The Natural History Journal of Chulalongkorn University 4(2):19-29, October 2004

A Synopsis of the Vegetation of Thailand

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ABSTRACT.–Although there has been active botanical collecting in Thailand throughout most of the 20th century and the inception of the Flora of Thailand project in 1970, there has never been a thorough, competent, and reliable classification of its vegetation. There have been numerous attempts to interpret Thailand's vegetation, ranging from preliminary to primitive, but none is suitable. The first regional classification was done by Kurz in 1877 for British Burma. This system is still the best and most detailed scheme since Kurz was a very competent forester and botanist. Much of Kurz's work has been adopted for Thailand, but with vastly inferior credibility and accuracy. This trend has been especially prevalent since the 1950's when the Thai Royal Forest Department began to obscure and otherwise confuse the issue.

The basic problem with understanding Thai vegetation is the fact that a holistic (*i.e.* total or comprehensive) approach has never been done. Most classifications have been based on one or two criteria, *viz.,* trees and rainfall. What is needed is a thorough survey including climate (especially rainfall), elevation, all vascular plants in all habitats, bedrock, and ecological information (especially transects) by a skilled team of plant taxonomists, plant ecologists, and other professionals (climatologists, agronomists, hydrologists). All surveys must be field checked, since relying soley on satellite imagery or aerial photographs is not conclusive enough.

Thailand has a monsoonal (seasonal) climate with a dry + hot season lasting from 4-6 weeks in the peninsula and 3-4 months in the north and north-east. The hottest and driest months are April-May, while August has the most rain. Frost often occurs in the northern mountains from December to February. During the past century the forest cover of Thailand has been reduced to 15%, most of which is in the north.

KEY WORDS: Vegetation; Thailand

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INTRODUCTION

Thailand, formerly Siam, is located in continental SE. Asia at approximately 6-20° N latitude and 98-105° E longitude. The country is *c.* 1620 km long, 780 km wide, and includes an area of 513, 115 km^2. The human population is estimated to be *c.* 63 million. The elevation ranges from sea level to 2565 m (Doi (Mt.) Intanon). There are 6 mountains over 2000 m high, all in the north, including Doi Chiang Dao, a limestone mountain, rising to *c.* 2150 m. Most of the mountains over 1000 m are in the north with the exception of Kow (Mt.) Kieo (1200 m) in the central area, Kow Soi Dow in the south-east (1556 m), and Kow Luang (*c.* 1800 m) in the Peninsula

The entire country experiences a monsoonal (seasonal) climate. The NE monsoon (dry) is from October-November to February-March and the SW monsoon (wet) lasts from April-May to October. Northern Thailand has three

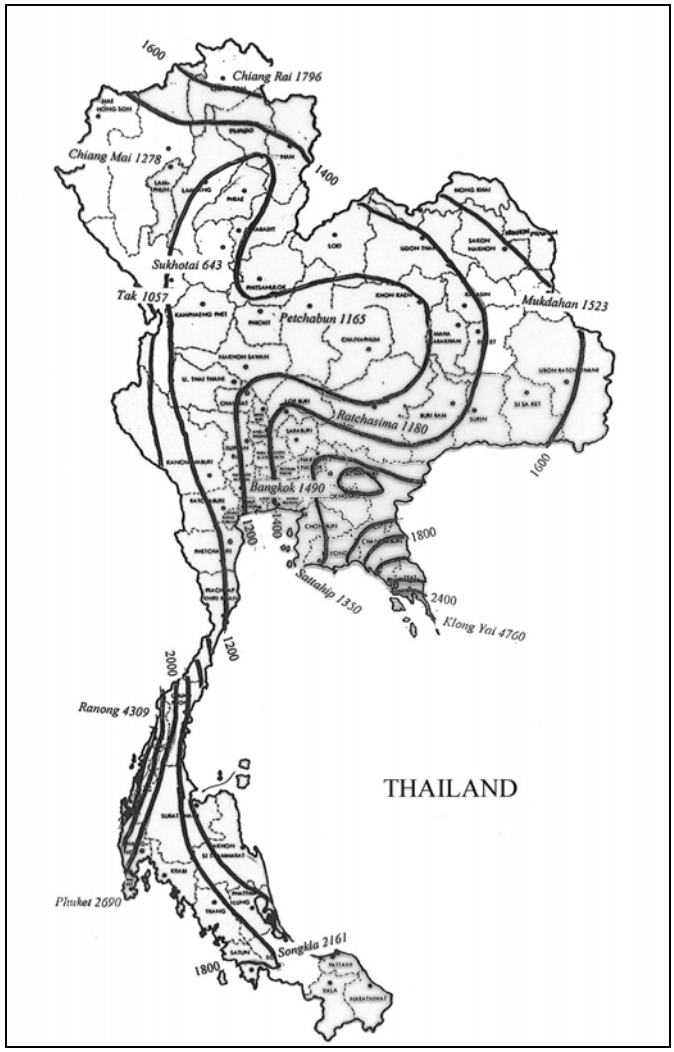

FIGURE 1. Thailand – Mean Annual Rainfall in millimeters. Redrawn from *"The ASEAN Climatic Atlas"* 1982. ASEAN Secretariat, Jakarta; p.13 and *"The Chao Phya River in Transition"* 1995 by Steve Van Beek, OUP, Kuala Lumpur.

distinct seasons, *viz*. rainy (May-October), cool-dry (November-February), and hot-dry (March-April). The other regions have only two seasons, *viz*. wet and dry. In general, the most rainfall (3000-4500 mm/year) and shortest dry period (3-8 weeks) is found in the far south, Ranong Province, and SE. The amount of rainfall decreases (1000-2000 mm/year) and dry period increases (3-5 months) towards the north and NE (Fig. 1).

Temperatures vary considerably with the seasons, latitude, and elevation. March-April is the hottest period with afternoon temperatures often rising to over 40 °C. November to February, especially in the north, is more pleasant with frost often occurring in the northern mountains.

There are two basic forest types in the country, *viz*. evergreen and deciduous. The amount of forest cover has steadily decreased throughout the country, especially during the past century, because of rampant forest exploitation, an insatiable and rapacious demand for agricultural land, urban expansion,

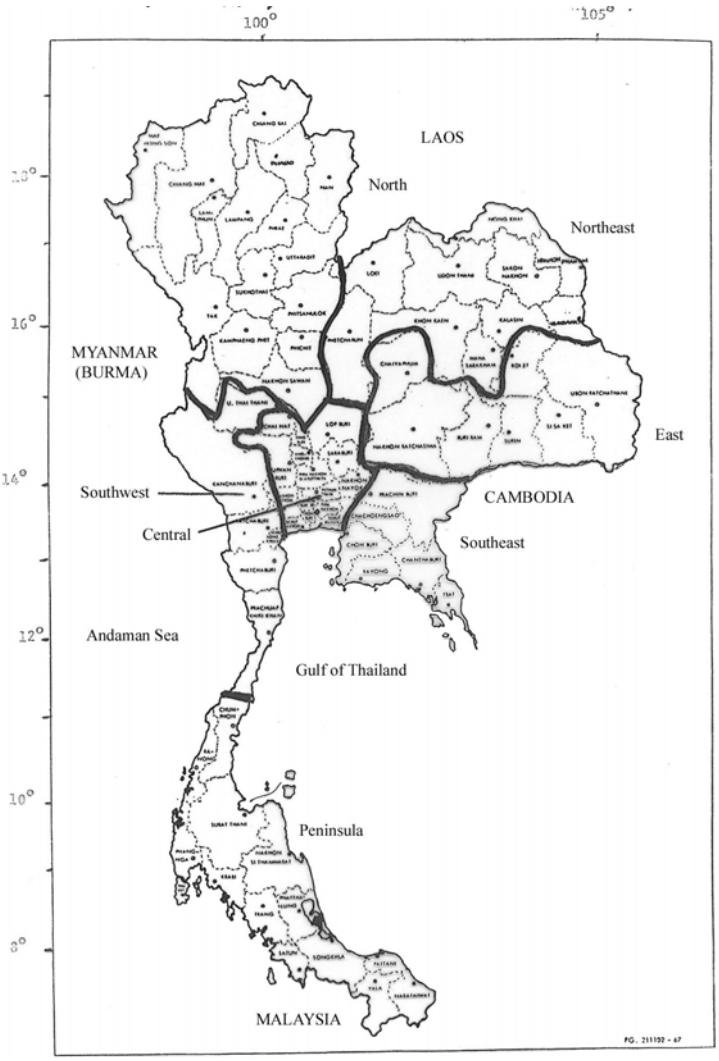

FIGURE 2. Floristic regions of Thailand. Redrawn from **Flora of Thailand** 7: 4 (2002) inside cover.

and economic "development". In essence, rampant human population increases combined with economic "advances" and political corruption have caused the demise of Thailand's forests and severe degradation of its associated biodiversity. During the previous century the amount of forested land decreased from an estimated 70% to what I now consider to be about 15% and steadily declining.

Most of this remaining forest cover is found in the north. The Thai Royal Forest Department (RFD), established in 1896 to "regulate" logging in the north, has been totally ineffective at conserving biodiversity in Thailand. In recent years there has been an increase in temperature as well as duration and intensity of the hot-dry season, flash flooding, and erosion with consequent decreases in rainfall which has caused more drought. Forest destruction, the ultimate cause of these problems, has not been properly controlled or rectified by the RFD or any other government agency.

This fact has been highlighted throughout the Thai Forestry Sector Master Plan (RFD, 1993). This seven volume set of documents not only specifies the myriad of problems caused by RFD concerning the degredation of Thai forests, but also presents recommendations for alleviation of the damage and remedial action. Unfortunately, this master plan has not been implemented in any manner beneficial to forest conservation.

As of 2001 there have been 333 protected areas established in Thailand. (RFD, 2001). This includes 102 national parks, 67 forest parks, 55 arboreta, *etc*. covering an area about 1/6 of the total area of the country. The condition of most of the forests in these places is deplorable since "development" has a strong priority over conservation.

The Flora of Thailand has divided the country into seven different regions, which roughly correspond with rainfall and current vegetation regions (Fig. 2). Hodel & Vatcharakorn (1988) recognize six regions of palm distribution in Thailand (Fig. 3). Aside from a few differences in the upper peninsula, along the Burmese border between 16° and 17° N, and truncating the lower half of the northern region, these two maps are quite similar.

Early Botanists

N. Williams (1904) and Kerr (1939) provide detailed accounts of early botanical work in Thailand. Some of the more distinguished individuals are noted here.

Engelbert Kaempfer, a Swedish student of Linnaeus, was the first botanist to visit Thailand (1690). Following him was Koenig (1778-1779) who described the first nine plants from the country in 1783. Finlayson (1821-1822), Helfer (1837-1839), Schomburgk (1857-1864), Parish (1860), Teysmann (1862), Thorel (1867), Pierre (1868), Harmand (1877), Murton (1881-1882), and Curtis (1889-1899) subsequently visited and collected many plants. None of these collectors attempted to write anything about the vegetation of the places where they collected specimens. As interest, funding, and travel improved more, detailed surveys of Thailand's flora were made. H.N. Ridley (Singapore) collected plants in peninsular Thailand from 1897 to 1910 (Ridley, 1911), while Jos. Schmidt (Denmark), led a biological expedition to Chang Island (Trat Province) during 1899-1900 (Schmidt, 1900). In northern Thailand the earliest collectors include Lindhard (Denmark) in 1904-05, Hosseus (Germany) during 1904-06, and Kerr (Ireland) from 1904-1922.

Initial Enumerations

The flora of Chang Island, based on the Schmidt expedition, includes a series of nine volumes on various plant families (including diatoms) and was produced, uncompleted, from 1900-1916. N. Williams (1904-05) listed 1042 species, many as new, found in the Kew Herbarium (England) from Thailand. Ostenfeld (1905) and other botanists working with Lindhard's collection, listed 100 species, several being new. Hosseus (1910) updated the previous lists and in 1911 (Hosseus, 1911) listed his own collections from northern Thailand, which included many new species. (Craib 1911, 1912) made detailed compilations

of both dicots and monocots from all known records for Thailand. From 1926-1934 Craib produced the monumental Florae Siamensis Enumeratio which was continued by Kerr (1936-1962) and Barnett (1962). This uncompleted work is still a vital reference for any botanist seriously working on Thai flora.

After Kerr left Thailand for retirement at Kew in 1932, there was little botanical collecting done in the country until Danish expeditions resumed field activity during 1957-59. The first issue of the Flora of Thailand was produced in 1970. Presently seven volumes have been completed and many more are envisioned.

Initial Vegetation Studies

Kurz (1877), a German botanist and forester stationed in Calcutta, provided the first detailed vegetation analysis for the region–specifically British Burma. He recognized two basic types of forest, *viz*. deciduous and evergreen, each with four subcategories. This system was adopted by Hosseus (1908) and Kerr (1911), in the first detailed vegetational reports for Thailand, both concerning the northern region.

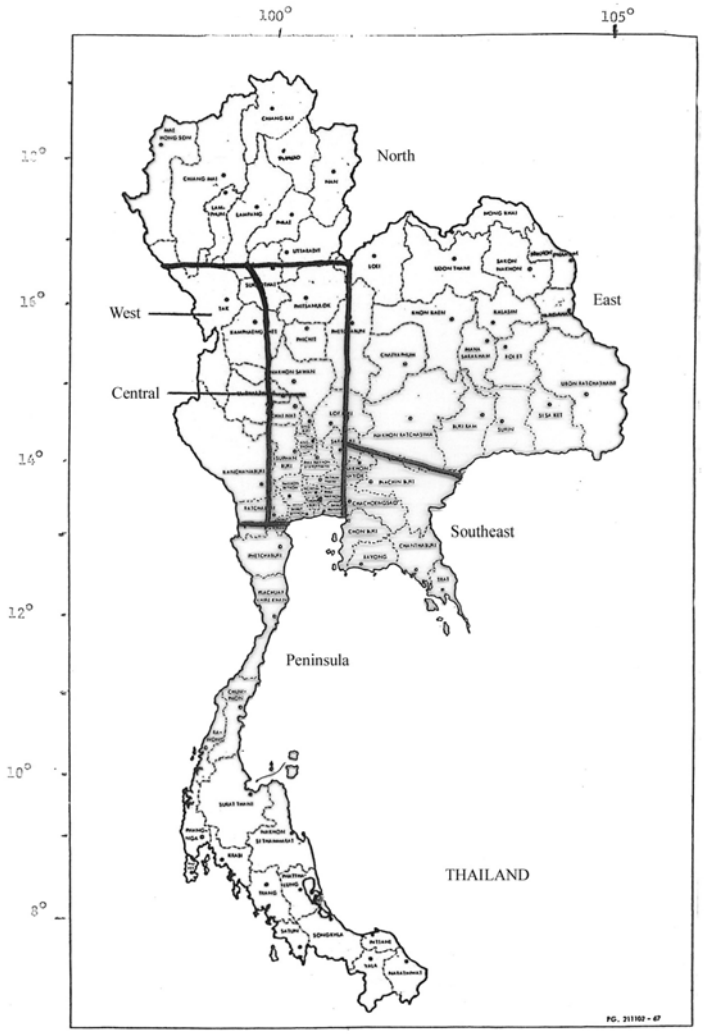

FIGURE 3. Palm regions of Thailand. Redrawn from Hodel & Vatcharakorn (1998).

Craib (1931), based on Kerr's extensive travels, wrote a sketch of Thailand's vegetation where it was noted that about 70% of the country was forested. This was followed by Credner (1935), a German geographer, who traveled throughout Thailand during 1927-29. He provided a more detailed vegetational analysis which included the first vegetational map for the country. Credner discussed eight kinds of vegetation, *viz.* mangrove, alluvial plains and rice fields, tropical rain forest, evergreen monsoon forest, deciduous monsoon (teak) forest, dry forest, thorn-bamboo scrub, and pine-oak forest. The term tropical rain forest was established by the German plant geographer A.F.W. Schimper in 1898. It is an evergreen, everwet, i.e. not monsoonal/seasonal, forest. Credner depicts this kind of forest for all the peninsula, extending along the Burmese border to *c.* 21° N, the SE, and a continuous strip from Nan Province (eastern north), along the Mekong River, west along the Dongrak range (bordering Cambodia), and north in the eastern border of the central plains. This is certainly unrealistic since all of the country has a seasonal climate, thus defying the definition of rain forest. Credner obviously based much of his ideas on rainfall since his map for this is quite similar to the vegetation map, especially in areas with 2000-3000 mm of rainfall per year.

The Thai Royal Forest Department (RFD 1950, 1962) also recognized seasonality for Thailand, but introduced some new terminology based mostly on the works of Champion and Edwards for forests in India and Burma (Edwards, 1950). It is unfortunate that Credner's opus, written in German, was not considered by the RFD. If it had, many of the subsequent problems in vegetational analysis could possibly have been avoided. The 1950 RFD forest types include: tropical evergreen, pine, deciduous dipterocarp, moist upper mixed deciduous, dry upper mixed deciduous forest, lower mixed deciduous forest, mangrove, savanna, beach, and swamp. The 1962 publication simplified the situation by including moist, dry, and lower mixed deciduous forest under mixed deciduous forest. All this RFD work was based entirely on trees. Subsequent reports by Samapuddi (1957), Loetsch (1957), Ogawa et al. (1961), and Neal (1967) all provide variations on Craib and Credner's work compounded with a perplexing assortment of terms. Neal (1967) attempted to match trees with rainfall and also noted that about 60% of Thailand was forested at that time. Of this forested area about 30% was evergreen and 70% deciduous. L.Williams (1967) was the first to note that a proper vegetational classification system should be based on floristics, physiognomy (forest structure), and bioclimate, i.e. a holistic (total or complete) approach. His work was the most extensive and applicable for that period, although rain forest is still used. His map is quite similar to RFD (1962), both clearly showing fragmentation and reduction of evergreen forested area compared to the RFD (1950) map.

Smitinand's (1977 and 1989) efforts at vegetational analysis are basically retrogressive since his vegetational distinctions and terminology are mixed and quite confusing. No effort by this RFD official was made to adopt a sensible, original, or in any way holistic system. This inconvenient, contradictory, and haphazard concept of trees, elevation, and putative rainfall based on theoretical and imaginary concepts has been "officially" accepted in Thailand. This unfortunate situation has essentially caused the stagnation of progressive vegetational analysis in the country.

Santisuk (1988), an acolyte of Smitinand, in his analysis of northern vegetation, introduced the ludicrous term "seasonal rainforest", a novel and totally unacceptable idea especially for a region which has several moths of drought. The work lacks botanical credibility (*i.e.* no field work was done) and has little ecological value. Unfortunately, it is still occasionally cited by witless authors. There have been a few more recent publications on Thai vegetation (Table 1), but from an academic viewpoint they are quite insignificant and in some instances outrageously incorrect.

TABLE 1. Summary of Various Forest Classification Schemes in Thailand.

Author	Deciduous			Deciduous + Evergreen	Evergreen Hardwood		Evergreen Hardwood + Pine
		sea level – *c.* 850 m		*c.* 800 – 1000 m	sea level *c.* 1000 m	*c.* 1000 – 2565 m	*c.* 1000 – 1800 m
Kurz (0877)	eng, hill eng	low forest savanna	mixed forest (lower & upper), dry forest		tropical evergreen	hill evergreen	pine
Hosseus (1908)	dipterocarp forest, Dipterocarpacceae hill forest			mixed oak-wood		evergreen	evergreen
Kerr (1911)	eng, pah paa, pa pe			oak-jungle		evergreen	evergreen
Craib (1931)	pa deng	savanna	mixed deciduous	dry evergreen	tropical rain forest	open hill	pine
Credner (1935)	dry forest	thorn-bamboo	deciduous monsoon		tropical rain forest	hill evergreen	coniferous
Champion & Edwards (1936, 1950)	deciduous dipterocarp		mixed deciduous	semi-evergreen		hill evergreen (evergreen-oak)	pine
RFD (1950, 1962) & Samapudi (1957)	deciduous dipterocarp		mixed deciduous		tropical evergreen	hill evergreen	coniferous
Loetsch (1957, 1957/58)	dry dipterocarp		deciduous monsoon with or without teak	tropical semi-evergreen	hill evergreen	hill evergreen	coniferous
Ogawa (1961)	dipterocarp-savanna	mixed savanna	tall deciduous or monsoon	ecotone of subtropical semi-evergreen forest	evergreen gallery	temperate hill evergreen	
Smitinand (1966)			upper moist mixed deciduous	dry evergreen	upper hill evergreen/moist lower montane (rain) forest		pine
Robbins & Smitinand (1966)	deciduous dipterocarp		mixed deciduous		evergreen gallery	hill evergreen	coniferous
Küchler & Sawyer (1967)				semi-deciduous			
Neal (1967)	deciduous dipterocarp		mixed deciduous with teak	dry evergreen	tropical rain forest	hill evergreen	coniferous
Williams (1967)	deciduous (dry) dipterocarp	savanna	mixed deciduous (dry & moist)		rain forest, moist forest	hill evergreen (lower & upper)	coniferous
Whitmore (1975)	dry deciduous dipterocarp	savanna	tropical moist deciduous (teak)	tropical lowland evergreen rain forest	semi-evergreen rain forest		dry deciduous dipterocarp + pine
Smitinand (1977)	dry deciduous dipterocarp, savanna		mixed deciduous		tropical evergreen (rain forest), dry evergreen	hill evergreen	coniferous
Smitinand *et al.* (1978)	dry deciduous dipterocarp		dry & moist mixed deciduous		dry evergreen	lower montane	coniferous
Santisuk (1988, 1997)	deciduous dipterocarp		tropical mixed deciduous		seasonal rain forest	montane	pine-deciduous dipterocarp, pine-oak-savanna, lower montane pine
Smitinand (1989)	dry deciduous dipterocarp	savanna	mixed deciduous (moist upper, dry upper, lower)	dry or semi-evergreen	lower & upper tropical rain forest	hill evergreen	coniferous
Ashton (1990)	dry deciduous (dipterocarp)				seasonal wet evergreen	seasonal evergreen dipterocarp (dry evergreen)	
Werner (1993)		pine-deciduous dipterocarp; pine savanna					lower montane pine-oak forest, pine-seasonal rain forest
Werner & Santisuk (1993)	dry deciduous dipterocarp	pine-deciduous dipterocarp	mixed deciduous			lower & upper montane rain forest	lower montane pine-oak forest
Zhu (1997)				seasonal rain forest, wet seasonal rain forest, seasonal evergreen forest	seasonal evergreen forest		
Santisuk (1998)			tropical mixed deciduous	mixed evergreen	seasonal rain/dry evergreen	lower montane rain forest & lower montane oak forest	
Kohta *et al.* (1999)	dry *Dipterocarpus*					primary evergreen broad-leaved (above 1600 m)	*Pinus kesiya* forest
Maxwell (1988, 1992, *etc.*)	deciduous dipterocarp-oak	degraded bamboo + deciduous forest	bamboo + deciduous	mixed evergreen + deciduous	primary evergreen without pine forest	primary evergreen without pine forest	primary evergreen + pine forest

The most recent and flagrant insult to vegetational analysis has been prepared by the World Wildlife Fund (Wikramayanake et al., 2002) concerning Terrestrial Ecoregions of the ***Indo-Pacific***. This book, at least as far as far as Indo-China is concerned, is absolutely absurd in concept, content, and credibility. The myriad of ecoregions presented for the region is based almost entirely on mammals and birds. Vegetation, sadly, has been added to supplement the zoological information. Whatever vegetational information presented is from the literature, which in many cases (especially Thailand) is incomplete, inaccurate, inadequate, and grossly inept. I suspect that the same is true for all the other regions discussed.

Thailand is noted to have twelve ecoregions which are noted along with the corresponding ecoregion number.

51. Kayah-Karen Montane Rain Forest, average rainfall 1500-2000 mm/year
52. Luang Prabang Montane Rain Forest, 1500-2000 mm
69. Northern Khorat Plateau Moist Deciduous Forest, 2000-3000 mm
68. Northern Thailand-Laos (teak-dominated) Deciduous Forest, 1000-1200 mm
72. Central Indochina Dry Forests, 1000-1500 mm
70. Chao Phraya Lowland Moist Deciduous Forest: west side, 1000-1100 mm; east side 1300 mm
64. Chao Phraya Freshwater Swamp Forests, *c*. 1400 mm
59. Southeastern Indochina Dry Evergreen Forests, 1200-2000 mm
53. Tenasserim-South Thailand Semi-Evergreen Rain Forests, rainfall not given
80. Peninsular Malaysian Rain Forests, more than 2000 mm
    a. Lowland Rain Forests, less than 1000 m elevation
    b. Tropical Montane Evergreen Moist Forest, more than 1000 m elevation
78. Myanmar Coastal Mangroves
79. Indochina Mangroves

Typical and as to be expected from a multi-authored, uncritical compilation such as this, many of the regions (especially Thailand) are poorly defined botanically and tend to merge with adjacent ecoregions. No attempt has been made to incorporate a holistic methodology and it is quite inappropriate to equate zoological ecoregions with vegetational ones.

A Simplified System

During my early years in Thailand (1969-1976) I was never satisfied with any RFD vegetational classification system, especially for evergreen and deciduous forests. In later years (1987-present) I have developed a simplified vegetational classification system for Thailand (Table 2). This system is based upon seasonality, forest and floristic type and condition, and elevation. In my opinion there is no rain forest in Thailand. Previous distinctions of evergreen and deciduous forests can be understood if the condition of the vegetation is considered, *i.e.* primary, secondary, or tertiary growth. This has never been stressed by previous authors since most were not experienced botanists and were unable to determine and understand vegetational degradation.

I have also made a concerted and professional effort to consider the entire flora of an area, not only trees, in my analyses. All of these concepts have been recently presented (Maxwell, 2001) along with recommendations as to how a holistic approach can be used to refine my system. The fact that I have not been able to include rainfall in my approach will hopefully be rectified and added as another parameter by others. At the moment, I am still unable to divide evergreen forests, especially above 1800 m on Doi Intanon and in the peninsula, into distinct associations. Others have, but I disagree. This can only be resolved by a concerted effort by a competent team of experienced botanists, ecologists, geologists, hydrologists, agronomists, climatologists, and satellite imagery specialists.

TABLE 2. Simplified classification for forest/vegetation types in Thailand (Maxwell, 2001)

Forest Type		Primary Growth	Secondary/Degraded Growth (da/sg)	Tertiary Growth (da/sg)	Elevation (m)
Seasonal (Monsoonal)	Almost ever-wet ("rain forest")	evergreen (egf)	evergreen scrub	bamboo thickets, grassland, cultivated areas, plantations	sea level – *c.* 1800
	Distinctly Seasonal	evergreen (egf)	evergreen + bamboo (eg/bb) deciduous dipterocarp-oak (dof)	bamboo thickets, grassland, cultivated areas	sea level – *c.* 1000 - *c.* 2565*
		deciduous with bamboo (bb/df)	bamboo thickets, grassland, deciduous dipterocarp-oak (dof)	cultivated areas	sea level – *c.* 850
		mixed evergreen + deciduous (mxf)	bamboo + mixed evergreen + deciduous scrub, deciduous dipterocarp-oak (dof)	bamboo thickets, grassland, cultivated areas	sea level – *c.* 1000
		evergreen + pine (eg/pine), deciduous dipterocarp-oak with pine (do/pine)	deciduous dipterocarp-oak (dof)	grassland, cultivated areas	*c.* 60 – *c.* 1800
Aquatic	Saline	mangrove	no vegetation, mangrove scrub	no vegetation	sea level – 25
	Fresh	lakes, ponds, swamps, marshes, rivers, *etc.*	scrub, grassland, cultivated areas	scrub, grassland, cultivated areas	sea level – 2550
Beach		beach vegetation	scrub, grassland	grassland, cultivated areas	sea level

*In peninsula and central Thailand egf can be found starting at or near sea level, but in northern Thailand, where the dry season is longer and more severe, it starts at about 1000 m.

CONCLUSION

The basic reason why Thailand lacks a proper vegetational system is that research for this has never been done or analyzed correctly. Kurz's basic system is still the most appropriate, not only because of his experience and competence, but also because of his thoroughness. Craib and Credner deserve credit for introducing a potentially creditable system for Thailand. Later publications occasionally show some originality, but most of them merely serve to further confuse and obscure reality. The Flora of Thailand, while being an essential taxonomic resource, has never tried to sort out the myriad of vegetational nomenclature noted for the habitats/ecology of the species listed.

A holistic approach to understanding the Thai vegetation has never been done. Most authors writing on this topic have relied on trees and/or rainfall as the indicators of forest types. Unfortunately, this has never been properly implemented. Another serious problem lies with the competence of the field investigators and credibility of the references various authors have relied on. Most of the authors I have noted here have not been competent botanists, but rather geographers, agriculturalists, or ecologists. Many of these authors depended on RFD staff or literature to provide information (especially plant names) – a very serious error, since botanical and ecological professionalism in the RFD has always been minimal. None of the authors discussing Thai vegetation has ever been critical of previous work. Realizing that most of these authors have essentially been vegetational tourists under the auspices of RFD without ever having lived or done research there, it is quite clear why their criticisms are lacking. People who do not know local plants, cannot recognize an intact habitat from a disturbed one, rely on RFD "experts" to give them information, and lack field experience in the country cannot possibly be expected to produce reliable results or comment productively on previous work.

In recent years, satellite imagery has been used to determine forest/vegetation types. Some of the results have been absolutely absurd, mainly because field observations have not been made. Forest/vegetation terminology in these assessments has mostly been botanically and ecologically incredible.

RECOMMENDATIONS

A uniform, accurate, and detailed system for forest/vegetation classification is needed for the Asia-Pacific region. This can only be done when a dedicated and well-financed team of experienced professionals employ a holistic approach to this task. For Thailand, there is a lack of competent field botanists, albeit there are numerous "specialists" and self-proclaimed "experts" in the RFD and Thai universities who fraudulently claim such abilities. Without holistic botanists, in contrast to those who only know some trees or merely teach botany, the flora of an area will never be thoroughly known. Lacking floristic expertise, ecologists will be unable to get reliable names for their transect studies. Remote sensing analysts, totally dependent on botanists and ecologists, will consequently not be able to correctly interpret their image colours.

The situation in Thailand is hampered by a total lack of coordinated effort in vegetational analysis. The various universities and government agencies all have their own agendas and budgets, thus there has never been any agreement on methodology and interpretation of results. I suggest that the Flora of Thailand committee consider this issue and try to initiate a programme where the vegetation of Thailand is properly studied.

ACKNOWLEDGEMENTS

I would like to thank Sam Coggins and Pranee Palee for typing my original manuscript on a computer. Ricky Ward is thanked for redrawing the information presented in Fig. 1, and Martin van de Bult for providing the RFD (2001) data and productive comments on the manuscript.

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Received: 10 August 2004
Accepted: 11 October 2004