and miscellaneous industries. The second part deals with minor forest-products, such as bamboos, rattan, barks, tree exudates and dye plants. The third part treats with export and domestic consumption. The fourth and fifth parts discuss forestry and related problems; and a short treatment of forest protection.

Raunkiaer, C. The Life Forms of Plants and Statistical Plant Geography. The Use of Leaf-Size in Biological Plant Geography. pp. 368-378. The Clarendon Press, Oxford, 1934.

It has long been known that a series of different adaptations in the structure of plants enable them to endure excessive evaporation, and thus allow them to live in an environment with intense evaporation, or where conditions for absorption of water from the ground, either physically or physiologically, are favorable. Examples of such structure are: (1) covering of wax; (2) thick cuticle; (3) sub-epidermal protective tissue; (4) water tissue; (5) covering of hairs; (6) covering of the stomata; (7) sinking of the stomata; (8) inclusion of the stomata in a space protected from air currents; (9) diminution of the evaporating surface; etc.

The subject is so complicated that it is difficult to reach an exact appraisal of these adaptations in characterizing individual plant communities biologically. The fact is that in a community which survives dry periods, some species are adapted to their environment in one way, others in different ways. We are still unable to determine quantitatively the value of individual adaptations or the different combinations of adaptations.

If we examine and compare simple and compound leaves of plants with the same life-forms in the same formations, or more properly in the same layer of the formation, for example the upper layer of the Deciduos phanerophytic vegetation of woodlands, or the upper story of the West Indian Evergreen phanerophytic vegetation, it is found that compound leaves are on an average much larger than simple leaves, and which belong to a smaller size class.

Raunkiaer decided on 6 classes: Leptophylls - 25 sq. mm. or 0.000024 sq.mm.; Nanophylls - 9 x 25 equal 225 sq. mm.; Microphylls - 9^2 x 25 equal 2,025 sq. mm.; Mesophylls - 9^3 x 25 equal 18,225 sq. mm.; Macrophylls equal 9^4 x 25 equal 164,025 sq. mm.; and Megaphylls.

Rawitscher, F., and R.L. Pendleton. Climate of Tropical Forests and Savannas. The Natural History Bulletin of The Siam Society 15 (1): 89-111. Sept. 1952.

Under natural conditions the boundaries between tropical forests and savannas depend, generally speaking, upon the humidity factor. An exact determination, however, of the amount of rain necessary for the existence of forests is very difficult. General considerations which lead to the establishment of rain factors, aridity coefficients, and climatic types of formulae do not include the important physiological factors of plant transpiration or the existence of subterranean water reserves which may be stored at great depths in tropical soils.

The data on water requirements of forests from classical plant ecology are based upon the assumption that the present distribution of tropical forests and savannas corresponds to the ecological conditions of their environment. It is known, especially from researches in central equatorial Africa, that great areas of savannas, now occupying deteriorated soils, were forested in former times.

More reliable data are obtained from the direct determination of transpiration values, which are scarce because of difficulty to obtain, or from a computation based on the knowledge of the total precipitation and of drainage water of an entire river basin covered by equatorial forest.

The practical importance of such data is emphasized. For example, it is possible to distinguish savannas which can be reclaimed. A consideration of all the facts involved indicates how this reclamation can best be done. It is clear that agricultural methods used in temperate regions are inappropriate when applied to tropical lowland soils. Such practices disturb the water balance of tropical soils, favor serious surface erosion, cause internal leaching of soils, and there is evidence that they produce an irreversible degradation of soil fertility.

Raymond, M. Carices Indochinenses Necnon Siamenses. Mèmoires du Jardin Botanique de Montréal, No. 53. 125 pp. Montréal. Feb. 1959.

Reinking, O.A., and G.W. Gross. The kao pan seedless Siamese pummelo and its culture. Philippine Journal Science. 19: 389-437. 1921.

Rich, R. W. Aerial photography as a means of measuring plant cover and composition. In Techniques and Methods of Measuring Understory Vegetation. Proceedings of a Symposium at Tifton, Georgia. pp. 79-81. Oct. 1958.

Richards, P.W. The Tropical Rain Forest - An ecological study. 540 pp. 43 text figs. and 15 plates. Univ. Press, Cambridge. 1952.

This is probably the most authoritative and comprehensive reference on this vast and complicated subject. It contains 17 chapters, divided into 6 parts. Part 1 - Treats with structure and physiognomy of the Tropical Rain forest; Part 2 - The Environment; Part 3 - Floristic composition of Climax communities; Part 4 - Primary successions; Part 5 - Tropical Rain forest under limiting conditions; and Part 6 - Man and the Tropical Rain forest.

A postscript treats with the future of the Tropical Rain forest. Included also are a long list of references; an index of plant names; and a general index.

_______. The types of vegetation of the humid tropics in relation to the soil. Proc. of the Abidjan Symposium U.N.E.S.C.O. pp. 15-23. 1961.

This is a discussion of: 1) the principal types of vegetation in the plains and lower mountain regions of equatorial and subequatorial zones and in adjoining tropical areas, and the soils in which they are to be found; 2) characteristics of soils in this climatic zone which influence the occurrence of vegetation, and the possible influence of the various types of vegetation on the soil; and 3) evaluation of the soil in bringing the land under cultivation.

_______. Plant Life and Tropical Climate. Biometeorology. pp. 67-75. 1962.

The absence of a cold season results in plant activities in the tropics being limited by lack of water rather than by low temperatures. The distribution of natural vegetation types in the tropics is thus mainly determined by the seasonal distribution of rainfall. The effects of excessively high temperatures on plants growing in some tropical habitats has been little studied, but the survival of some plant species in the same areas seems to be dependent on the cooling effect due to transpiration. Information on the growth rates of plants, apart from a few cultivated species, is surprisingly incomplete. Available data indicate that the very high rates among some species depend on the rapid development of new leaf area rather than on net assimilation rates being higher than those of temperate plants. Scanty evidence suggests that the rate of organic production by tropical forests is not much higher than in temperate hardwood forests.

In tropical countries, with little seasonal change, plants often show regular rhythms of flowering, leaf change, etc., but these may be out of phase with the climate. Even where there are marked wet and dry seasons, plants do not always behave in the way expected. For example, some trees lose their leaves in the wet season, but not in the dry period. Seasonal rhythm in plants seems to be partly dependent on internal physiological rhythm and not entirely on the external environment. Even in latitudes where differences in day-length are very small, day-length may be an important factor in controlling flowering and other seasonal phenomena in plants.

Literature cited contains twelve titles.

_______., A.G. Tansley and A.S. Watt. The recording of structure, life-form and flora of tropical forest communities as a basis for their classification. Imperial Forestry Institute, University of Oxford, Institute Paper No. 19. pp. 3-19. 1939.

This paper forms a valuable supplement to Burtt Davy's Institute Paper No. 13, published in 1938. It embodies the opinion of a

Committee appointed by the British Ecological Society to report on the classification of tropical vegetation. The authors consider that a natural scheme of classification should be based on the structure, life-form and flora of the component communities, rather than on mixed criteria including habitat. They emphasize, also, that Associations should be named from species present, not from a presumed formation to which the Association belongs.

They have not attempted any reclassification of the Formations as outlined in Paper 13, pending the accumulation of more data on the subject. They consider that the three main classes of Formation - Woodland, Grassland, and Desert - do not require any special term by which to designate them, and that the term Formation-type is most aptly applied to the aggregate of communities all over the world dominated by a distinctive life-form, for example, Rain-forest, Thorn-forest, etc., while such geographically distinct unit of such a Formation-type is recognized as a distinct Formation.

A useful feature of this contribution is the reduction in number of features to be recorded, from 96 proposed in Paper 13 to 42, on the ground that the larger number is likely to deter field investigators from attempting any systematic recording of vegetational data by the immensity of the task. The object of suggesting so many factors was aimed at securing the cooperation of those who, although unable to undertake a definite ecological survey, are interested in cognate subjects, such as ornithology, anthropology, etc., and which have a bearing on the biotic influences affecting the forest.

The authors point out that this paper is intended to aid foresters, ecologists and botanists interested in tropical vegetation, and to stimulate field investigations along definite and uniform lines.

Ridley, H.N. On the flora of the eastern coast of the Malay Peninsula. Trans. Linn. Soc. Bot. II. 3: 267-408. pl. 61-66. 1893.

Concerns Pahang in the Malay States, but includes a few plants from adjacent provinces of Thailand.

______. The Scitamineae of the Malay Peninsula. Journ. Str. Br. Roy. Asiat. Soc. 32: 85-184. 1899.

Includes some Thai species.

______. New Malayan plants. Journ. Bot. Brit. & For. 38. 68-74. 1900.

Includes Didymocarpus cyaneus, a new species from Kasum, Thailand.

______. New Malay orchids. Journ. Str. Br. Roy. Asiat. Soc. 39: 71-87. 1903.

Includes some orchids from Langkawi Islands, southern Thailand.

______. New Malayan plants. Journ. Str. Br. Roy. Asiat. Soc. 41: 31-51. 1904.

Includes species from Langkawi Island, southern Thailand.

______. The Gesneriaceae of the Malay Peninsula. Journ. Str. Br. Roy. Asiat. Soc. 44: 1-92. 1905.
Includes some Thai species.

Ridley, H.N. New and little-known Malayan plants. Series II. Journ. Str. Br. Roy. Asiat. Soc. 44: 189-211. 1905.
Includes some Thai species.

______. New or rare Malayan Plants. Series III. Journ. Str. Br. Roy. Asiat. Soc. 49: 11-52. 1907; (Series IV) 50: 111-152. 1908. Series (V) 53: 1-61. 1910; (Series IX) 75: 5-38. 1917.
Includes some from Thailand.

______. A list of ferns of the Malay peninsula. Journ. Str. Br. Roy. Asiat. Soc. 50: 1-59. 1908.
A systematic list, including records from southern Thailand.

______. The flora of the northwestern states, Malay Peninsula. Kew Bull. Misc. Inf. 1910: 202-204. 1910.
A letter to J.D. Hooker concerning a trip to find the division between the floras of Malaya and Thailand.

______. Botanical expedition to lower Siam. Gard. Chron. III. 49: 361-363, 383-384. 1911.
A general description of the author's field trip in 1910.

______. The flora of lower Siam. Journ. Str. Br. Roy. Asiat. Soc. 59: 15-26. 1911.
A floristic description.

______. An account of a botanical expedition to lower Siam. Journ. Str. Br. Roy. Asiat. Soc. 59: 27-243. 1 folded map. 1911.
Includes an extensive systematic enumeration with many new species.

______. The Gymnosperms of the Malay Peninsula. Journ. Str. Br. Roy. Asiat. Soc. 60: 53-68. 1911.
Includes some Thai species.

______. A botanical excursion to Pulau Adang. Journ. Str. Br. Roy. Asiat. Soc. 61: 45-65. 1912.
An account and enumeration of new plant species. This is one of a group of islands west of Langkawi and Terutau, in southern Thailand.

______. Two new orchids from the province of Bandon, S.W. Siam. Journ. Fed. Malay St. Mus. 5: 156-157. 1915.
An enumeration of 8 species from the mountain Kao Nawng, including such new species as Coelogyna tricarinata and Chrysoglossum robinsonii.

____. The plants of Koh Samui and Koh Pennan. Journ. Fed. Malay St. Mus. 5: 158-168. 1915.

An enumeration of collections by H. C. Robinson on these islands on the northeast coast of the Malay Peninsula.

____. The fern allies and Characeae of the Malay Peninsula. Journ. Str. Br. Roy. Asiat. Soc. 80. 139-164. 1919.

A systematic treatment, including species from Thailand.

____. On a collection of plants from Peninsular Siam. Journ. Fed. Malay St. Mus. 10: 65-126. 1920.

A systematic enumeration of collections by C.B. Kloss, including many new species and varieties from the islands and the west coast between Lat. 7° and 11°N.; includes an article, on pages 66-80, by Boden Koss on 'Some account of the journey on which the plants were collected'.

____. Two new Siamese plants. Journ. Fed. Malay St. Mus. 10: 127. 1920.

Milliusa concinna (Annonaceae) and Pachynocarpus grandiflorus (Dipterocarpaceae) from southwest and peninsular Siam based on F.W. Foxworthy's collections.

____. New and rare species of Malayan Plants. II. Journ. Str. Br. Roy. Asiat. Soc. 82: 167-204. 1920; (XII) 86: 292-311. 1922.

These parts include plants from the Langkawi Islands, southern Siam.

____. The flora of the Malay Peninsula. 5 volumes. 1: 1-918. figs. 1-75. 1922. 2: 1-672. figs. 76-131. 1923. 3: 1-405. figs. 132-159. 1924. 4: 1-383. figs. 160-209. 1924. 5: 1-470. figs. 210-229. 1925.

The most comprehensive flora on the region of southern Siam, including Pattani Circle and parts of Nakorn Srithammarat and Puket Circles. The introduction contains data on some collectors in Thailand. Reviewed in Journ. Siam. Soc. 17: 215-216. 1923.

____. The ferns of the Malay Peninsula. Journ. Malay. Br. Roy. Asiat. Soc. 4: 1-121. 1926.

A systematic treatment with descriptions and data on distribution, but no keys; includes many Thai species.

____. Firmiana and Erythropsis. Kew Bull. Misc. Inf. 1934; 214-217. 1936.

A review of species including E. fulgens of Thailand.

____. Notes on Xylocarpus. Kew Bull. Misc. Inf. 1938. (7): 228-292. 1938.

Includes X. parvifolius and X. minor recorded as new species from Siam.

Robbe, E. Etude des lois d'accroissement d'un peuplement de Pinus merkusii. 56 pages. Dactylographiées, non publiés. Service des Eaux et Forêts du Cambodge. 1949.

______. Exposé critique des travaux à entreprendre en vue de l'aménagement des forêts du plateau de Kirirom. 14 pages. 1948.

Rocher, M.L. De l'amelioration de la production des forêts du Vietnam. 21 pp. Secretariat d'Etat à l'Agriculture. Sept. 1959.

This paper discusses the utilization of the forests of Vietnam. Brief consideration is given to the problem of human interference with the forest cover. There is also a discussion of the climate and secondary forests of Vietnam; diverse elements of the Vietnamese forests and their role; technique in the production of firewood; and production of wood for paper pulp.

Rock, J.F. The Chalmoogra tree and some related species: A survey conducted in Siam, Burma, Assam, and Bengal. U.S. Dept. Agric. Bull. 1057: 1-29. 16 plates. 1922.

Rolfe, R. A. New Orchids. Kew Bull. Misc. Inf. 84-88: 1906. 412-416: 1908. 61-66: 1909. 158-162: 1910. 141-145: 1913. 373-376: 1914. and 199-206: 1924.

Parts cited contain new species of plants of Thailand.

Rollet, B. (Ed.). Direction des Recherches Forestières. Etudes sur les forêts claires du Sud de l'Indochine. Part I: 250 pp.; Part 2: 99 pp. illustr. maps. 1952.

The term 'forêts claires' is applied in a broad sense to open but fairly dense forest, also steppes and savannas. These are, respectively, rich and poor in woody species, easily penetrable, with scant or no undergrowth. Although they are not truly deciduous forests, they resemble them on account of their floristic simplicity and lack of stratification or a series of understories.

In the introduction the author discusses the climatic and biotic factors that influence this type of open forest. He analyzes the open Deciduous forest in seven distinct regions in southern Indochina with emphasis on their origin. He treats in a general way the dominant characters from the standpoint of physiognomy, floristics, dynamic statistics and economic factors.

There is a list of the botanical names of plants cited in the text, with their corresponding Cambodian and Vietnamese names.

The second part treats with the study of Deciduous forest of South Laos by Ly Van Hoi, entitled 'Etude sur les forets claires du Sud-Laos'. These observations were made while conducting a forest inventory in the region of Savannakhet and Thakhek, in central Laos, on forest types possessing more or less distinct characters, influenced by the nature of soil. The result of a floristic study made on an area of 73 hectares is discussed, with data on the climatic characters of the region and a plan indicating the location of tree counts made.

In a general way, this deciduous forest resembles that of Cambodia, with an abundance of Dipterocarpus tuberculatus and D. obtusifolius; the almost total disappearance of Dipterocarpus intricatus; and a scarcity of Pentacme siamensis.

In Cambodia the most important tree species, in order of volume per unit area (hectare), are: Shorea obtusa, Pentacme siamensis, Terminalia tomentosa, Dipterocarpus intricatus, D. obtusifolius and D. tuberculatus. In South Laos, on the other hand, the order of volume is Dipterocarpus tuberculatus, Shorea obtusa, D. obtusifolius, Terminalia tomentosa and Pentacme siamensis.

A description of the various soil types is given. This is followed by a discussion of the floristics of 135 tree species in the study area. The families and species in terms of frequency, percentage-wise, are listed.

The second article, in Part II, is by Neang-Sam-ol on 'Contribution a l'Etude des Forêts claires de la region des 3 Frontières, accompanied by illustrations.

Inventories were made in Cambodia on 24 characteristic forest types in the region between Kratié and the three frontiers. The first series was conducted in a plain on basaltic and old alluvial soils; and the second series at an altitude of 1,600 to 1,900 ft. (500 to 600 m.) on basaltic soils.

The 8 principal and characteristic species of the Deciduous forest are: Pentacme siamensis, Shorea obtusa, Terminalia tomentosa, Dipterocarpus obtusifolius, D. tuberculatus and D. intricatus, Pinus merkusii and P. khasya. The first three are the more resistant to fire. Pines either form pure stands or may be mixed with the Dipterocarpus species.

The author gives a list of the dominant species in the various formations, as well as the approximate area covered by the various forest types in South Vietnam, Cambodia and South Laos.

___. Note sur les forêts claires du sud de l'Indochine. Bois et Forêts des Tropiques. 31: 3-13. illustr. Sept.-Oct. 1953.

This contribution is a compilation of conclusions reached following an intensive survey of the open forests of 7 distinct areas in Cambodia and South Vietnam, and 8 upland regions in southern Indochina. This survey was carried out in plots, each of one hectare in area. Gregarious species, as well as the comparatively large number of scattered species, were studied. Dominant species were recorded in order to define the various types of vegetation. Data presented are the result of a statistical analysis of enumeration tables prepared from the systematic sampling.

The author deals with the quantitative composition of stands, particularly from the standpoint of distribution of species and according to their diameter. Consideration is given to economic factors, in an attempt to assess volumes of standing trees.

A series of photographs illustrate such forest types in Cambodia as: a semi-dry secondary forest of Lagerstroemia between Krek and

Mimot; a forest reserve at Kalat; and one between Saigon and Dalat in South Vietnam.

______. Pour un inventaire forestiér du Vietnam. Vol. III, pp. 639-666. Bibl. Dehra Dun. 1954.

______. Emploi de photographies aériennes au 1:40,000 pour l'interprétation de la végétation et les inventaires forestièrs au Vietnam. Bois et Forèts des Tropiques. 74: 16-24. Nov.-Dec. 1960.

Aerial photographs (panchro-with yellow filter) were taken to evaluate the utilization of soil and to prepare an inventory of existing vegetation.

The tests, on a scale of 1:40,000, were made in the region of Battambang, Kompong-Cham and northwest of Phnom Penh in Cambodia, and in the region of Kirirom, Chu-Yang-Sin and Lang-Han in South Vietnam.

It was determined that certain trees are readily distinguishable from the air, especially when in flower, such as Lagerstroemia which is gregarious. Other trees recognizable when in flower are Shorea talura, S. obtusa, and Pentacme siamensis. Individual species of Conifers (Pinus, Podocarpus and Dacrydium) are not identifiable from the air, but lowland 2-needled pine (Pinus merkusii), even when mixed with Dipterocarpus obtusifolius, is recognizable.

Interpretation of aerial photographs on a scale of 1:40,000, according to the author, is subject to a number of limitations. Such interpretation is extremely useful in estimating an area with identifiable forest types. On the other hand, the application of aerial photographs to prepare tables to estimate the volume of standing timber is subject to objections.

Three aerial photographs and 2 tables accompany the report.

Rose, E. Le Nuoe-Man (Eau de poissón). Gouvernement Général de l'Indochine. Série Saigon Bulletin No. 4. 18 pp. Saigon. 1918.

This is a discussion of the economic source of a national fish condiment so popular in Indochina.

Rothe, P.L. Forèt d'Indochine. Bois et Forèts des Tropiques 1:25-30; 2: 18-23; 3: 17-23. illustr. Maps. 1947.

The forests of Indochina were less well-known even to French foresters and ecologists, than other French overseas territories. Various reasons were responsible for this. Perhaps the principal reason was that the forests of Indochina were utilized mainly for local use or to supply the market of neighboring countries.

The forests of Indochina are diverse, and may be classified into several types, with intermediate transition formations. In the first part the author discusses: (1) mangrove forest; (2) post-mangrove; (3) inundated forest around the great lakes of Cambodia; (4) open deciduous; and (5) closed, dense forest.

In the second part, there is a historical review of forest exploitation in Indochina. The third, and final, part treats with

diverse forest products of Indochina and their local utilization.

_____. Régénération naturelle en foret tropicale. Bois et Forets des Tropiques. 8 (4): 368-370. 4 illustr. 1948.
Contains a discussion of the natural regeneration of 'dau' (Dipterocarpus alatus) in Cambodia.

Royal Forest Department. Siamese Plant Names. Part I - Botanical Names - Local Names. 504 pp. Bangkok. Sept. 1948.
The principal object of this publication is to familiarize the reader with the botanical names, and their corresponding vernacular names, of plants growing in Thailand. In order to be usable by those who are not familiar with the Thai or Siamese language, all the Thai characters have been transcribed into Roman characters, following the phonetic transcription adopted by the Royal Institute of Siam and published in March 1932.
Plants listed are those whose local names and their authentic botanical identity were established at the time of publication.
Each citation contains: (a) the generic and specific names with the author's name included; (b) family; (c) habit of the respective plant; (d) local name or names according to locality; (e) foreign names when available; and (f) appropriate synonyms.
Knowledge of Thai plants, including their corresponding botanical and local names, up to the time of publication was largely the effort of the late Prof. W.G. Craib and Dr. A.F.G. Kerr, both of whom were responsible for the 'Florae Siamensis Enumeratio'.

Royal Irrigation Dept. (Thailand). Administration reports for 1914-15 to 1925-26. Bangkok. 1927.

_____. Tank irrigation scheme. Kasikorn 26 (1): 25-37. Bangkok. 1953.

Royal Thai Navy, Meteorological Dept. Annual meteorological data 1927-55. Bangkok. 1955.

Ryan, F.D., and A.F.G. Kerr. Dipterocarpaceae of northern Siam. Journ. Siam. Soc. 8 (1): 1-24. pl. 1-5. 1911.
Botanical, economic and sylvicultural data on species of Dipterocarpus, Shorea and Hopea, with a supplemental list of species.

Sakamaki, S., and J.A. White. Asia. 528 pp. illustr. Webster Pub. Co. St. Louis. 1953.
This informative publication contains a chapter on the Federation of Indochina and another chapter on the Kingdom of Thailand.

Sakarik, R. Varietal studies of cabbage. Kasikorn 23 (1): 12-23. 1950.

______., and P. Tripetch. Liming experiment on peanut. Kasikorn 23 (3): 199-204. 1950.

Saman, L. The food value of sweet potato. Kasikorn 26 (6): 569-575. 1953.

______. Sweet corn. Kasikorn 26 (2): 218-224. 1953.

______. Selection of land for planting coconut trees. Kasikorn 27 (3): 244-249. 1954.

Salvoza, F.M. Rhizophora. Nat. & Appl. Sci. Bull. Univ. Philippines 5: 179-237. pl. 1-9. 1 folded map. 3 figs. 1936.
Monographic; includes citation of Thai specimens.

Samapuddhi, K. The forests of Thailand and forestry programs. Thailand Royal Forest Dept. 34 pp. 8 plates. Bangkok. 1959.
This handbook describes the nature and character of Thai forests. It contains three parts: a general description of the forests of Thailand; data relating to timber trade and consumption within the country; and the forestry program submitted to the National Economic Council for consideration.

Sampson, A.W. Effect of Chaparral Burning on Soil Erosion and on Soil Moisture Relations. Ecology 25 (2): 171-191. 9 figs. 5 tables. 1937.
The burning of a heavy chaparral cover disturbs abruptly the biological and physical equilibrium that existed before the fire. Reaction between factors favoring the maintenance of a reasonably stable vegetation, and the change in the stability of soil and water relations is accentuated. The degree of change in the habitat depends chiefly upon climatic factors, character of the vegetation and its rate of regeneration, type of soil and topography. If erosion is the stronger factor, the eventual result will be the removal of top soil, associated perhaps with a change in the rate of infiltration and in its waterholding capacity. If, on the other hand, factors favoring regeneration are stronger, the area will soon progress to pre-fire conditions, accompanied by geologic normality in soil erosion, and perhaps by predictable rates of stream and spring flow.
The study supports the conclusion that chaparral and its understory vegetation protect the soil effectively against abnormal erosion. In turn, this protection may favor the relatively high infiltration capacity of the soil. Judging from some measurements and extensive observations, the grazing of steep, recently burned slopes may measurably increase soil erosion. This conclusion applies both to areas of well-formed soils and to lands whose soils are somewhat protected from the elements by a gravelly 'erosion pavement'.
A somewhat lengthy bibliography completes the article.

Sampson, A.W., and A.M. Schultz. Control of Brush and Undesirable Trees.

Unasylva 10 (1): 19-29; 10 (3): 117-129. 1956.

Much of the earth's surface is covered with brush. Many of the major brushlands of the world are climax; that is, they constitute vegetative cover that has changed little in composition under prevailing conditions of climate, soil and fire.

Large-scale efforts to control undesirable woody species has awaited mass production of machinery to do the job effectively and economically. This modern age of large-scle operations tends to overlook, however, that many small-scale efforts, using home-made tools, might do the same job more effectively and more economically.

In the first part of the paper the authors place major emphasis on a consideration of factors determining the kind of equipment to be used; degree of brush clearance for economic returns; kind of vegetation to be cleared; character and size of stems; density of cover; and topography.

In the second part of the article types of equipment are briefly described and illustrated with photographs or drawings. The comparative advantages of each piece are enumerated and, so far as possible, the approximate cost per acre for certain stipulated conditions are cited.

A list of vernacular and botanical names of plant species mentioned is included. The literature cited contains 43 titles.

born, C.C. The Mammals of the Rush Watkins Zoological Expedition to Siam. The Natural History Bulletin of the Siam Society 15 (1): 1-25. Sept. 1952.

The Chicago Natural History Museum's Rush Watkins Zoological Expedition to Siam had as its main objective the securing of a habitat group of the Malay tapir. However, about 200 specimens of other mammals were collected, representing 27 forms and others were seen but not collected. This small collection included an undescribed bat and some new locality records.

The article contains an annotated list of bats collected. A list of literature cited is included. See also reference to Haas, F., 'Some non-marine mollusks from Siam'.

ltwongse, Y. S. An outline of rice cultivation in Siam. 10 pp. The Ministry of Agriculture. Bangkok. 1911.

As the trade and commerce of Thailand are mainly connected with the rice-growing industry, it is often asked how it is cultivated, harvested and prepared for the market.

The process of rice culture is very similar in all rice growing countries, but the source of water supply, the nature and elevation of the soil, and the climate cause some variations in the methods employed. This pamphlet presents some general information on the rice industry of Thailand.

asas, P. My country Thailand - its history, geography and civilization. 421 pp.; illustr.; index. Maruzen Co. Ltd. Tokyo. 1942.

Satow, E.M., C.E.W. Stringer and others. Lao tea (Camellia theifera Griff.) Kew Bull. Misc. Inf. 219-222. 1892.
Correspondence and a report on this product of Thailand.

Savetanak, S. A study of the effectiveness of Nitragin strain and local strain of nodule bacteria. Kasikorn 25 (1): 33-43. 1952.

Saxton, W. T. Phases of vegetation under monsoon conditions. Journal of Ecology 12 (1): 1-38. World Soils. Jan. 1924.

Sayn-Wittgenstein, L. Recognition of tree species on air photographs by crown characteristics. Forest Research Division Technical Note No. 95, 1-56; illustr.; keys. Department of Forestry, Canada. 1960.
The characteristics of tree-form is important in species recognition on air photographs. Brief references are made to the value of phenology and ecology in species identification. Descriptions are given of the appearance of some tree species on air photographs, accompanied by elimination keys for the identification of such species.

Sayupatham, T. A cogon eradicating grass. Kasikorn 27 (2): 154-156. 1954.

_____. Lime pickles. Kasikorn 23 (6): 439-443. 1950.

Schermerhorn, W. Actual problems in aerial survey. The International Training Center for Aerial Survey, Delft. The Netherlands Series A/B No. 1. Volume 1. 30 pp. 1960.
In this contribution there is a discussion of: (1) the post-war years as compared with previous years; (2) the milestones of 1960; (3) subjects of a planning program for aerial survey; (4) application of physics to the research on and improvement of photographs; and (5) consequences of the introduction of digital methods in photogrammetry.

Schindler, A.K. Uber einige kleine Gattungen aus der Verwandtschaft von Desmodium Desv. Repert. Sp. Nov. Fedde 20: 266-286. 1924.
A critical treatment; includes some Thai species.

_____. Desmodii generumque affinium species et combinationes novae. III. Repert. Sp. Nov. Fedde 23: 353-362. 1927.
Includes Phyllodium siamense and Pteroloma kerrii; species new to Thailand.

Schlechter, R. Orchidaceae novae et criticae. Repert. Sp. Nov. Fedde. 2: 81-86, 129-134, 166-171. 1906; 3: 45-51. 1906; 3: 276-280. 1907.
Includes new species collected by Hosseus.

_____. Uber Stemona Lour. Notizbl. Bot. Gart. Berlin 9: 190-196.

fig. 7. Dec. 30, 1924.
Includes S. kerrii from Thailand.

__. Die Gattungen Cymbidium Sw. and Cyperorchis Bl. Repert. Sp. Nov. Fedde 20: 96-110. 1924.
A clarification with many transfers, including Thai species.

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Includes Toxocarpus siamensis and Tulophora schmidtii; new species collected by Schmidt.

idt, J. Flora of Koh Chang. Contributions to the knowledge of the vegetation in the Gulf of Siam. Bot. Tideskr. 24: 1-13, 15-22, 79-125, 157-221. figs. 1-8. 1901; 241-280. 1 fig. 329-367. 1902; 25: 1-47. 1903; 26: 115-176. pl. 1,2. 1904; 29: 97-152. figs. 1, 2. 1909; 32: 309-370. 1915-16.
Includes all material, cryptogams and phanerograms, collected by the Danish Expedition to Siam (1899-1900); and an account of collections contributed by various specialists. Contains an index.

__. La vegetation de l'ile Koh Chang. Bull. Soc. Geogr. (Paris) 8 (4): 275-290. figs. 29-36. 1903.
A floristic description of the island Koh Chang, off the south-east coast of Thailand.

__. Vegetation of Koh Lom, a small rocky island west of Koh Chang. Journ. Siam. Soc. 18: 241-242. 1 pl. 1925.
A general description. This is a translation by E. Seidenfaden from Danish, with explanation by A.F.G. Kerr.

idt, M., D. Godard, and P. De La Souchere. Soils and Vegetation in the Darlac and on the Plateau des Trois Frontières. Centre de Recherches Scientifiques et Techniques. Archives des Recherches Agronomiques au Cambodge, au Laos et au Vietnam, 1, No. 1 (8): 8, 112 pp., illustr.; colored plates; map; table. 1951.
The characteristics of basaltic soils in the Darlac area vary according to the age of lava flows, pluviometry and vertical variation between topographical level and the water table level. Table of soil profiles.
See also Bulletin Bibliographique Mensuel. Inter-African Information on Bureau for Soil Conservation and Land Utilization. Oct. 1951.

mburgk, R.H. The vegetable products of Siam. Technol. 1: 355-362. Reprinted in Pharm. Journ. (London). II. 3: 123-128. 1861.
This is a general account.

__. Siamese products. Technol. 2: 444-450. 1862.
Notes on various products, mostly of botanical origin, with a list of 125 plant materials, with their vernacular names, including

woods used medicinally or as sources of dyes. Contains a few Latin identifications.

______. A visit to Xiengmai, the principal city of the Laos or Shan States. Journ. Asiat. Soc. Bengal 32: 387-399. 1864.
A traveler's account with botanical observations. Xiengmai is now generally spelled 'Chiengmai', largest city in northern Siam.

______. The paper-tree of Siam (Ton-khai), Trophis aspera. Technol. 4: 337-339. 1864.
A general account.

Secretariat d'Etat a l'Agriculture. Causeries sur le Developpemente des Resources Naturelles au Viet Nam. 83 pp. Saigon. Sept.-Oct. 1959.
This publication contains a series of 5 articles by specialists on forest policy and forest products of Vietnam. The second article by Nguyen-van-Chi, deals with the forests in relation to forest policy. The fifth article, by Léon Rocher, treats with the alleviation of the exploitation of the forests of Vietnam.

Sen Gupta, J.N. Problems of silviculture and management of mangrove forests. West Bengal. Paper presented to the Second Session. Asia-Pacific Forestry Commission, Singapore. 1952.

Services du Protectorat. Activité colonisatrice du Tonkin: Colonisation dans la haute et moyenne region du Tonkin, l'Indochine. Bulletin Economique 41 (4): 735-779; illustr. 1938.
In the vast delta region, covering about one-tenth the area of Tonkin and which is now part of North Vietnam, about 8 million inhabitants are concentrated. Owing to the agonizing situation of a populace attempting to earn a minimum subsistence in a limited area with a strange geographical paradox, the authorities of the Protectorate have attempted to remedy this disequilebrium. This report presents a succint account of efforts made in the past and the project in progress 27 years ago to remedy this critical situation through work on the village level and by attempting to increase the cultivation of a variety of crops.

Setten, G.G.K. Growth and yield of Berus (Bruguiera cylindrica). Malayan Forester 16 (2): 74-87. 1953.

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Sittisunk, P. Insecticides used in controlling leaf curl disease in tobacco. Kasikorn 25 (5): 491-500. 1953.

Sleumer, H. Monographie der Gattung Hydnocarpus Gaertner, nebst

schreibung und Anatomie der Fruchte und Samen ihrer pharmakog-
stisch wichtigen Arten (Chaulmugra). Bot. Jahrb. Engler 69:
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A monographic treatment; includes Thai species.

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Relates to Nostochopsis lobatus, eaten in Chiengmai.

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plates. 107 figs. Washington, D. C. 1945.
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untry were visited, large collections were assembled and pre-
rved, and information was obtained by personal observations or
rough interviews with local officials and fishermen. These
llections were supplemented by specimens brought in by various
sistants in the Bureau of Fisheries of Thailand, as well as
terials obtained from other sources.

J.J. Bulbophyllum Thon. Sect. Cirrhopetalum. Bull. Jard. Bot.
itenzorg II. 8: 19-29. Oct. 1912.

M.A. Arthur Francis George Kerr. Proc. Linn. Soc. London 154:
35-286. 1943.
An obituary of this investigator of the flora of Thailand.

W.W. The section Soldanelloideae of the genus Primula. Journ.
inn. Soc. Bot. 52: 321-335.
Includes P. siamensis.

and, T. Reserved Trees of Northeastern Thailand. Thai Forest
lletin (Botany) No. 5. 19 pp. 18 diagrams. Royal Forest
epartment. Bangkok. Oct. 1960. (Mimeographed.)
The division of Thailand on a regional basis is established in
elation to the distribution of forests. In this sense the north-
astern region covers the provinces of: Nakhawn Rachasima, Chaiya-
hum, Buriram, Surind, Sisaket, Ubolrachadhani, Udawndhani, Khawn-
aen, Nakhawn-phanom, Mahasarakhan, Kalasin, Loei, Roi Et, Nawngkhai
nd Sakulnakhawn.
The forests of northeastern Thailand may be divided into 3 types:
emi-Evergreen; Mixed Deciduous; and Dry Dipterocarp forest. A few
imber tree species occur scatteringly in some or all the types.

Dipterocarpus obtusifolius is found both in Semi-evergreen and Dry Dipterocarp forest; Shorea talura grows in the 3 types; Pterocymbium javanicum thrives in Mixed Deciduous and Semi-evergreen forest; and Xylia kerrii occurs prolifically both in Dry Dipterocarp and Mixed Deciduous forest types. The most valuable timber is 'mai phayung' (Dalbergia cochinchinensis Pierre), which is almost comparable to teak (Tectona grandis) in value. All but 2 of the 78 species treated in the paper are well known botanically, so that it was considered expedient to omit a detailed description of these. A field key is given for the use of foresters and others interested in the region. Vegetative characters are largely employed, and features of the fruits also have been incorporated.

This is a contribution from the Forest Products Research Division of the Royal Forest Department's working program for 1958-1959. This is in pursuant of the study of all reserved trees of Thailand, as planned by the Forest Department.

Smythes, B.E. The birds of Burma. Second edition. 1953.
Contains some notes on the vegetation of Burma.

Spencer, J. C. Asia - East by South. A Cultural Geography. 453 pp. 136 figs. John Wiley & Sons, Inc. 1954.
This volume treats with cultural geography in its widest interpretation. The introductory part treats with the geography of Asia. The publication is divided into three parts. The first part deals with Systematic Geography; the second, with the regional growth of culture; and the third part is for reference purpose, and contains a very comprehensive bibliography. One chapter discusses the evolution of Thailand, the development of agriculture, subordinate elements of the economy, and the regionalism of modern Thailand.
Another chapter deals with India, a state of mixed cultures.

Sprague, T.A. Dolichandrone and Markhamia. Kew Bull. Misc. Inf. 302-314. 1919.
A systematic treatment, including Thai species.

Spurr, S.H. History of Forest Photogrammetry and Aerial Mapping. Photogrammetric Engineering 20 (1): 551-560. 1954.
The future of aerial survey of forests seems assured. In the long run, the use of aerial photographs will probably be greatest in everyday forest management (Spurr, 1952). At the moment, however, forest inventory techniques still hold the spotlight. Combined aerial-ground inventories are now the rule in forestry. In many cases no check on the accuracy of comparative methods has been made. Where careful comparisons have been carried out on a small scale, as by Loomis (1946), Pope, Cameron and Hill (Spurr, 1952), Welander (1952), and Ferree (1953), the results have come fully up to expectations and have justified the present-day acceptance of aerial photographic techniques.

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A critical study.

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Published for the National Science Foundation and the Department of Agriculture by Centralny Instytut Informacji Naukawo-Technicznej I Ekonomicznej, Warszawa, Poland. 1962.

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Occurs in Thailand.

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Includes S. confusa, occurring in Thailand.

___. Miscellaneous botanical notes. I. Bull. Bot. Gard. Buitenzorg III. 17: 383-411. 2 figs. 1948.
Refers to Justicia quadrifaria from Thailand. Notes on Malayan species of Aralia appear on pages 391-397.

inberg, D. J. Survey of World Cultures; its peoples, its society, its culture. 351 pp.(Ed. Thomas Fitzsimmons.) No. 5. 1959.
Cambodia became an independent state in 1954 after nearly one hundred years as a French protectorate. Strategically located in the heart of Southeast Asia, and poised between two great power blocs of the modern world, Cambodia and its neighbors, Laos and Vietnam, the three states of former French Indochina come increasingly to the center of international attention as armed rebellion in Laos threatenes the peace of the whole area.
In this volume the complex interaction of old and new is examined in detail to high-light the character of the Cambodian people and to clarify and to give meaning to the present situation and future course of the Cambodian state.

Stephens, W.M. Mangroves: Trees that make land. Smithsonian Report for 1962. pp. 491-6, 4 plates. Washington, D.C. 1963.
This paper treats, in a semi-popular style, the history, habits, and uses of mangrove, with emphasis on red mangrove (Rhizophora mangle) and its occurrence in the Florida Everglades. A series of 7 photographs complement the article.

Stonov, L.D. Defoliants and desiccants. Translated by U.S. Department of Commerce - Office of Technical Services. Joint Publications Research Service. 147 pp. Aug. 23, 1962.
Published by the State Scientific and Technical Publishing House of Chemical Literature, Moscow, 1961, this paper discusses materials used for the defoliation of cotton leaves, as well as those for the preharvest drying or desiccation of a number of grain and technical crops. The preharvest removal of cotton leaves makes it possible to mechanize harvesting. During the drying of seeds of legumes, and sugar beets, corn, millet, rice and other crops prior to cutting, the maturing of these crops is accelerated. The brochure is designed for agrochemists, agronomists, brigade leaders of collective farms (colfarms), state farm directors and workers at the experimental and research establishments, as well as for party and economic organizations.

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Suwankiri, T. Bread fruit. Kasikorn 26 (2): 176-180. Bangkok. 1953.

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Suwatabandhu, K. Weeds in paddy fields. Thailand. Dept. Agri. Tech. Bull. 4: 1-21. 1950.

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The assumption that within each forest type the volume of Greenheart (Ocotea rodiaei) per acre is constant has proved to be correct by correlating timber volume measured in the field, with the areas of Greenheart-bearing forest types estimated on a photo-interpretation map.
The regression equation thus produced can be applied to a Greenheart-forest from a photo-interpretation map of another area in order to estimate the volume of Greenheart in that area without carrying out a field survey.

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gton, C.F. Three Malayan species of Bruguiera. Malayan Forester 9 pp. 131-132. 1940.

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The contents are divided into three parts. Part I is a survey of the geology, history and world distribution of the genus Dipterocarpus; distribution of the Dipterocarpus in the Malayan Peninsula; field observations on Dipterocarps; and general references to forests of Malaya.
The second part contains keys to groups of Malayan Dipterocarpus: (a) a field key based mainly on characters of trunk and bark; (b) based on flowers; (c) and another based on fruits.
The third part describes specific distribution areas of the natural groups of the genus Shorea: (a) the Balau group of Shorea; (b) the Meranti pa'ang group; (c) the Meranti Damar Hitam group; and (d) the Red Meranti group; followed by the genera Anisoptera; Balanocarpus; Cotylelobium; Dipterocarpus; Dryobalanops; Hopea; Parashorea, Pentacme, Vatica.
The report also contains 114 text-figures, 109 references and alphabetical lists of scientific and vernacular names.

rd, G. Second voyage du Père Tachard et des Jésuites enyoyez par le roi au royaume de Siam. 416 pp. 1 pl. Paris. 1689. Another ed. 369 pp. 1 pl. Amsterdam. 1689.
Includes some botanical observations, and illustrations of several plants.

Tangmonkol. T. Yam bean cultivation in Borabue. Kasikorn 25 (1): 12-15. 1952.

Tay.or, G. Colquhounia coccinea. Curtis's Bot. Mag. 167 (3): 115. 1950.
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Teijamann, J.E. Verslag einer reis naar Siam, in het gevolg van den Gouvernements Kommissaris Mr. A. Loudon. Natuur, Tijdschr. Nederl. Ind. 25: 149-208. 1863.
An account (in Dutch), with an alphabetical list of plants of Thailand and another of vernacular names with their botanical equivalents.

Terra, H. de. Component geographic factors of the natural regions of Burma. Ann. Assoc. Amer. Geogr. 34: 67-96. 1 pl. 6 figs. 1944.
Includes vegetational regions on a climatic basis.

Thanomkulbutra, C. Spacing rice seedlings at transplanting in relation to applications of lime and fertilizers. Kasikorn 23 (4): 265-275. 1950.

Thepsithar, S. Thailand's Teak Exports. The Bangkok Chamber of Commerce Journal 9(3): 3. Bangkok. March 1955.
Contains statistics on volume of teak extracted during 1946-52, and volume exported during 1948-53.

Thirawat, S. Forest Conservator, Central Region, Thailand. Bulletin No. R. 17. 85 pp. Royal Forest Department, Bangkok. 1956.
This phamplet furnishes general information on forests, forestry and forest policy in Thailand. It contains information on Teak and other timbers exploited for domestic use and for export; and discusses the forest program adopted by the Thai Royal Forest Department.
Thailand is divided, for forest administrative purposes, into four regions, each in charge of a Conservator. Each region has four to seven divisions. Each division, in turn, is composed of a group of provinces, of which there are 71 in all. In each province the governor is virtually responsible for forestry matters, so that there is some difficulty in pursuing a consistent forest policy.
Thai plant names are given with the corresponding botanical equivalent, which enhances the value of the Bulletin.

Thompson, V. Thailand, the New Siam. 864 pp. Macmillan. New York. 1941.
This comprehensive publication is divided into three parts. Part one discusses the geography of Thailand; its people; history; foreign relations; administration; justice; and defense. The second part treats with land and population; natural resources;

agriculture; commerce; industry; public works; finance; and labor. The third part deals with religion; social organization; social problems; public health; opium; culture; education; press and public opinion.

A large bibliography is included; a list of newspapers and periodicals that were reviewed; biographical notes of individuals and commercial organizations; footnotes referring to chapters; and an index.

Thornthwaite, C.W. An approach toward a rational classification of climate. Geog. Rev. 33 (1): 54-94. 1943.

Traipob, P.H. Growing grapes in Thailand. Kasikorn 23 (3): 164-167. 1950.

Trew, D.M. Site mapping from aerial photos. The Forestry Chronicle 37 (4): 423-424. Dec. 1961.

If site maps are needed for closer rotation and calculation of yield, then all forest land should be site typed by photo interpretation. However, the author gives a word of caution when aerial photos are used. There is more to photo interpretation than meets the eye. In advocating site-mapping from photos it should be understood that stereo-vision alone is not the only prerequisite. Miniature stereo image of a forest facilitates those who have the training, experience and mature judgment to read and understand it. Many foresters remain skeptical of photo information because of exaggerated claims of accuracy made by over-enthusiastic novices.

Troll, C. Der asymetrische Aufbau der Vegetations-zonen und Vegetationsstufen auf der Nord und Suedhalbkugel. Ber. u.d. Geobotanische Forschungs-institut Ruebel in Zürich f.d. 1947. 1948.

_______. Landscape Ecology and Land Development with Special Reference to the Tropics. Journ. Tropical Geography 17: 1-11. May 1963.

In this paper the author defines geography and its two main aims. He traces the works of Warming, Cowles and Clements, Barrow and McKenzie in terms of plant ecology, human ecology and landscape ecology. There is also a discussion of tropical savannas as examples of natural landscapes.

Five plates and 5 figures, with a reference list of 29 titles accompany the article.

Trung, Thai-van. Ecologie et Classification de la Vegetation Forestière du Viet Nam (In Russian). Botanical Journal of W.L. Komarsv. 40 pp. 1 map. Academy of Science, USSR. 1962.

This is an abstract of a dissertation submitted for the Doctorate Degree in Biological Sciences at Leningrad University. Dr. Thai Van Trung is now Chief of the Botany Department at the Institute of Forest Investigations in Hanoi, North Vietnam. This publication presents the results of more than 20 years of observations and experiments on the forests of almost all parts of Vietnam, from Langshou and Kao bau, on the border of China, as far as Laskay and Kamay in the extreme South, where the author worked during 1941-45 on the utilization and replenishment of the forests.

Until recent years the vegetation of the Peninsula of Indochina, part of which now forms Vietnam, attracted little attention from ecologists and phytogeographers, and therefore it was inadequately studied or known.

Many papers dealing with the taxonomy of woody plants and purely technical publications, such as Lecomte's contributions (1905-1952) on the Flora of Indochina, have been published. But there is no publication on the general vegetation of Vietnam to compare with published information available on other tropical countries.

The author divides the vegetation of Vietnam into 14 climatic types, ranging from closed evergreen, rain or subhumid tropical type to upland formations, such as steppe, prairie and desert, and subhumid vegetation to that of cold and dry zones. He discusses also edaphic and authropogenic subtypes, such as forests prevailing on calcareous soil; bamboo and closed secondary forest; mangrove forest on littoral saline soil; artificial forest of Casuarina equisetifolia on coastal sandy soil; artificial Eucalyptus forest on cloud-covered slopes; and secondary savannas.

The report is accompanied by a preliminary map of the forests of Vietnam, with the various forest types and subtypes indicated in different colors.

Truong-Van-Hiéu. Les perspectives de la culture du laquier au Viet-Nam. 12 pp. Secretariat d'Etat à l'Agriculture. Sept.Oct. 1959.

A brief historical account is given of the culture of lac in Vietnam; the different species of host trees; lac requirements within Vietnam, and potential production for exportation; the culture of lac in Vietnam; and location of an experimental station for such studies.

Tulyakanit, C. Coffee. Kasikorn 23 (5): 377-387. 1950.

______., T. Suwankiri and P. Siri. Report on the growing of cacao in Singora (Songkla). Kasikorn 26 (3): 307-310. 1953.

Turpin, F.H. Histoire civile et naturelle du royaume de Siam, et des revolutions qui ont bouleverse cet empire jusqu'en 1770; publiée par M. Turpin sur des manuscrits qui lui ont éte communiqué par M. l'Eveque de Tabuaca, Vicaire apostolique de Siam et autres missionnaires de ce royaume. 2 volumes. Paris. 1771.

______. History of Siam. A general collection of the best and most interesting voyages and travels. London. 9: 573-655. London. 1808. 1814. (Transl. from French. John Pinkerton. Ed.)

Chapter 8 deals with natural history, and chapter 9 discusses the trees and fruits of Thailand.

l1, W.B. Ascolepis gracilis, Turrill. Cyperaceae. Tribus Hypolytreae. Hook. Icon. Pl. 31: pl. 3020. 191
A new species described from Thailand and West Africa.

a, T. Notes on genus Gastrodia of southeastern Asia. Journ. Jap. Bot. 17: 579-586. 3 figs. 1941.
In English and Japanese; includes G. tiaensis and G. hayatae, reported as new species from Thailand.

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_. Report on the economic and social aspects of production and utilization of fertilizers in the ECAFE Region. 207 pp. Dec. 1950. (Mimeographed.)
This report was prepared jointly by the secretariats of the Economic Commission for Asia and the Far East and of the Food and Agriculture Organization of the United Nations.

_. Report of the Mission on Community Organization and Development in South and Southeast Asia. United Nations Series on Community Organization and Development. 165 pp. 1953. (Mimeographed.)
This is a technical report by Professor H. Belshaw and Dr. J. B. Grant.

_. International Rice Commission. Use of rice-fields for fish culture in Thailand. News Letter. 13: 18-19. 1955.

Army. Photo interpretation of vegetation in the Tropical Pacific area and its use as an indicator of kind of ground. Engineering Notes No. 20. 107 pp., 28 plates, 24 figs. Aug. 1944.
Prepared by U.S. Geological Survey under the direction of Chief of Engineers, Military Intelligence Division Office, U.S. Army.

_. Cambodia. Health Data Publication No. 2A. Walter Reed Army Institute of Research. Walter Reed Army Medical Center, Washington, D. C.

Department of Agriculture. Policy and programs which tend to deter United States trade in agricultural products in Thailand. For. Agr. Circ. FATP 31-55. Washington, D.C. 1955. (Mimeographed.)

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______. Office of Foreign Relations. The Agriculture of Siam. 49 pp. Washington, D. C. Aug. 1950. (Mimeographed.)
This preliminary report was prepared for the Economic Cooperation Administration, so as to be available for the guidance of persons operating with the United States program of technical cooperation with Thailand.

U. S. Department of Commerce. International Affairs. World Trade Information Service. Operations Reports Licensing and exchange controls - Cambodia. Part 2: Ser. 61-53. 6 pp. Aug. 1961.

______. Bureau of International Programs. Basic data on the economy of Cambodia. Economic Reports. Part 1: No. 61-65. 16 pp. Sept. 1961.
This report superseded basic data on the economy of Cambodia. World Trade Information Service, Part 1: No. 58. Jan. 1958.

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Uthaisri, S. Economic position of broadcast rice farmers. Kasikorn 25 (3): 218-223. 1952.

Valeton, T. New notes on the Zingiberaceae of Java and the Malayan Archipelago. Bull. Jard. Bot. Buitenzorg 2. (27): 1-168. pl. 1-30. 1918.
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Van-Hoi, L. Contribution à l'étude des forêts claires du Sud-Laos. 99 pages. 1952.

Van Leeuwen, W. Contribution to the knowledge of the insect-galls of Siam. Journ. Siam. Soc. 15: 44-65. figs. 1-14. 1922.
Contains descriptions of galls on 36 species of plants in 22 families.

J. Conditions ecologiques, groupements vegetale et flore du aos. Soc. Bot. de France. Mém. 1958: 3-41. map. 1959.

. Les forêts du Laos. Bois et Forêts des Tropiques 70: 5-21. llustr. March-April 1960.

Knowledge of the general ecological conditions in Laos contributes to a better understanding of the dominant forest types in that country.

Six climatic zones prevailing in Laos correspond, in general, to separate climatic types of forests. Adjacent to the dense, humid and semi-deciduous forests there are deciduous forests in which teak (Tectona grandis) is found. Within or near the climatic forests there are other formations, which are either transitory or of a secondary nature; also those stabilized under the influence of the soil, and known as pseudoclimatic forests, or man-made, peniclimatic forests.

A map of the geology of Laos; a schematic map of the principal forest types; 9 photographs; and 31 references are included.

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Particular reference is made to the work done by the Department of Science of Thailand.

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Largely concerns chemistry and nutritive values and includes some botantical data.

nam. Presenting Vietnam. Spec. Ed. Published by the Review Horizons. 20 pp. Saigon, Vietnam. 1960.

A brief review of the ethnic and physiographic features of Vietnam is given.

Whatever the truth may be, or whichever theory one supports, it can be taken as certain that the Vietnamese race, as it is today, with its own peculiar characteristics, forms a homogeneous race, the product of the long-past mingling of peoples. It may not be possible to make a precise scientific analysis of each constituent element - Mongol, Indonesian, Indo-Malay, Melanesian and others - but it is undeniable that the mixture of these elements through the course of centuries has resulted in a nation which has ethnic originality. On that basis it maintains that it has just claims to authentic nationalism.

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Wager, J.V.K. Uses of aerial photographs in forest recreation. Photogrammetric Engineering 16 (1): 618-619. 1950.
The author is head of the Department of Forest Recreation and Game Management, Colorado, A.& M.College, Fort Collins, Colorado.

Wainio, E.A. Lichenen summo note Doi Sutep (circ. 1675 m.s.m.) in Siam borealis anno 1904 A D re: C.C. Hosseo collecti. Ann. Soc. Zool.-Bot. Penn. Vanamo 1:33-35. 1923.
A systematic treatment, including new species from northern Thailand.

Walker, E.H. A contribution toward a bibliography of Thai Botany. The Siam Society; The Natural History Bulletin 15 (1): pp. 27-88. Sept. 1952.
This Bibliography contains the majority of major and minor references dealing specifically with the plants of Thailand. This is not a complete bibliography of Thai botany, for many important toxonomic monographs of groups which include Thai species are not listed and many publications with incidental references to Thai plants have been omitted.
This publication was prepared as a supplement to the more extensive reference, 'A Bibliography of Eastern Asiatic Botany', by E. D. Merrill and E.H. Walker, Arnold Arboretum, Harvard University, 1938. This vast Bibliography contains about 21,000 titles, covering Mainland China, Japan, Manchuria, Mongolia, Tibet, Korea, and eastern Siberia. It includes also the most important floras and comprehensive works on adjacent regions, such as the Philippines, Indochina, Thailand, Burma, India and Central Asia.

______., and R. L. Pendleton. A survey of the vegetation of Southeastern Asia, the Indo-Chinese Province of the Pacific Basin. Proceedings of the Eighth Pacific Science Congress. 4: pp. 99-144. 1957.

Walker, F.A. The management and exploitation of the Klang mangrove forests. Malayan Forester 6: 71-78. 1937.

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Walton, R.C., R.C. Barnard, and J.Wyatt-Smith. The Silviculture of lowland Dipterocarp forest in Malaya. Malayan Forester 5. 15: 181. 1952.

Ward, B.E. (Ed.). Women in the New Asia. 529 pp. illustr. UNESCO. Paris. 1963.
This publication is an outgrowth of UNESCO's long-range research project on Mutual Appreciation of Eastern and Western Cultural Values, which was launched with a symposium of social scientists held at Calcutta in 1958. It should be looked on as a

ly, from a new perspective, of the Status of Women in South (1954), edited by A. Appadorai, also under the auspices of O. During recent history, the world has seen revolutionary es in the de jure status of women - politically, legally, mically, and educationally; but de facto changes have not kept with them. The present volume attempts to explore the latter ts of the issue, and in so doing, it offers a refreshing do- it for social scientists as well as interested laymen.

men in the New Asia is divided into three parts. The first ides a long analytical paper by Barbara Ward wherein she liantly examines, in cross-national framework, the influence odern medical measures, communication, urbanization, new em- ment and wages, education, political emancipation, and kinship ems on the changing roles of women in South and Southeast Asia. second part presents autobiographical and sociological data on ifferent countries, contributed by 18 authors. Of the two or papers written on each country, one provides social-anthropo- cal analysis of women's role in the society and the other pre- s an autobiographical sketch of a leading, atypical woman zen. The third part comprises two papers-one, by Romila Tharper, omen's emancipation movements in southern Asia and the other, . Smith, on the population characteristics of South and Southeast ..

he volume was written by 20 persons drawn from a wide spectrum rofessions, for the contributors include anthropologists, jour- sts, social workers, physicians, and politicians as well as makers. It illustrates at least two points of general interest. st, the change in the social roles of women in Asia during the t three generations is largely the result of their access to rn systems of education. This is obvious, because nine out of women writing their biographical notes are successful professionals the tenth, the first woman to attain the baccalaureate in Laos, a socially active, nonprofessional by choice. Second, the changes the women's roles are generally restricted to the urban centers, nly among the new elites of the new Asia, who radiate innovations the farflung corners of their countries. On the sociological el, S.C. Dube points out how caste becomes invisible in Indian ies; B.S. Siriwardena describes how towns have exercised liber- ng influences on women in Ceylon; and F. Wong shows how urban ditions engender change from extended to nuclear families among Chinese of Singapore. It is interesting to note that the women such countries as Burma and Thailand, who have long held equal portunities with men and have had for generations many roles open them, are not as professionally active or generally outstanding the women of India, Ceylon, or Pakistan, who, only two generations o, had very few roles available to them.

Women in the New Asia is a fascinating, objectively written do- ment offering comparative data from 11 (now 10) different countries, even though it does not tell us much about the women of the masses who live in the rural areas of these old countries that have become new nations.

Wanandorn, P.W. (Winit Toh Komes). The Cape gooseberry. Journ. Siam. Soc. Nat. Hist. Suppl. 8 (4): 335-336. 1932.
A brief note on the introduction of Physalis peruviana.

______. Yellow-banded leaves in Saccolobium giganteum. Journ. Siam Soc. Nat. Hist. Suppl. 9 (1): 145. 1933.
Considered a natural sport.

______. (Phya Vinit Vanontan Toh Komes) A reputed rejuvenator. Journ. Siam Soc. Nat. Hist. Suppl. 9 (1): 145-147. 1933.
Concerns phsiological effects of a drug from the roots of Butea superba.

______. Notes on introduced plants in Siam. Journ. Siam Soc. Nat. Hist. Suppl. 9 (1): 89-107. 1933; 9 (3): 265-285. 1934.
Notes on many species.

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