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I. Natural Vegetation and Physiography of the Central Plain of Thailand*

by

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Introduction

The climate of the Chao Phraya Plain is profoundly influenced by the monsoon. The remarkable alternation of dry and wet seasons characterizes this monsoon climate. The annual amount of precipitation in this area is ca. 1000–1200 mm, most of which comes with the SW monsoon during the period from May to September. From November to April is the dry season.

As a result of research, it is known that in such an area as the Central Plain of Thailand with little local differences of temperature and rainfall, the type of vegetation is strongly influenced by hydrographical conditions controlled by topography. The drying in the rainless season in the marginal portion (Fan-Terrace Complex Area) of the plain, and the deep prolonged inundation during the wet season in the deltaic region and the Plugged River Channel Area act as the limiting factors over the type of vegetation. The purpose of this paper is, therefore, to present primarily the relationship between vegetation and topography.

1. Physiography of the Central Plain of Thailand

The Central Plain of Thailand stretches from Uttradit at the northern end to the Gulf of Thailand at the southern end. Its areal extension is 420 km from north to south and 50～150 km from east to west. On the basis of topography and geology, the Central Plain may be divided into four areas, namely, Plugged River Channel Area, Fan-Terrace Complex Area, Old Delta, and Young Delta.[11)]

A) Plugged River Channel Area

The rivers, with their headwaters rising in the mountains of North Thailand, run down to the northern end of the Central Plain and flow gently southward through the Plain, forming a kind of valleys-in-valley here and there, until they reach Chainat where the deltaic region

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begins. The valleys-in-valley are 10 to 20 km wide, ca. 60 m in elevation at the northern end of the Plain and 20 m at Chainat.

Geologically speaking, these valleys-in-valley are Recent alluvial valleys, comprising natural levees and backswamps just like the ordinary alluvial valleys of major rivers. The natural levees are ca. 10 m in height, 4 to 6 m in relative height from the adjoining backswamps, and are composed of loamy material accumulated by Recent fluvial action. The sediments in the backswamps are loose and clayey.

In this paper, the area of valleys-in-valley, or Recent alluvial valleys, is called Plugged River Channel Area, according to Takaya.[11]

B) Fan-Terrace Complex Area

The area between the Plugged River Channel Area and the hills bordering the Central Plain is a terrain of gentle slopes and slight undulation. Geologically speaking, this terrain consists of fans and terraces of different ages ranging from Recent to Plio-Pleistocene.

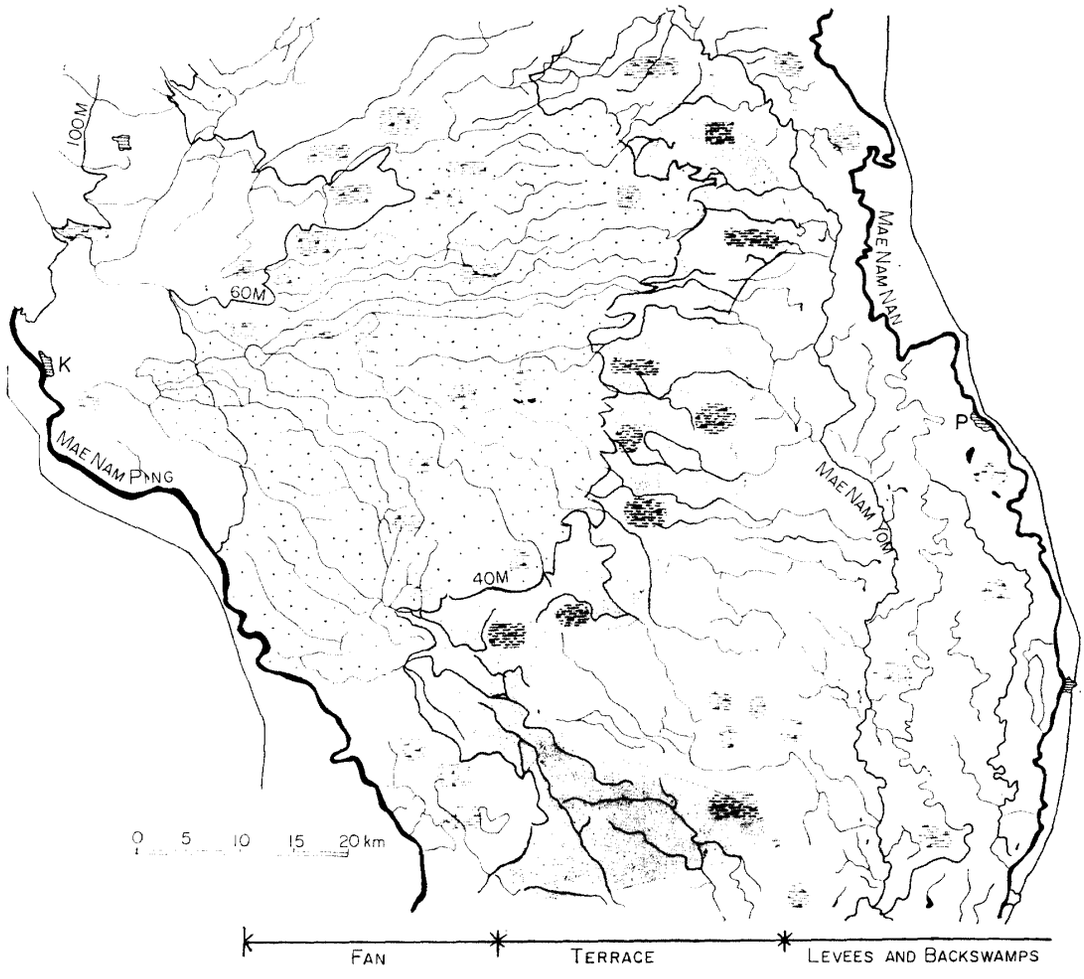


Fig. 1 A Physiographical Map, showing the Fan-Terrace Complex and Plugged River Channel Areas

Fans and terraces of Recent age are composed of unconsolidated fresh sediments of loamy and sandy texture, while those of Plio-Pleistocene are composed of strongly weathered material, as exemplified by honeycomb-structured laterite more than 5 m in thickness. Other fans and terraces have more or less weathered and weakly compacted loamy to sandy material.[1)]

Hydrographical conditions of this terrain are thus complicated. In terms of edaphology, however, the terrain may be classified into three types of ground by the near-surface condition. They are, (1) ground with thick layers of fresh sediments, (2) lateritic ground with thin fresh sediments, and (3) ground with naked laterite. Field observations reveal that the thick fresh sediments occur almost always along active and abandoned stream courses which tend to concentrate in the area of fans rather than in the area of terraces, while the naked laterite occurs in the terrace area rather than in the fan area. (See, Fig. 1)

C) Old Delta

The Old Delta begins at Chainat, ca. 170 km inland from the Gulf of Thailand, where the Chao Phraya river makes its first bifurcation. The Old Delta has the configuration of a delta with the radius 100 km and the arc 70 km. The elevation at the apex is ca. 15 m, lowering to 5 m at the border to the Young Delta.

The Old Delta is supposed to have been formed in the Upper Pleistocene period. The ground surface is very slightly undulating due to erosion during the Pleistocene period and to the levees of Recent age. The relief locally attains to 4～5 m. The deposits are mostly very slightly indurated clay, but unconsolidated loamy material of Recent levees is distributed along distributary channels.[3,8,10,12)]

D) Young Delta

A deltaic area south of the line linking Ayutthaya and Suphan Buri is called Young Delta. This is a very flat and lowlying terrain, being 2 m or so above sea level for the most part.

Since this is a newborn land the sediments, dominantly clay, still retain water and so loose that they subside by their own weight. According to the soil map compiled by the Soil Survey of Thailand[6)] this monotonous terrain is divided into three zones by the nature of soil. The inlandmost zone is the area of fresh water clay, the middle zone is of brackish clay, and the coastal zone is of marine clay. The brackish clay of the middle zone is the so-called acid sulphate soil which is rich in sulphate and has very low pH values.[10)]

2. Water Condition and Vegetation

A) Plugged River Channel Area

In this area, the water level in the backswamps rises rapidly from the beginning of the wet season, and the high water level lasts long after the end of the wet season. In the dry season the backswamps dry up.

The natural levees of such big rivers as the Mae Nam Chao Phraya, Mae Nam Yom

and Mae Nam Nan are high enough (about 10 m) to survive inundations in the wet season.[11] These levees are usually covered by the Semi-evergreen phase of the Gallery forest,[7] because the levees are too high and the water supply from underground is poor during the dry season.

The backswamps are relative swales sandwiched between levees, but their floors are not flat, their relief attaining to 5 m. Therefore, the water depth varies from place to place, for example, the lowest depressions which are deeply inundated have 6 to 8 m deep water, whereas higher parts or abandoned levees are under very shallow water or seldom inundated. In the lowest parts water remains throughout the year and hydrophitic herbs grow, such as *Neptunia oleracea, Aeschynomene indica, Sesbania roxburgii, Ludwigia adscendens, L. prostrata, L. linifolia, Ipomoea aquatica, Nelumbo nucifera, Pistia stratiotes,* and *Scirpus gorssus*. The greater part of the swampy area is cultivated into paddy fields, where water does not stay throughout the year, though the inundation during the wet season may attain a depth of 2 to 4 m. In the relative swells, woody vegetation may be found. The environment of the backswamp area is thus minutely varied, but it is a swale as a whole.

B) Fan-Terrace Complex Area

In terms of water supply, the Fan-Terrace Complex Area can be defined as a water-deficient area as a whole. The area, lacking large rivers, has to rely on the precipitation *in situ*. This leads to the severe shortage of water during the rainless season. And even in the rainy season, the area is short of water because of the area's relatively high elevation and its porous basement. Only some limited parts of the area receive flush-type flood water during the rainy season.

As mentioned in the previous chapter, the ground of the greater part of the Fan-Terrace Complex Area is a complex of naked laterite, laterite with very thin loamy veneer and thick loamy outwash deposits. Laterite, at least near the surface, is so completely indurated as to be called iron stone and as porous as cobble aggregation, and the underlying unconsolidated layer is highly impermeable, so the water condition of the laterite area is very poor during the dry season. Loamy deposits, on the other hand, are quite favorable for plants to grow, because the water-holding capacity is high. Therefore, the thickness of the loamy deposits beneath the ground surface bears a grave significance in the Fan-Terrace Complex Area. Another crucial factor is the availability of shallow ground water. Most of outwash deposits are developed along active and abandoned stream courses which coincide with the channels of shallow ground water. In this respect as well, a zone of outwash favors the growth of plants. A schematic sketch of the surface condition is given in Fig. 4.

The vegetation of the Fan-Terrace Complex Area is well controlled by the physiographic condition mentioned above. Two distinctive types of forest can be observed; they are the Savanna forest and the Gallery forest.[7] (See, Fig. 2)

The Gallery forest occurs only on the natural levees where sandy loam of fluviatile sedimentation is developed as thick as 5~10 m or more. The soil in this forest is deep and rich. The forest comprises two phases, Evergreen and Semi-evergreen. Which phase of

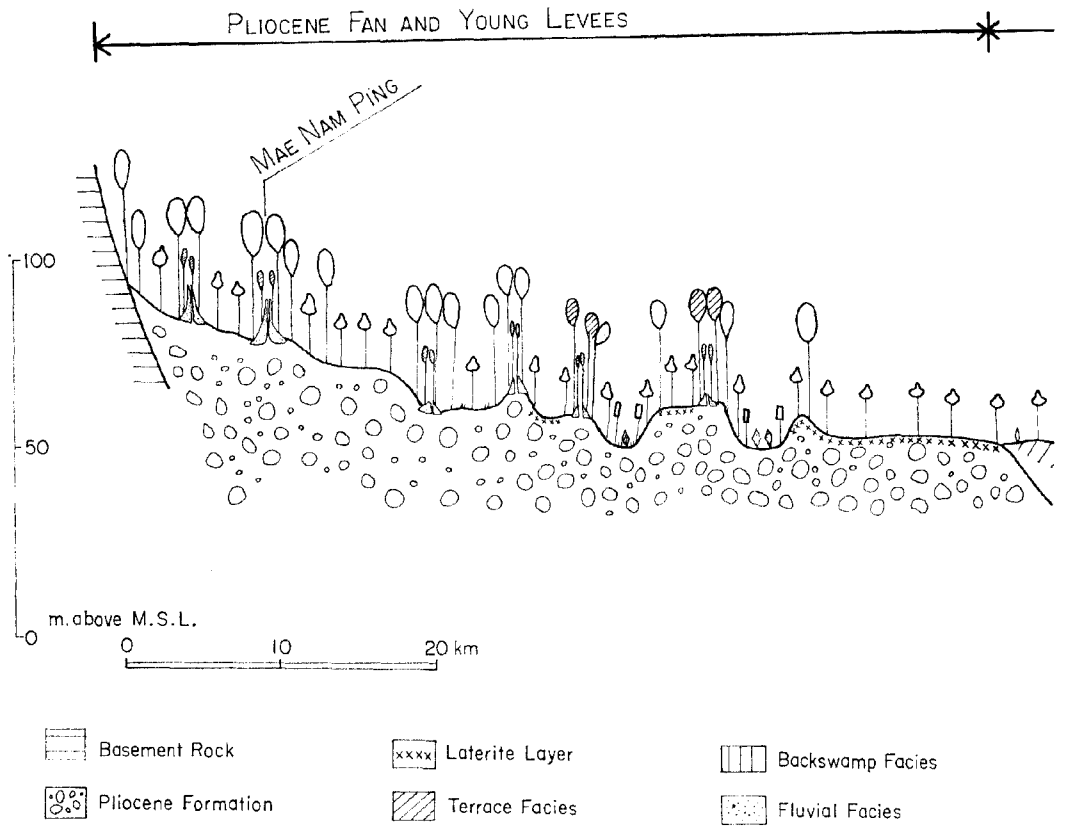


Fig. 2 E-W Cross-Section along the Line of Long. 80°20′E,

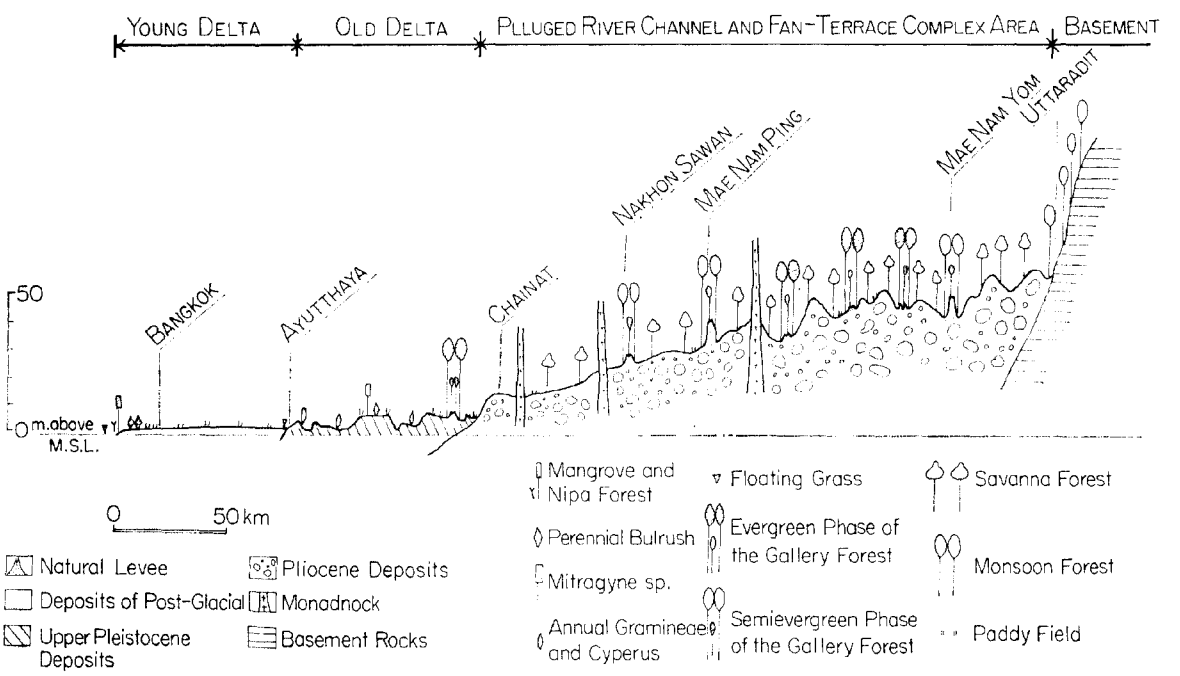
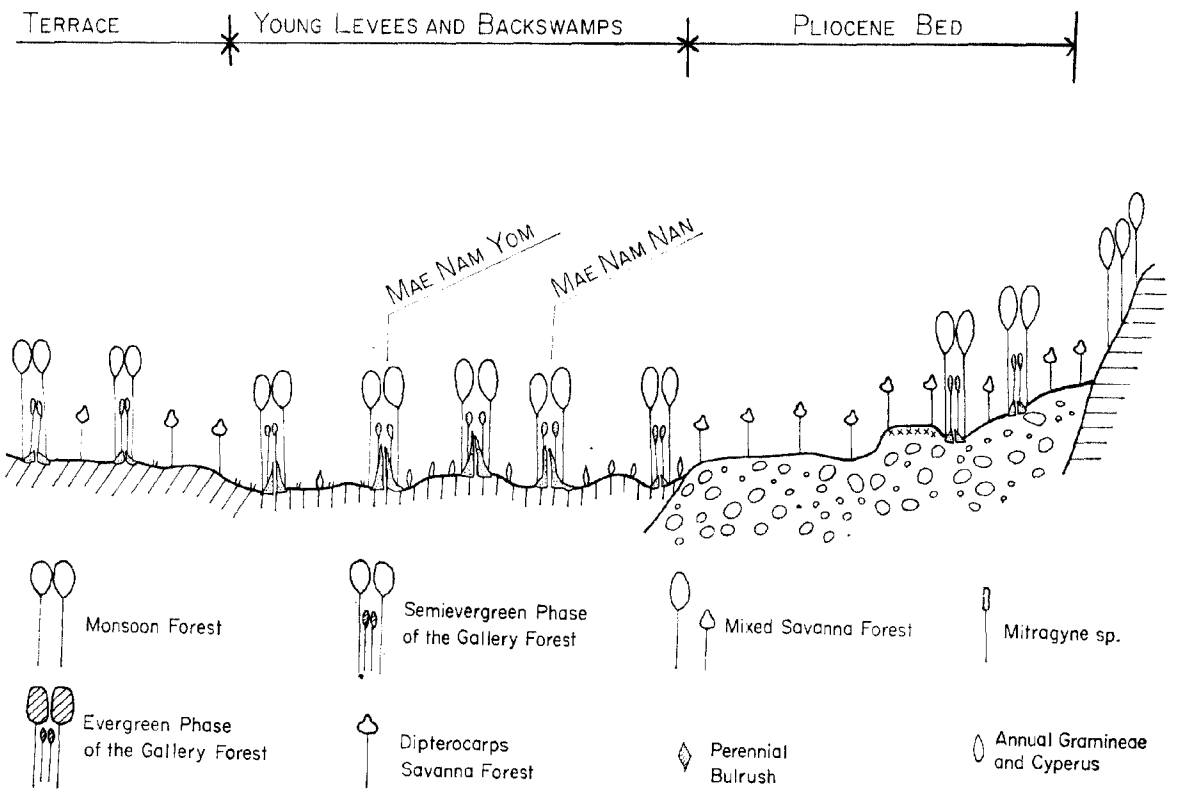


Fig. 3 N–S Cross-Section through Bangkok, Ayutthaya, Chainat and Uttaradit, showing the Relationship between Vegetations and Physiography

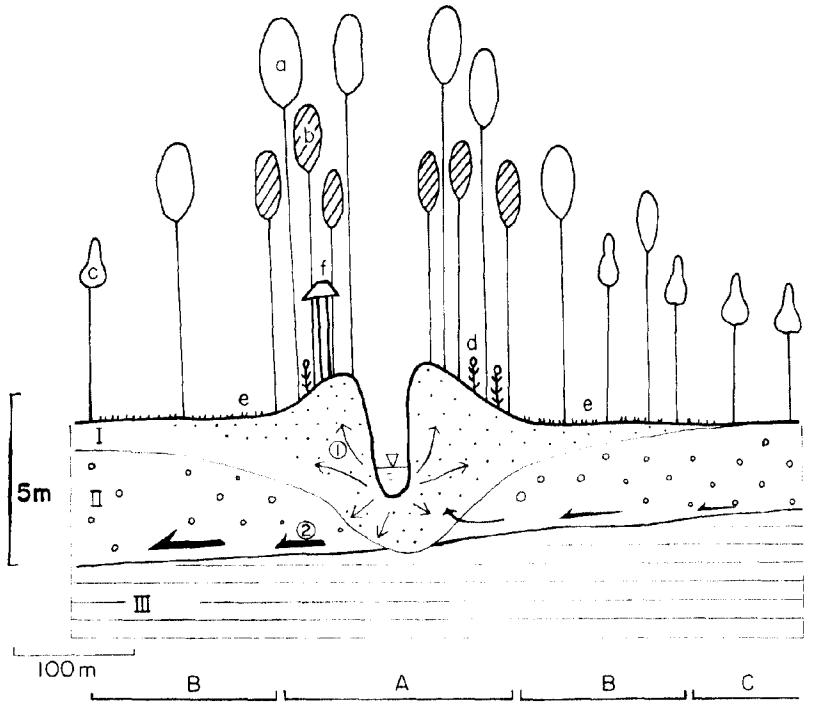


showing the Relationship between Vegetations and Physiography

the forest can grow on the levees is dependent upon the water supply from underground during the dry season.

The Evergreen phase of the Gallery forest is found only on the levee near a spring or pond where the continual water supply is possible even in the rainless season. This type of forest is quite dense and the canopy trees are tall, about 30 m or more, and often form buttresses. The component species are *Dipterocarpus alatus* (Yâng), *D. costatus* (Yâng Déng), *Hopea odorate* (Takien), *Anisoptera robusta*, *Mangifera camptosperma* (Mak Mâng), *M. coloneura* (Mamûang Pâ), *Ficus* spp. and so on. No specially dominant species can be found and all members are commingled. Many herbaceous plants are found in the forest and their litter is deposited on the ground surface.

On the other hand, the Evergreen phase on large levees grades into the Semi-evergreen phase, as observed along the rivers Mae Nam Ping and Mae Nam Yom. It seems that the water supply from underground during the dry season is rather poor there. The trees of the first story are isolated from each other and about 80% of them are deciduous. The second story, 15~20 m high, is enclosed largely by evergreen members. Lower stories are not developed well, but lianas are very abundant hanging from every trunk. Fresh litter thickly covers the ground surface. These features may indicate the edaphic climax of Gallery



I. Loamy fresh sediments
II. Honey comb structured laterite
III. Unhardened laterite or unlateritiged rocks
A. Levee, ground with thick layers of fresh sediments, covered by the Gallery forest
B. Ground with thin fresh sediments, covered by the Mixed Savanna forest
C. Ground with naked laterite, covered by the Dipterocarp Savanna forest
a. Deciduous tall tree
b. Evergreen tree
c. Dipterocarp tree
d. Zea maize cultivation
e. Rice field
f. House
① Capillary absorption of stream flow into loamy stuff
② Shallow ground water current

Fig. 4 Water condition around levee

forest in this area.

Another important type of forest found in this area is the Savanna forest. This forest is in sharp contrast to the Gallery forest in both general appearance and character. The distribution of the Savanna forest seems to be limited to the terrain of naked laterite or laterite associated with thin sediments.

The Savanna forest can be divided into two subtypes, *i.e.*, Dipterocarp savanna forest and Mixed savanna forest, though the two subtypes are more or less gradational according to the thickness of fresh sediments on the ground.

The Dipterocarp savanna forest covers the most xeric ground where the soil is extremely thin and sterile, and thick laterite prevents water supply from underground. The forest is characterized by four dominant species of Dipterocarpaceae, namely, *Pentacme siamensis*

(Rang), *Shorea obtusa* (Teng), *Dipterocarpus tuberculatus* (Plûng) and *D. obtusifolius* (Yâng). The trees, generally below 15 m in height, are more or less isolated, presenting the aspect of an open forest, and their trunks are very hard and compact in texture, the sign of retarded growth due to poor supply of water. These trees shed their leaves entirely during the dry season. With such a severe shortage of water, even the growth of grasses is markedly impeded there. Only xeric members belonging to *Uvaria, Helicteres, Evolvulus, Pouzolzia, Uraria, Setaria* and some gramineous grass can grow there, and sometimes thorny shrubs are found also as undergrowth. In comparison with other types of forest, the Dipterocarp savanna forest remains almost uncultivated due to these unfavorable conditions.

The Mixed savanna forest apparently represents the mesic phase and can grow where somewhat thick sediments lie on the laterite surface. The component species are numerous and well mixed, and unlike the case of the Dipterocarp savanna forest, no distinct dominant species are present. *Dipterocarpus tuberculatus, D. obtusifolius* and *Shorea obtusa* are still abundant, but also frequent are *Xylia kerrii, Terminalia tomentosa, T. mucronata, Adina cordifolia, Vitex pubescens, V. peduncularis, Bombax kerrii* and other species. Some bamboos are found here and there. The trees constituting the Mixed savanna forest are 15～20 m in height, taller than those of the Dipterocarp savanna forest. The bole is relatively straight and well branched, but the crowns are scarcely in touch with each other. The ground layer consists of grasses and such shrubs or herbs as *Leea, Helicteres, Uvaria, Gardenia, Cratoxylon, Phyllanthus, Crotalaria* and others vigorously growing there. The sporadical distribution of the trees which remain unfelled within the newly cultivated paddy field gives a peculiar impression of the landscape resembling a park. The time of defoliation is strongly influenced by the degree of moisture in the soil, and sometimes the trees standing in the irrigated paddy field keep their leaves long after the end of the wet season.[7]

The area covered by the Mixed savanna forest has a potentiality to be cultivated into paddy field if the water supply is ensured by means of irrigation. In fact, the larger part of the area has been already cultivated.

In the middle part of the fan, ponds and swamps occur where the underground water table is high. Also, springs may serve as the source of water supply. The swampy region of the fan is covered by hydrophitic perennial grasses such as *Nymphaea, Nelumbo, Ludwigia, Polygonum, Sesbania, Aeschynomene,* Gramineae and Cyperaceae. Around the region, *Mitragyne javanica* var. *microphylla* is occasionally found.

C) Old Delta

The water regime in the Old Delta is similar to that of the Plugged River Channel Area, but the rise of the water level is slower and the maximum depth is shallower. From the end of September through November the backswamps are inundated 1～3 m deep. In this area cultivation of the floating rice is common.[13] The life form of floating grass type is highly adaptive to this swampy condition where the deep and prolonged inundation prevents the growth of woody vegetation. Most of the backswamps in the Old Delta are

thought to have been a grassland once, covered by mainly annual Gramineae and Cyperaceae, but these areas are now largely cultivated into paddy fields. At the beginning of the dry season, the inundation shrinks and chains of small pools are left behind. These pools begin to dry up in the middle of the dry season.[4)]

The natural levees never suffer inundation. The natural levees in the Old Delta seem to have been once covered by tropical mixed evergreen forests, but the original vegetation has been destroyed by human activity. Most villages are situated on the levee, and trees are replaced mainly by such introduced species as *Samanea saman* (Rain tree or Châm chu ri, a native of Brazil), *Deronix regia* (Flame tree or Hâng nok yung farang, supposedly a native of Madagascar) and *Tamarindus indica* (Makaam tree, cultivated in pantropic regions but supposedly a native of tropical Africa) and other useful trees.

In the backswamp region, some trees and bush clumps such as *Diospyros* sp. (Tako), *Ficus* spp., *Streblus asper* (Khoi), *Combretum quadrangulare* (Sakei), etc., are sporadically found on termite mounds in paddy fields in the relatively higher portion near the levee, whereas in the relatively lower portion *Mitragyne* sp. is occasionally found without termite mounds below them. Since *Mitragyne* can grow in a swampy environment, it is reasonable to guess that the area around this place was previously covered by swamp forests.

D) Young Delta

The Young Delta is very flat and very wide. No termite mound is found in this area. The inundation is slower and shallower in the Young Delta than in the Old Delta. Another different feature from the Old Delta is that the flood water coveres nearly the entire surface of this area without leaving any piece of land above water. Such extensive inundation is due to the flatness of the ground surface. During the rainless season the ground remains dry. More detailed observation reveals, however, that the flood pattern within the Young Delta slightly varies with the aforementioned zones. The inlandmost zone is flooded rather quickly and deeply, while the coastal zone is slower to be flooded but the water, though shallow in depth, remains for a prolonged period, locally presenting an aspect of a perennial marsh.[5)]

A characteristic feature of the Young Delta is that, owing to the prolonged inundation, there is no natural woody vegetation, with the exception of the mangrove forest in the coastal region. The vegetation found on the canal banks or roads is either man-made or secondary one. Only in the relatively higher portions such shrubs as *Combretum quadrangulare* (Sakei) are occasionally found. The Young Delta today is almost entirely cultivated into paddy fields. In the main part of the Young Delta, annual type weeds are dominant because the repetition of prolonged inundation and drying prevents the growth of perennial herbs.

In the coastal zone, especially in the southeastern part of the Young Delta, where the shallow water remains throughout the year, many hydrophitic perennials grow vigorously. One of the representative associations in this area is *Scirpus grossus* association which is considered to indicate a climax phase. Associated genera are *Monochoria, Aneilema,*

Typha, Juncus, Scirpus, Cyperus, Eleocharis, Cladium, Scleria, Fimbristylis, Hydrocera, Aeschynomene, Sesvania, Anmannia, Rotala, Gratiola, Lindernia, Torenia, and so on.

Along the coast, mangrove and nipa forest extends on the tidal mud where the invation of sea water occurs all the time and the water table is stable. The representative plants of the forest are *Bruguiera gymnorhiza* (Pasak), *Kandelia candel* (Rang Katé), *Rhizophora apiculata* (Kang Kăng), *R. mucronata, Avicennia marina, Nypa fruticans, Acrostichum aureum, Acanthus ilicifolius,* etc. (See, Fig. 3)

In most cases, ponding water is yellowish brown in color owing to suspending colloidal substance, but some of the pools on acid sulphate soils in the Young Delta contain clear water by the effect of sulphate acid exuding from the soil. Submerged plants and acidophilous hydrophitic members such as *Utricularia, Blyxa, Najas, Hydrilla, Eleocharis, Eriocaulon,* etc. can grow only in these pools of clear water.

3. Summary and Conclusion

The Central Plain of Thailand, where the local variations of temperature and rainfall are not remarkable, has two distinct seasons, wet and dry, which strongly influence the type of vegetation. The characteristic features of the vegetation in the Central Plain can be summarized as follows.

There are two distinctive types of woody vegetation, Savanna forest and Gallery forest.

The Savanna forest covers the area of the Fan-Terrace Complex, and comprises two subtypes, Dipterocarp savanna forest and Mixed savanna forest. In the dry season trees shed their leaves entirely.

The Dipterocarp type of savanna forest occurs where the thick laterite layer crops out on the ground surface and the hydrographical condition in the dry season is extremely poor. The forest is characterized by four dominant species of Dipterocarpaceae, namely, *Pentacme siamensis, Shorea obtusa, Dipterocarpus tuberculatus* and *D. obtusifolius.*

The Mixed type of savanna forest has no distinct dominant species, but the flora is rich where laterite is overlain by the deposits of loam or sandy loam. This forest is largely cultivated into rice field today.

The Gallery forest occurs as a narrow belt on the natural levees along streams, except the area of the Young Delta, depending upon the water supply from underground in the dry season. The forest is of semi-evergreen phase in many cases. The canopy trees are tall and apart from each other, and about 80% of them are deciduous. The second layer of the forest is composed of dense evergreens.

The natural levees in the Old Delta and near the springs and ponds in the marginal portion of the Fan never suffer inundation in the wet season. They receive a constant supply of water from underground, thus allowing the Gallery forest to flourish as the evergreen phase. This type of forest is dense and well mixed, and the canopy trees are tall, but most of them have already been destroyed by human activity.

Most of the backswamps in the Plugged River Channel Area and the Old Delta, as well as the major portion of the Young Delta, suffer the prolonged inundation during the wet season, and dry up in the dry season, so that these parts can support only the grassland of annual Gramineae and Cyperaceae, and are cultivated mostly into paddy rice fields.

In the area surrounding ponds on the Fan, in some spots of backswamps in the Old Delta, and along the coastal margin of the Young Delta, shallow water remains throughout the year, so that hydrophitic perennial grasses and swamp forest can grow, as representated by the *Scirpus grossus* association.

Scirpus grossus can be used as an index of the environment of permanent swamp where the water depth is shallow throughout the year. *Mitragyne javanica* var. *microphylla* is an index of swamp forest which once existed there.

Mangrove and nipa forest extends in the sea-facing zone, where the invasion of sea water occurs all the time.

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