DISSERTATION

SUCCESSIONAL TREND OF PEAT SWAMP FORESTS AT PHRU TOH DAENG AND PHRU KUAN KRENG, SOUTHERN THAILAND.

by

CHAROENWITT HANKAEW

2000

THESIS APPROVAL

THE GRADUATE SCHOOL, KASETSART UNIVERSITY

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TITLE: Successional Trend of Peat Swamp Forests at Pru Toh Daeng and Pru Kuan Kreng, Southern Thailand.

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DISSERTATION

SUCCESSIONAL TREND OF PEAT SWAMP FORESTS AT PHRU TOH DAENG AND PHRU KUAN KRENG, SOUTHERN THAILAND.

MISS CHAROENWITT HANKAEW

A Dissertation Submitted in Partial
Fulfillment of the Requirements
for the Degree of
Doctor of Philosophy (Forestry)
Graduate School
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2000

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The successional trend of peat swamp forest was studied at two locations : Phru Toh Daeng, Narathiwat and Phru Kuan Kreng, Nakorn Sri Thammarat provinces. Plant communities from 20 sample stands (40x40 m^2); 11 stands from Phru Toh Daeng and 9 stands from Phru Kuan Kreng, were intensively studied. There were totally 135 species in 29 families, including 75 tree species in Phru Toh Daeng and only 3 tree species in Phru Kuan Kreng. The dominant species were Family Myrtaceae: *Melaleuea cajuputi* Powell; *Eugenia kunstleri* King; Family Euphorbiaceae: *Macaranga pruinosa* (Miq.); Family Lauraceae: *Endiandra mycrophylla* (Bl.) Borel.; Family Annonaceae: *Goniothalamus giganteus* Hook.f.et.Th., and Family Sapotaceae: *Ganua motleyana* Pierre ex Dubardin. Four community types of peat swamp forest could be recognized, two primary forest types; a *Eugenia kunstleri* community type, and a *Ganua motleyana - Xylopia fusca* community type and two secondary forest types; a *Macaranga pruinosa* community type, and a *Melaleuca cajuputi* community type.

Regarding to successional trend of Peat Swamp Forest at Phru Toh Daeng and Phru Kuan Kreng, the results showed that, in Toh Daeng peat swamp forest, the present diversity of plant species in the surroundings is sufficiently high to enable succession in the most species-poor areas to progress from pure *Melaleuca cajuputi* to a *Melaleuca cajuputi* association through to the *Macaranga pruinosa* community type, on to the *Eugenia kunstleri - Goniothalamus giganteus-Macaranga pruinosa* sub-type of the *Eugenia kunstleri* community type, the *Eugenia kunstleri – Ganua motleyana* sub-type and eventually to the *Ganua motleyana - Xylopia fusca* community type. In Kuan Kreng peat swamp forest, there is no prospect of succession beyond the *Melaleuca cajuputi* association sub-type because of the absence of any reservoir of colonists from more advanced stages in the succession. The environmental factors, particularly soil and water properties, results showed that pH of both soil and water was very low in all stands at both study sites. The depth of peat was the most important factor in influencing the pattern and distribution of dominant species and community types. Toh Daeng peat swamp forest indicated a high biodiversity as compared with Kuan Kreng in terms of both plant and animal species and plant communities. There were high diversity of 75 tree species, 88 species of fishes and 93 species of birds in Phru Toh Daeng and 3 tree species, 49 species of fishes and 62 species of birds in Phru Kuan Kreng.

These information can be used as a basic knowledge in land use zoning and for sustainable management and conservation planning of natural peat swamp forests.

Acknowledgment

I am greatly indebted to Prof. Dr. Sanit Aksornkoae of Kasetsart University for his guidance, and kind encouragement throughout my graduate study. The suggestions, comments and constructive criticism of my graduate committee; Assoc. Prof. Dr. Utis Kutintara and Dr. Pisoot Vijarnsorn, are gratefully received. I gratefully acknowledge Prof. Dr. Kasem Chunkao, Assoc. Prof. Dr. Somkid Siripattanadilok, and Assoc. Prof. Dr. Samakkee Boonyawat for their considerably suggestions.

Special thanks are due to my colleagues of Sirindhorn Research and Nature Study Center and Kuan Kreng Wildlife Conservation Station for their kind help in collecting samples, and to the Soil Analysis Section, Pikul Thong Development Study Center for providing the soil and water analysis.

Thanks are also due to my friends; Dr. Chawalit Vitthayanon for his kind surveyed of fishes, Dr. Supaporn Thaipakdee and Mr. Phillip D. Round for their kind reading of several drafts, Mr. Verawat Liemmanee for computer analysis, and my colleagues of Rangsit University for their assistance and providing facilities throughout this study. I am very grateful to Rangsit University for providing grant support and working facilities.

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I would like to express my greatest thanks to my late father who was my idol and inspiration and to my mother who brought me up with love, support and understanding to the present day.

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LIST OF ABBREVIATIONS

PSF	Peat Swamp Forest
TD PSF	Toh Daeng Peat Swamp Forest
KK PSF	Kuan Kreng Peat Swamp Forest
PD	Padee
KU	Kok Ku
KL	Kok Kala
PW	PaWaiy
TD	Toh Daeng
LB	Luobo sarma
KS	Kok Sataw
KP	Kao Kampan
BY	Thung Baya
MR	Kok Mairau
MN	Munoh
SL	Sala Takaein
HP	Hua Pakaew
KT	Kuan Tin
KR	Kuan Kreng
SM	Samed Ngam
TM	Kuan Taleymong
KW	Kuwa
BP	Ban Pran
YN	Yuan Nok
ha	hactare
ht.	height
H′	Shannon & Wienner Index (species diversity index)
OM	Organic Matter
SLCA	Single Linkage Cluster Analysis
NMDS	Non-mrtric Multi-dimentional scaling

Successional Trend of Peat Swamp Forests at Phru Toh Daeng and Phru Kuan Kreng, Southern Thailand.

Introduction

Peat Swamp forest (PSF) is a high fertility forest that has a special character with water logged all or almost the year. For a long time, swamp forest has developed through changes of the appropriate ecology system consisting of high biodiversity and thousands of accumulated organic. Consequently, it is the source of valuable ecology that helps to keep the equilibrium of nature and environment. The important function of Peat Swamp forest is regulation of hydrology such as water supply, flood control, flow regulation and prevention of saline water intrusion. It is also the great place of carbon storage that plays an important role to climate regulation of the world.

Peat Swamp forest is one of the wetland that is fragile and sensitive ecosystem that support a various plants and animals. Since it is a habitat of the waterbirds, in the international wetland convention, swamp forest is classified as wetland that reserved for conservation and management (Ramsar Convention, Recommendation 6.1: Conservation of Peatlands). Moreover, there are several agreements on the wise use of conservation and management of peatland.

Peatlands are very important natural environments providing a broad range of natural products, as well as being important for biodiversity conservation, water balance and climate regulation. Both biodiversity conservation and value carbon storage function of tropical peatland is much higher than temperate counterparts. Peatlands have an important role in the hydrology of river catchments. As peat catchment areas, to prevent excessive loss of water that can lead to other serious consequences.

Peatland ecosystem sustain a wide range of organisms and contain many invaluable genetic resources for agriculture and flood crops, horticulture, timber, fisheries, livestock and biotechnological developments.

It is estimated that peatlands hold soil carbon stocks which accounts for 35% of total terrestrial carbon (Immirzi and Maltby, 1992) The importance of tropical peatlands to the global carbon store is proportionately higher, because of their grater carbon density and depth. 5% of the global carbon may reside in tropical peatlands and they increasingly being released to the atmosphere because of peatland losses, due to fires and other unsustainable land use. Thus, peatlands play an important role in the climate change issue. Formulation and implementation of proper conservation and wise use management of peatlands will be necessary to avoid the continuous loss of carbon to the atmosphere.

There are about 30,000,000 hectares of Peatland or water logged or flatland in tropical zone and 20,000,000 ha. of them are in South East Asia. PSF in SEA distribute in Indonesia, Malaysia, Philippine and Thailand. PSF in Thailand are about 64,000 ha. (Phengklai, et. al., 1991), mostly are in the South. The largest peatland of Thailand is in Narathiwat which consisting of 46,400 ha. The second is the peatland surround Thalae Noi Non Hunting Area and north of Songkla lake in Songkla, Phattalung and Nakornsrithamarat, 12,800 ha. Furthermore, there are small peatland distribute in Suratthani, Trang and Pattani, (Vijarnsorn, 1992).

Toh Daeng Peat Swamp forest, in Narathiwat province is the most fertility swamp forest left in Thailand. It consists of high biodiversity and magnificent ecology. PikunThong Development Study Center, has classified land use, based on the expectation of the physical impact on land use in swamp forest, into 3 zones: preservation, conservation, and development zone. Therefore, the studies on forest structure, biodiversity, and knowledge on water, soil, ecology and environment are the most important thing for management plan before implementing any development.

Kuan Krang PSF, is also one of the most important area. Since it is the part of both the origin of Pak-Panang River and Songkhla Lagoon connected to the north part of Talae Noi Non Hunting Area, which is nominated to be the first Ramsar site in Thailand. As the result of the disturbance from activities and projects, Kuan Krang PSF has been degraded rapidly in a short time. The development in swamp forest has an impact on its environment and also Talae Noi Non Hunting Area. Recently, there are many projects that are managed to conserve and develop peatland in order to maximize its usefulness such as the Royal Celebrity forest plantation project, done to rehabitat the degraded peatland, which is the development of Pak-Panang River Project under the Royal Initiation. The profound surveys for information before zoning the areas will results in the success in Kuan Krang PSF conservation and development.

Increasing concerns have been raised about degradation of the peatland resource in Southeast Asia over the past 15 years, particularly as a result of environmentally unsound development activities. Peatlands have often been converted for agricultural development and also to fulfill the growing population demand for settlement and other facilities.

The drainage of peat soils and the establishment of plantations in peat areas, combined with dry climatic conditions were the main contributing factor to the burning of peatlands. The drying of deep peat makes them very susceptible to fires that are extremely difficult to extinguish and capable of continuing to burn in deep seams for months if not years.

The indirect functions and values of peatlands are often been valued unjustly and appreciated only when it has been degraded or lost. Unless prompt preventive measures are undertaken, it is highly likely that severe degradation to peat resources will continue to occur in the future, probably in dry seasons when the forest fires recur. There is an urgent need for measures to manage the peat resources to prevent and suppress these incidents of peat forest fires, not only in Indonesia but throughout Southeast Asia, where 60% of the world's tropical peat resources are located.

An extensive area of PSF in Peninsular Thailand has been cleared and converted to other land use. It has now become a familiar scenario in the landscape of the country that the remaining PSF is being surrounded by areas reclaimed and developed for various land development project, mostly agriculture, industry and residential.

Research study on peat swamp forest in Thailand is not widely done because of the limitation on areas, knowledge and information. Therefore, it is necessary to do research and understand basic of ecology of PSF before implementing any development in such area. The study of ecological structure and changing direction of PSF succession in both Toh Daeng and Kuan Krang will be adequate and useful information for the future management plan of peatland.

Objectives

The main objectives of this investigation are as follows :

To know the basic information on ecology of peat swamp forest especially the structure and biodiversity, in the southern part of Thailand in order to enhance the knowledge and well understanding the ecology of peat swamp forest.

To compare the successional trends of peat swamp forest community between Toh Daeng and Kuan Krang Peat swamp forests.

To apply the results of the study as basic information for the sustainable management and conservation plan of peat swamp forests of the country.

Hypotheses

The balance of ecology system in natural swamp forest is very important. When one community of plant has been disturbed, it will be substituted by another. However, nature will help it adjust itself in some degree. The development of plant community will take place and the changeable cycle varying to the appropriateness of the degree of ecological condition. Finally, when the balance of nature is stable, that area will become fertility forest as it used to be. On the contrary, if the balance of nature is disturbed again and again until its ecological condition has been changed completely, plant community therefore will be changed and unable to return to be the forest. The hypotheses of this study are as follows :

1. Community Structure of Toh Daeng PSF will have more biodiversity than Kuan Kreng PSF.
2. Community Structure of Toh Daeng PSF should consist of specific characteristics indicating PSF community. Changes of peat swamp forest in conservation area including primary peat swamp forest can be or cannot be rehabilitated.
3. Changes of Kuan Kreng PSF community can be compared with any changes of Toh Daeng PSF community. This information can be used as data base in classifying and zoning of land use.

4. Any areas being disturbed again and again from both nature and human invasion until its ecological condition completely changed, it's plant community will be changed and cannot be reserved.

Review of Literature

Definitions

There were very confused on the meaning of wetland that had waterlogged or Flooding or peatland, especially always misunderstood about these wetland areas to be wasted areas, caused done many wrong development project on these areas. Consequently, it was necessary to adjusted to the same meaning of the definition about peatland, swamp, peat swamp forest before do any projects.

Peat swamp forest occur in the place that has fresh water logged all or almost the year. Mostly PSF is in tropical zone which has too many rain and low evaporation that made flooding in the lowland or shallow come to be pond or lake or swamp. (Walter, 1971). Like Far East Asia, Thailand has classified plant community that always flooding name "swamp forest" into 3 types: (Whitmore,1975; Santisuk and Niyomtham, 1985) : mangrove forest, freshwater swamp forest and peat swamp forest.

Peat swamp forest is the plant community occurring in the shallow that has flooding all over the year. It has organic matter or vegetation accumulated for long time. Raining is the main source of water in this area. Oxygen deficiency that causing slowly decomposes and making PSF to become peat bog is the result of water logged for a long time (Santisuk and Niyomtham, 1985).

Peat is defined as organic matter derived from vegetation having 25% or less inorganic matter on a dry mass basis (e.g. Andrejko et al. 1983). Peat typically consists of more or less fragmented plant residues sequentially deposited. The presence of plant fibers distinguishes peat from organic aquatic sediments (Okruszko 1979).

Organic soil is material which has 17% or more carbon by mass (e.g. Canada Soil Survey Committee, Subcommittee on Soil Classification 1978). Organic soils have also been classified as **histosols** (Soil taxonomy 1975).

Muck is dark, well-decomposed organic material with a high mineral matter content which has accumulated under condition of imperfect drainage. In the

USA, peats or sediments with 20 to 50% organic matter content are referred to as mucks (Staneck and Worley 1983).

Peatlands or **mires** are wetland ecosystems that are characterized by the accumulation of organic matter, which is produced and deposited at a greater rate than it is decomposed, leading to the formation of peat (Gore 1983). Peatlands and mires are usually supported by a humid climate and high water table levels, lading to low-level microbial activity in the soil (Reinikainen 1976). Peatlands ecosystems are also characterized by a high degree of interaction between living organisms and the environment. Thus, the vegetation plays a decisive role in modifying edaphic conditions.

The term **mire** can probably be considered as a slightly wider concept than **peatland**, because it encompasses all peat-forming habitats and this feature distinguishes mires from all other ecosystems (Moore 1984).

The term **muskeg** is used in Canada to designate peat-supporting organic terrain, especially in connection with engineering and geotchnics (Radforth 1969). The word is Indian in origin and has been used widely in North America as a synonym for peatland.

Bog, fen, swamp and **marsh** are more specific term than peatland, mire and muskeg. They are strongly linked to the concepts of trophy and nutrient status of the site. **Bogs** are ombrotrophic sites influenced solely by water that falls directly as rain or snow. The peat is predominantly *Sphagnum* moss peat. **Fens** are at least slightly minerotrophic sites influenced by water derived predominantly from outside their own immediate limits. The peat is formed mainly from *Carex, Phragnites* etc., residues. **Swamps** are well-wooded, minerotrophic wetlands or mires, where the peat layer thickness varies or can even be totally absent. **Marshes** are grassy wet areas, periodically inundated with standing or slowly moving water. The substratum usually consists of mineral or organic soils with a high mineral content, but there is little peat accumulation. **Bogs** are peat-rich ecosystems found primarily in the high latitudes on waterlogged soils; **swamps** are peat-poor systems generally occupying seasonally inundated soils in tropical and subtropical regions. These definitions bind the terms to latitude and % peat-rich or peat-poor ecosystems, shown in Figure 1.

The fundamental criterion determining the development of mire vegetation is the quality of the water feeding a mire. The nutrient, humic acid and free oxygen contents and the rate of the water flow are important properties describing the water quality. There are several words in common use for mire, each of them implying some special characteristic connected to the site (site by Paavilainen and Paivanen, 1995).

Trophy describes the nutrient status of mire vegetation and the substrate. The term **ombrotrophic** describes a site receiving nutrients only in the form of precipitation or wind-borne dust (e.g. Sjors 1948; Eurola et al. 1984;Jeglum 1991b). Ombrotrophic conditions represent the extreme situation at the lower end of nutrient availability, and ombrotrophic sites usually have a thick peat layer. An ombrotrophic situation develops in the centre of a mire complex when it grows above its margins. Ombrotrophic mires are characterized by low pH levels as well as by low electrolyte and calcium contents (e.g. Tolonen and Hosiaisluoma 1978; Eurola et al. 1984).

A site is **minerotrophic** when the nutrient concentration in the surface peat and mire water is significantly higher than that of precipitation. This may happen where the depth to underlying mineral soil is shallow or if nutrients are being supplied by mineral-rich surface water or groundwater.

The terms **ombrogenous** and **geogenous** reflect the genesis of peat.

An ombrogenous mire is a landscape unit which includes the ombrotrophic (only rain-fed) centre as well as the minerotrophic border separating the mire from the surrounding upland. The term **geogenous** includes waters of limnogenous, topogenous and soligenous origin. **Limnogenous** indicates that the water is derived from lakes or rivers, while **topogenous** and **soligenous** refer to water derived from mineral soil, respectively static and flowing (Gore 1983; Damman 1986).

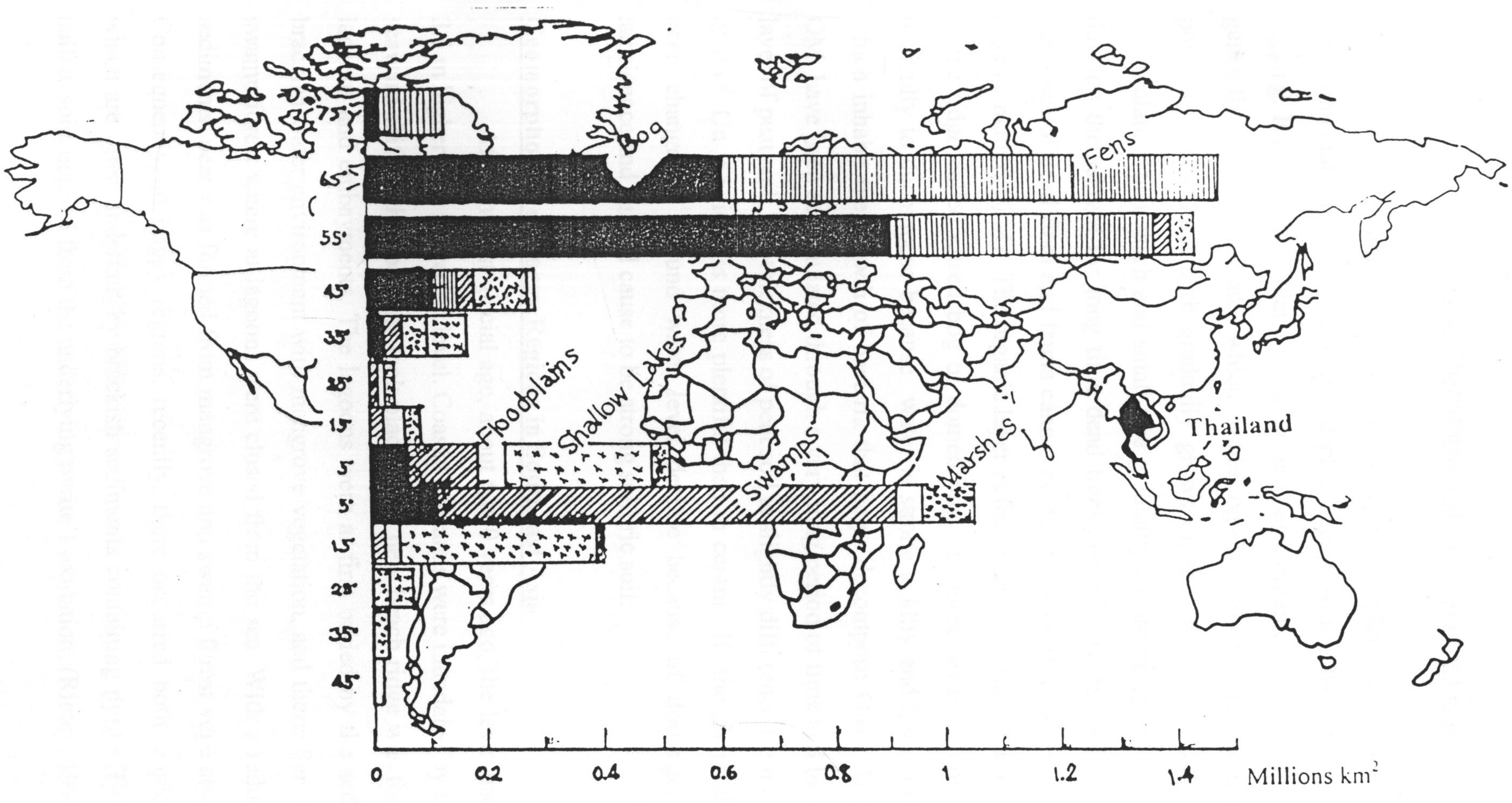


Figure 1. Area of Natural Wetlands, showed the distribution of bogs, fens and swamps (Millions km^2).

Origin and Distribution of Peat Swamp Forest

Peat swamp forest is an ecosystem which has been originated by environmental factors, especially edaphic factor which has strong acidity water logging. It is a wetland that always accumulates organic matter on the ground. PSF generally occurs in the area which water logged is not too deep and at the edge of ponds or lakes. First herb gradually grows on the edge of the lake or pond and accumulate. Then shurb and small tree gradually substitute grow on that area. PSF develop themselves for long time dead trees and animals fall into water. Some of carcasses of dead flora and fauna cannot be decomposed so they are accumulation of organic matters (OM). The organic layer in the middle of swamp has deeper peat than in the ridge called raised bog or domed bog. In these areas organic matters have difficulty to decompose because water is strong acidity and high sulfur compound which inhabit the growth of bacteria that helps decompose OM. The decomposed OM have been accumulated through a very long period of time and become the thick layer of peat soil. The thickness of peat soil is slightly difference from central to ridge of PSF. On the ridge is more plentiful than in central. If the physical structure has been changed :- ground water level decline because of drainage, soil will be subsidence and packed cause to be strong sulfuric soil.

Geomorphology of Boggy Regions in Southeast Asia

After the last glacial age, about 6,000 years ago, the level had risen to 3 to 3.5 m higher than the recent level. Coastal lowlands were inundated by sea, and later a seaward shift of the coastline took place and a new beach ridge was formed, shaping lagoons and embayments. The lagoons were at first buried by the sediments in the brackish water environment with mangrove vegetation, and thereafter by fresh water swamp forest where at lagoons were closed from the sea. With a reduced supply of sediments, peat was formed from mangrove and swamp forest vegetation's' residues. Consequently, in boggy regions, recently, there occurred both tropical peat soils, which are often underlain by brackish sediments containing pyrite (FeS_2) , and acid sulfate soils derived from the underlying pyrite's oxidation. (Rieley, 1991).

The soil parent materials in the shoreline consist of the woody peat and the underlying brackish sediments. The woody materials from swamp forests form tropical peat soils, and brackish sediments give rise to surface acidification, that is the formation of acid sulfate soils, after they were aerated.

Topographically, swampy lands especially in the tropics occur mainly on the coastal lowland. Primarily, they have been covered by climax evergreen forest as so called swamp forest. Soils in the swamps vary from place to place depending upon the kinds of sedimentation and parent material. However, peat and acid sulfate soils appear to be the dominant ones.

The formation of the swamps in Thailand

The formation of the swamps in Narathiwat provinces is closely related to the geomorphological phenomena of the emergence shoreline. During the period 5,000 to 3,800 yrs B.C., the sea began to regress, which led to the development of progadational lagoons and beaches. In addition, some main streams also emerged into the tidal flat system, forming unique back swamps between the lower stretches of the main river courses. Once the lagoons and back swamps were closed, the water became stagnant and the sediments settled. Due to dilution of the sea water by rain, the water became favorable for the development of herbaceous, water loving plants. After sufficient organic matter residues had accumulated and the swamp became shallower, the native plants gradually changed to the mixed swamp forest types. Finally, the whole swamp came to be occupied by typical fresh water swamp forest. (Vijarnsorn, 1985).

As a consequence of this dense vegetation, when these plant have fallen and died, the peat can easily be developed because the waterlogged conditions are more conductive to peat accumulation than to peat decomposition. Since this peat is normally flooded mainly by rain water and is no longer enriched by influxed of plant nutrients from outside, they grow poor in nutrients, while containing high fiber contents.

Climatic and Geographic of Peatland / Distribution.

Important factors for peat development are control of water level, climate, amount of rainfall and evaporation rate in those areas.

In general, a tropical peat forest is situated in a tropical rainforest climate, Koeppen Af. Although Pontian Johor, Peninsular Malaysia, is situated in Koeppen Af, the Narathiwat climate belongs to the transitional zone from a tropical monsoon climate, Koeppen Am, to a tropical rainforest one, Koeppen Af, in Figure 3. The figure shows that Narathiwat has extremely high rainfalls in November and December, whereas a relatively dry season with lower rainfall from January to April.

The evapo-transpiration losses between January and April are double the monthly precipitation resulting in a water shortage for plants. In November and December, high floods occurs at times. Under such a climatic condition, the occurrence of peat swamps should have been determined much more by topography than by climate.

Peatlands of Southeast Asia

There are 150,000,000 hectares of peatland in the world that distribute from tropical zone to Arctic Tundra. There are 30,000,000 ha. of Peatland or water logged or flatland in tropical zone and 20,000,000 ha. of them are in South East Asia. PSF in SEA distribute in Indonesia, Malaysia, Philippine and Thailand. PSF in Thailand are about 64,000 ha. (Phengklai, et. al., 1991), mostly are in the South.

Distribution of Tropical Peat Soils and Acid Sulfate Soils in Southeast Asia

The total area of tropical peat soils amounts to about 30 million ha, two thirds of which exists in Southeast Asia, as shown Table 1. The majority of the peat soil is distributed in Sumatra, Kalimantan, Iran jaya, Sarawak, Brunei, Sabah and Peninsular Malaysia. Some areas of the peat soil occur in the southeast coast of Thailand and in the Mekong Delta of Vietnam.

Peatlands in Southeast Asia comprises peat swamp forest (covering about 35 million ha.) and former peat swamp forests converted to agricultural lands (about 8 million ha.) and they represent 60% of the world's tropical peatland resources (Andriesse, 1988). The majority of the peat resources of Southeast Asia occurs in

Table 1. Distribution of tropical peat soils in the world

Region	Country	Peat area x 1000ha
Asia	Indonesia [1/]	18,392
	Malaysia [2/]	2,365
	Vietnam [1/]	141
	Brunei [1/]	71
	Thailand	45
	Sub-total	20,951
Africa	Zaier [3/]	1,000
	Kenya,Ugandn [3/]	500
	Others [3/]	1,500
	Sub-total	3,000
South America	Venezuela [3/]	3,000
	Brazil [3/]	1,000
	Guianas [3/]	500
	Columbia [3/]	350
	Other [3/]	300
	Sub-total	5,150
	Total	29,101

Cited : [1/] Kyuma & Pisoot (1992)
[2/] Zahari, Kamarudin & Aini (1992)
[3/] Driessen (1978)

Indonesia, which is over 85% of total peatland area in Southeast Asia. These peatland cover very large area at altitudes from sea level to about 50 meters above mean sea level, especially near East Sumatra, Klimantan, Irian Java, Papua New Guinea, Brunei, Peninsular Malaysia, Sabah, Sarawak and Southeast Thailand.

Distribution of Peatland in Thailand

The data from Department of Land Development (1989) informed that peatland are 80830.36 ha. in Thailand, were in the East such as Rayong, Chanthaburi and Trad 5363.2 ha., and most of them are in the South 7546.56 ha., such as Chumporn, Nakornsrithamarat, Phattalung, Pattani and Narathiwat.

Peat soil or organic soil always occurs with suffatesoil or sodic soil or organic soil where underneath of substratum of marine clay. Vijarnsorn (1991) reported that the largest peatland of Thailand is in Narathiwat which consisting of 46400 ha.. The second is the peatland surround Thalay Noi Non Hunting Area and north of Songkla lake in Songkla, Phattalung and Nakornsrithamarat, 12800 ha.. Furthermore, there are small peatlant distribute in Suratthani, Trang and Pattani.

The Royal Forestry Department (1995) had studied of distribution and classification of PSF and divided PSF to be 2 types, Primary PSF and Secondary PSF, shown as Table 2 and Figure 2.

1). <u>Primary Swamp Forest</u>

It is the PSF which composing of high diversity of species, and has many characteristic structures same the as the tropical evergreen forest. There are many canopies. The ground has water logged all year which accumulate a very thick organic materials. There were in four areas in the South consisting of 9031.5 ha., that were Toh Daeng and Bachao PSF (Narathiwat 8978 ha.), Kunthule PSF (Surathani, 47.5 ha.) and Ban Dan PSF (Trang, 6 ha.).

2) <u>Secondary Swamp Forest</u> :

It is the community of Melaleuca dominance covering that is always called Melaleuca forest. PSF which is very often disturbed by several fires which decreasing almost all the OM layer to clay soils. Their soil are very strong. Melaleuca is the good species

Table 2 Distribution of Peat Swamp Forest in Thailand

Pronvince	PSF area (ha)
Primary P S F	
Narathiwat	8,978
Suratthanee	47.5
Trang	6
Subtotal	9,031.50
Secondary P S F	
Trad	452.5
Rayong	120
Narathiwat	21,991.50
Nakornsrithamarat	18,946
Chumporn	3,285
Suratthanee	1,542
Songkla	4,828.50
Pattanee	1,209.80
Yala	190
Trang	85.56
Patthalung	2,767.50
Phuket	62.5
Krabi	47
Subtotal	55,527.86
Total	64,559.36

cited by Royal Forestry Department, 1996

Figure 2 Peat swamp forest of the study areas. a). Primary PSF preservation zone of Toh Daeng PSF. b). Secondary PSF conservation zone of Toh Daeng PSF. c). Secondary PSF. (Disturbed Melaleuca Forest)

which can grow on these areas, and efficiency disposal by the water. Melaleuca forest distributes to many parts, in the East, 572.5 ha. and 54956.36 ha. in the South.

Physical Characteristics of PSF.

Soil in PSF.

Peat soil is originated by the accumulation of organic matters, such as leaves, twigs, tree trunks or carcasses of dead fauna, through a very long period of time. The thick layer of peat-which lies over the underneath substratum of marine clay- help suppress acidic condition produced by pyretic substances within clayey particles which finally would not be able to bleed up to the upper organic soil layer.

In sunken organic matters, the rate of decomposition is very slow. The decomposed stuff, as so-called the organic soil or peat with its thickness ranging from 0.5 to 5,0 meters in Toh Daeng Area, is brownish, light, and water well-absorptive in its characteristics.

Mineral and organic matter content are important indicating the physical and chemical properties of the soil. Minerals have, generally, a wild variety of chemical composition, a wide range of weathering rates and have individual particles differ greatly in size and shape. Organic matter is a very active and important portion of soil.

Organic matter increase the amounts of water a soil can hold and the proportion of this water available for plant growth. Also, it is a major source of soil phosphorus and sulfur, and it is a nitrogen reservoir. Furthermore, the decomposition of organic matter produces acids and other substances. Small amount of organic matter can modify a soil physical proper ties and strongly affect its chemical and biological properties.

In the Narathiwat, the peat layer of organic soil is more or less decomposed, and mainly consists of fiber or woody fragments of various sizes. However, in the case of reclaimed swamp, the surface soil appear to be more decomposed and are extremely acidic (Vijarnsorn and Matsumoto, 1987). The nutrition factor limiting crop growth in Narathiwat organic soil are low pH and high AL low N, P, and K, and low Cu, B, Zn and Mo (Nilnon et al ., 1987).

Peat, in Thailand, refers to soils that have an organic matter content of more than 20 percent, and where the organic layer is commonly thicker than 40 cm. Almost all of such soils are distributed in the coastal swamp or marsh in the southeast coast and peninsular Thailand. These soils commonly occur in association with acid sulfate soils. The total areas of peat in Thailand comprise about 45,264 ha., the vast majority, 60% (26,600 ha), is found in the Narathiwat Province, which is located along the east coast of the peninsula near the border of Malaysia. (Vijarnsorn, 1995).

However, it should be stated that the number of peat soils can be decreased upon utilization. It is common that when swamps are drained, most of the peat layer disappears due to burning and subsidence.

The thickness of peat in Thailand is commonly not more than 3 m. Its underlying material ordinarily consists of a muddy layer which is relatively high in pyrite (FeS_2) content. It is postulated that these pyrites formed under the brackish conditions when the lagoons were filled with marine sediments and closed.

Therefore, once these swamps are begun to be reclaimed, or the water is drained out, these peats can be easily converted to acid sulfate soils. The reason is that when peat layers subside subsequent to burning by the farmers and decomposition, the underlying materials enriched in pyrite are often subjected to oxidation and became acidified. As in Narathiwat Province, many of these drained swamps have changed from peat to acid sulfate soils. It was estimated that about 60 percent of the soils in the swamps at present, have already converted to typical acid sulfate soils

Due to the increasing need for land for agriculture, created by the population growth, some parts of the original swamp have been cleared. The conventional method of reclamation is to drain the water, burn the forest and cultivate paddy rice. It has been estimated that about 26% of the swamp, especially along the fringe, has been cultivated. Nevertheless, most of the cleared swamp has not been used for crops even though a drainage scheme has been installed. The rice yield in these swamps varies from place to place. However, the rice yield commonly decreases to 1,000 or 600 kg/ha. after continuous cropping over several years.

As a consequence, soils in the Narathiwat swamps have changed a great deal. At present, they consist of the following soil groups and series. (LDD, Vijarnsorn, 1995), which classified as 4 groups; shallow to moderately thick Peat, thick Peat, acid sulfate soil and alluvial soil.

The first group, shallow to moderately thick Peat, includes soils which have a peat layer as thick as 40 to 130 cm. The underlying materials mainly consist of unripe marine clay rich in pyrite content, these soils are classified as the Kab Daeng series and occupy about 3,000 ha. The peat layer is somewhat well decomposed and extremely acidic. The pyritic mudclay, in general, is found to occur at a depth of between 50-100 cm from the soil surface. The second group, thick peat, is the soils which contain a peat layer thicker than 1.30 m. belonging to the Narathiwat series, they occupy approximately 23,600 ha. The peat layers are more or less undecomposed, mainly consisting of fibers or woody fragments of various sizes. The third group, acid sulfate soils which the peat layer is somewhat thin, commonly less then 40 cm thick, occupy the reclaimed swampy areas, or the areas where at least parts of the water have been drained out. As a consequence, a pyritic mud clay is commonly found to occur within 1 m from the soil surface. Therefore the soils become extremely acidic and jarosite mottles appear from place to place upon to oxidation. From the pedological point of view, these soils can be separated into two groups : Potential acid sulfate soils and Actual acid sulfate soils

Potential acid sulfate soils have been found to occur over about 15,500 ha., at present, only three main soil series have been mapped in these swampy areas. They are the Rangae series, Thon Sai series and Chien Yai series. Actual acid sulfate soils contain jarosite mottles, and which have sulfidic soil material within 1 m from the soil surface. It has been recognized as the Munoh series, occupy about 1,500 ha., it always appear to intermingle with the Rangae series, Thon Sai series or Chien Yai series in drained swamps.

The last group is alluvial soils which occur Just outside the fringe of these swamps, there occur various kinds of alluvial soils which formed in the thick riverine deposits. In general, these deposits are underlain by pyretic mud at a depth of between 1.5 to 2 m, which is the same as the peat or acid sulfate soils in the swamps, these soils cover about 1,150 ha. Soils belonging to these groups are named the Takbai series and Bangnara series.

Water in PSF

Topographically, the coastal PSF floor is a low lying flatland and usually is year-round water logged. Rainfed water drains out of the forest floor very slowly but is not stagnant. The underwater condition caused the slow decomposition rate of plant and other organic materials because of its nearly airless circumstance. Thus, the water in PSF possesses physical and chemical characteristics that differ greatly from water in other areas.

The colour of peatwater is brownish. This is a result of the decomposition of tannic substance disintegrated from branches or twigs of dead plant in water. Tannic content brings about the dilute acidic condition in water (pH level about 4.5-6.0). Thus, the peatwater during rainy season can be drinkable without harmful side effects to humans. Furthermore, it can be employed for extensive farming and water animals depend upon its huge body as well.

Biodiversities of peat swamp forest

Peatland ecosystem sustain a wide range of organisms and contain many invaluable genetic resources for agriculture and flood crops, horticulture, timber, fisheries, livestock and biotechnological developments. Peat swamp forest vegetation has been recognized as an important reservoir of plant diversity in Southeast Asia (Sivius *et al.*, 1984; Whitmore, 1984). Peat swamp forest has a relatively high diversity of tree species, with an average of 30 -55 tree species per hectare. Many of the plants are restricted or endemic to this habitat. The principal wildlife species existing in peatland ecosystems usually live in the forest area of the peat swamp. These forests are home to many rare and endangered wildlife species such as Sumatran tiger (*Panthera tigris sumatranus*), tapir (*Tapirus indicus*), Asian elephant (*Elephas maximus sumatrensis*), lesser one-horned rhino (*Rhinoceros sondaicus*), orang utan (*Pongo pygmaeus*) and hundreds of birds species, including hornbills and cassowaries.

Forest Naural Resources

Only a few studies have done on PSF community in tropical. Niyomdham (1986) had studied on vegetation of PSF on the tide zone of Bang Nara River and Toh

Daeng PSF since 1983, found that there were Flowering plant 279 species, within these 48 species had never found in other areas. After that Chamlong and his colledge (1991) further survey and reported that PSF in Narathiwat had 109 families, 437 species of flower plants and 15 families, 33 species of ferns. Figure 3 showed some important species of peat swamp forest.

Thawatchai and Chawalit (1985) had studied of environment characteristic of PSF and found that flora which grew on PSF should adapt themselves. At the forest floor, the very harsh environment caused big trees to intensively adapt their roots system to cope with acute problems of living possibly in water with loose organic soil layer and nearly airless circumstance. Several types of buttresses, stilts roots and pneumatophore are the outcomes of well evolution of trees' roots system through aeons of time as shown in Figure 4. Buttresses and stilt roots incredibly support heavy tree trunks to stand firmly on loose floor while pneumatophore -similar to human breathing organs - exchange airy particles effectively between trees' inside tissues with outside water-logged world. Vegetation in Kuan Kreng PSF, 82 species, mostly were Melaleuca and Cyperus spp. And others were species of peat swamp. Disturbed rate from fires and human activities were 7 % per year (Water Irrigation Department, 1992).

<u>Wildlife and Fauna Natural Resources</u>

Preliminary survey of the Center of Research and Nature study of Sirinthorn PSF (Chawalit and Picha, 1994), and the report of survey and research study of Toh Daeng (Picha, 1996) found that wildlife in Toh Daeng were 325 species. There were 62 species of mammals, 196 species of birds, 50 species of reptiles and 17 species of amphibains. Within these groups, there were 3 new record species of bird in Thailand :- *Eurostopodus teminckii, Copsychus pyrropygus, Cyornis turcosa, and 3 species of mammals :- Dyacopterus spadiceus, Rattus annandalei* and *Petinomys vordermanni.* And there were 4 endanger species and 11 threatened species.

Vit and his colleague (1990), noticed that Toh Daeng PSF had many species of fish which never been in others areas both important in economic for consumer and their beatiful. There were 3 new record species :- *Chace bankanensis*

(BLKR), *Parakysis verrucosa* (SILAS) and *Parasphromenus deissneri* (BLKR). They had very adaptive characteristics to live in PSF conditions.

Wildlife in Kuan Kreng PSF were 6 species of mammals, 8 species of reptiles, 31 species of birds and 2 species of amphibian (Water Irrigation Department, 1992).

Peat Swamp Forest Successions

Natural successions of plant community in peatland were considered the parts of PSF which divided into 3 parts :

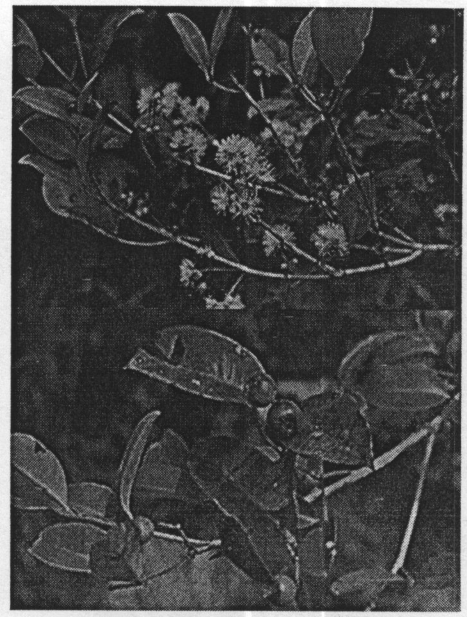
1. Peat swamp forest or Primary Swamp forest which is the plentiful forest in the central of PSF like as the nucleus or core of forest. It composed of many canopies of many peat species and undergrowth species had many network of roots.

2. Melaleuca Forest or Secondary Swamp forest which is high disturbance peatlands both natural itself and human activities. Mostly of trees, was a species of Melaleuca that very dense appeared.

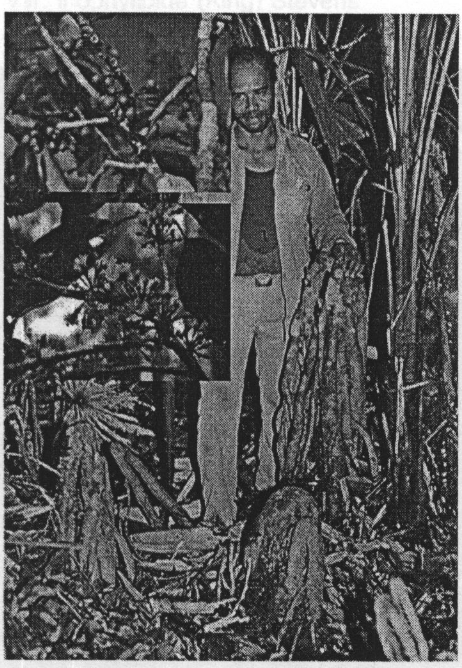
3. Grass areas which are the destroyed PSF or the secondary PSF used for agriculture. Mostly grasses were Cyperus sp. and *Lepironia articulata.*

As indicated by the pollen analysis (Andriess, 1964), the early natural vegetation was comparable to the herbaceous or marshy types. After sufficient organic residues accumulated, the swamps became shallow. The native plants were gradually taken over by mixed swamp forest types and finally by a tropical swamp forest. It is suggested that the order of plant succession was *Elaeocarpus* spp, *Illex* spp, *Hibiscus* spp and *Meliaceae*, ending up with typical fresh water swamp as at present dominated by various trees families. According to recent observation in the virgin swamp, more than 100 genera of tree and other plants are growing in heavy density. They generally comprise of the coniferae, broad leaf tree, palms and padanus, climbers and orchids, herbs, ferns, reeds and sedges. For instance, *Neesia altissama, Stemonurus malaccennsis, Elaeocarpus grandiflorus, Calaphyllum inophylloides, Baccaured*

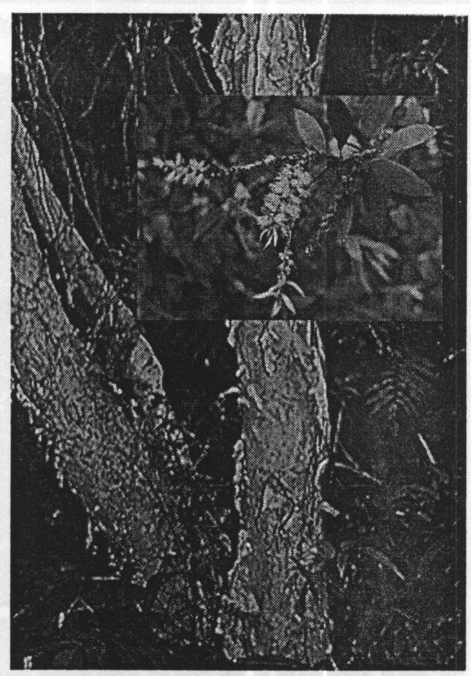
Macaranga pruinosa (Miq.), Muell. Arg.



Eugenia kunstleri King

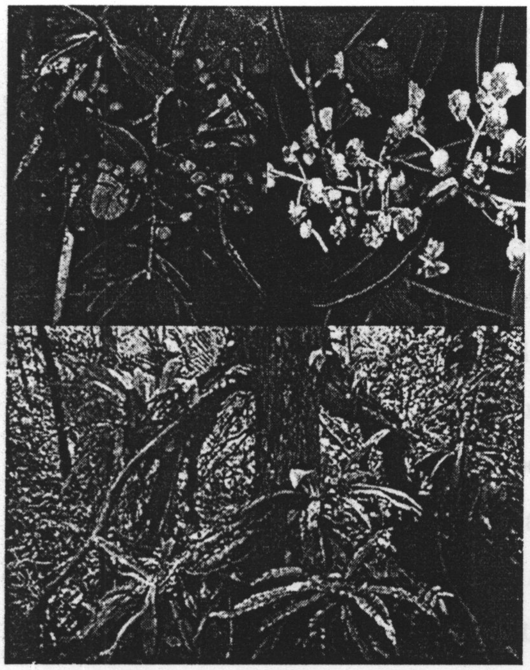


Ganua motleyana Pierre ex Dubard

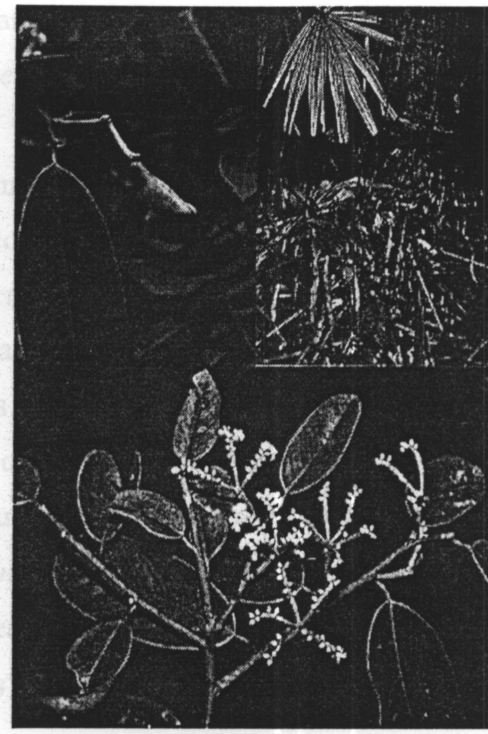


Melaleuca cajuputi Powell

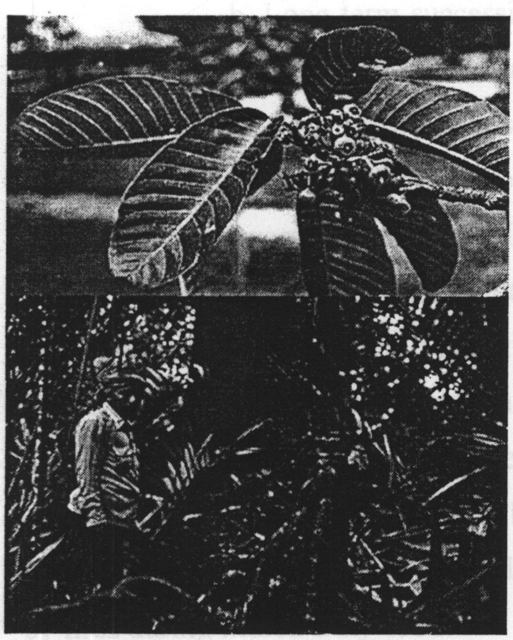
<u>Figure 3</u> Dominant species of PSF, both in primary and secondary PSF.



Calophyllum teysmannii Miq.
var. inophylloide (King) Stevens



Stemonurus secundiflorus BL.



Neesia malayana Bakh.

Xylopia fusca Maing. ex Hook.f. et Th.

<u>Figure 4</u> Vegetation and root system adaptation in PSF.

bracteata, Dialium patens and Eugenia spp are the dominant trees while *Calamus caesius, Daemonorops angustifolia, Oncospera tigilaria* and *Cyrtostachys lakka* represent the palms and padanus.

Primary peat swamp forest is a climax vegetation usually has not change their structural characteristics and vegetation composition in their community. When PSF were disturbed and area opened, consequently there were plant succession within community (Figure 5). There are 2 kinds of plant succession :

a. Temporary succession : it is succession in stage of soil of peatland has not much disturbed. Soil still has peat or organic matter, pioneer species of PSF invaded to substitute growth on this area such as *Macaranga pruinosa, Alstonia spathulata, Alstonia angustiloba and Archidendron clypearia, and* ground cover are ferns. If there is no more disturbed in this area the species of primary swamp forest grow later, and compete with pioneer species and then become the primary swamp forest again.

b. Long term succession : happen when PSF are disturbed again and again, and then all organic matter catches fires. Soil are strong acidity and only *Melaleuca cajuputi* can grow on this soil, sometimes *Eugenia grandis* are together growth. Ground is covered mostly by grasses and *Cyperus sp.*. Because of these characters, it is favored to be called Melaleuca forest.

PSF community has evolution and many processes of change for a long time until it become a climax vegetation. It can be changed easily from the primary forest to the secondary forest only in 2-3 years. PSF is very sensitive to the changed of environment, especially drainage of water cause the imbalance of the lake ecosystem lake, and made it easily burning. After being disturbed again and again PSF gradually decreased and finally disappeared. Figure 6, showed TD PSF disturbed by fires during March-May 1998.

Figure 5 The natural succession occurred in PSF, a) The gap open in old PSF showed the succeed of pioneer species. b). succession of the primary were disturbed c). Melaleuca leaf cover on the ground after disturbance that cause fires in dry season.

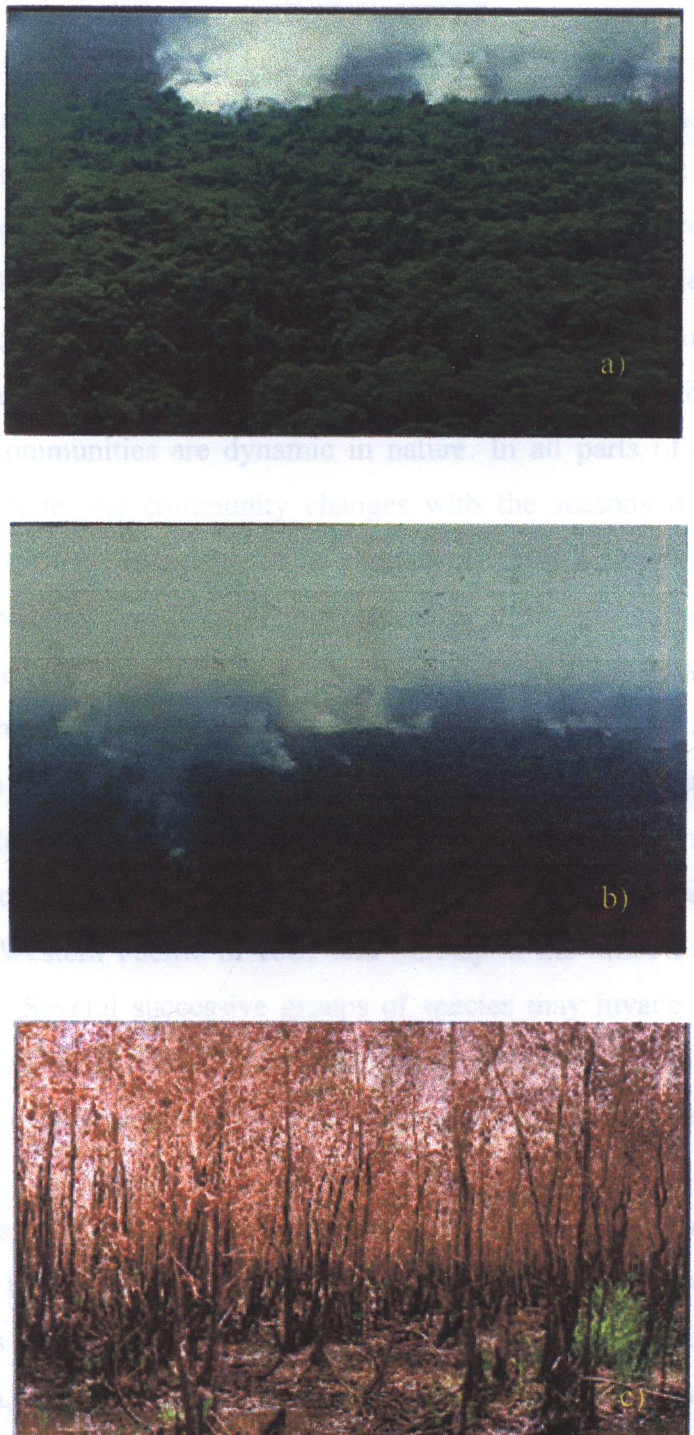


Figure 6 Showed the severely fires both in primary and secondary zone.

Concepts of succession

The term succession can be used in two ways. It can refer to the sequence of plant, animal, and microbial communities that successively occupy an area over a period of time, such as the changes that can be observed over the hundred years following the abandonment of plowed field. It can also refer to the process of change by which these biotic communities replace each other and by which the physical environment becomes altered over a period of time. Succession occurs for a variety of reasons that vary in their importance from place to place and form time to time.

Plant communities are dynamic in nature. In all parts of the world with seasonally of climate, the community changes with the seasons in terms of both presence of species and in their relative abundance. Over longer periods of time, community composition will often change according to the principles of succession and climax. Succession involves the immigration and extinction of species together with change in their relative abundance. Primary succession occurs on bare ground where vegetation has not previously been found. Such sites are relatively small in extent on a world scale and are represented by land slips, new surface created by human disturbance or new volcanic island emerging out of ocean, as in the case of Krakatoa in the Western Pacific in 1883 and Surtsey in the mid-Atlantic , south of Iceland in 1963. Several successive groups of species may invade as seral stages. Secondary successions occur when an established vegetation cover is removed or modified to and earlier seral stage. The end product of succession is the climax community.

Kangas (1990) outlined two types of wetland (or mire) formation. In the classical model, the direction of the succession is from aquatic towards terrestrial systems. It starts with open water and, through drying energies (sediment buildup, evapotraspiration, drainage), progresses towards the climax state of mesic forest. This type of mire development has also been called terrestrialization (Malmer, 1985).

Constant environmental conditions are implied by the classical model of wetland and mire successional However, this assumption is seldom justified because many environmental conditions vary with time. A disturbance may cause the succession to stagnate or even reverse its direction. If the disturbance has a periodic nature, the ecosystem may develop towards cyclic climaxes. Kangas (1990) mentions possible disturbances such as fire, extremely dry of wet spells, wind throw, disruptions by animal populations, and the actions of man. In the northern hemisphere the extreme cold periods may also disturb the succession. In the long-term, mire formation may be considered as the anti-cycles of glaciers (Verry 1988). Usually, the glacier strips away the earlier organic layers, but in Finnish Lapland a 1.5-m-thick peat layer has been found beneath four superimposed till beds, indicating several glaciers since the formation of the peat deposit in question (Hirvas 1991).

Paludification refers to the conversion of a mineral soil site to a mire due to a rise in the groundwater table. The direction of the succession is from a dry site towards a wet one, which is opposite to the classical model (Kangas 1990). It is primarily a northern phenomenon, with a spreading of *Sphagnum* mosses and an accumulation of peat. The *sphagnum* mosses and peat act as water holding reservoirs. The water stagnates and the oxygen content in the soil decreases, resulting in death of the trees and accumulation of peat. Peat accumulation occurs when the rate of addition of dry matter exceeds that of decay (Vlymo 1983). The term paludification has come to include the formation of peat directly, or via terrestrial humus, on podzolized soils and even bare rock surfaced (Gore 1983).

Primary peat formation is also an important way of initiating wetland and mire formation in the boreal zone. This is a process whereby the surface is occupied by mire vegetation immediately after the retreat of water or glacial ice. This type of mire formation has been typical along emerging coastlines (Huikari 1956).

Change

Change is one of the most fundamental characteristics of ecosystems. Three major categories of ecosystem change can be identified.

1. Long-term change in the physical environment. Ice ages come and go (Pielou, 1991), soils develop or they may be eroded, and lake become shallower and may eventually disappear as they are filled in with sediments. This type of change normally occurs very slowly, and generally we cannot observe the consequences for biotic communities within our life time. The resulting changes in the physical environment tend to be directional over long periods; those in the vegetation can be

seen in the composition of pollen found at various depths in the sediments or peat of lakes and bogs.

2. Changes in the genetic constitution of organisms as the result of natural selection. This type of changes is occurring continually and is called evolution. It can occur rapidly in response to rapidly changing physical or biotic selection pressures, but it also occurs on longer time scale in response to slow but directional changes in climate, soil condition, and other organisms.

3. Changes in the types, number, and groupings of organisms occupying an area and concomitant change in certain features of the physical microenvironment. This type of change occurs in both newly exposed, previously uncolonized physical environment, and in previously colonized areas following disturbance to the biota are accompanied by changes in the microclimate and soil. Sometimes these physical changes result from the changes in the biota; sometimes vice versa.

The last categories of change; the temporal development of, and changes in, ecosystem structure and function, is the most familiar.

Ecological succession

Ecological succession, the process of ecosystem development, occurs in virtually every type of environment found on earth, although the details vary according to the type of ecosystem. Succession in very dry (xeric) environmental is called xerarch succession; that in moist (mesic) and very wet (hydric) environments is called mesarch and hydrarch succession, respectively. The resulting seres under these three different moisture conditions are called xeroseres, mesoseres and hydroseres.

The successional pattern of plant communities on an oligotrophic soil is generally very different from that on a eutrophic soil.

Three main categories of succession can be identified. In many cases, the replacement of one community by the next results from changes in the physical environment that have been produced by the resident organisms. These changes often render the less optimal for the organism producing the change and more optimal for those organisms that replace them. Such a process is called autogenic succession, in contrast to allogenic succession, which occurred when geological processes cause changes in the physical environment, which in turn lead to changes in the biota. The filling in of a lake with sediment and the resulting change in the biota is an example of allogenic succession, whereas the subsequent biotically-controlled conversion from bog community to forest is an example of autogenic succession. The rates of change vary wildly in different seres and between the different stage of a single sere. Such relatively stable communities, which represent either the final or an indefinitely prolonged stage of a sere, are called climax communities-or simple climax. The climax can be considered both in terms of physiognomy and in terms of structure and floristic composition. Thus, the term can be used to refer both to plant formations or biomes and to plant associations.

The nature of vegetation

The building blocks of vegetation are individual plants. Each plant is classified according to a hierarchical system of identification and nomenclature using carefully selected criteria of physiognomy and growth form. The individuals of one species, taken together, form a species population and within the local area of a few square meters to perhaps as much as a square kilometer , group of plant species population which are found growing together are known as plant communities. Much more will be said of plant communities later, but within plant communities , the presence or absence of particular species is of primary importance. After this, the amount or abundance of each species present is of interest. This book is concerned with reasons and methods for collecting data of these kinds and with techniques for their analysis.

There are many situation where vegetation merits study. The commonest examples of the use of vegetation description are in the recognition and definition of different vegetation types and plant communities know as the science of phytosociology; the mapping of vegetation communities and types; the study of relationship between plant species distribution and environmental controls; and the study of vegetation as a habitat for animals , birds and insects. Change in vegetation over time may also need to be described using concepts of succession and climax.

Information on vegetation may be required to help to solve an ecological problem: for biological conservation and management purposes; as and input to environmental impact statement; to monitor management practices or to provide the basis for prediction of possible future change.

Concept of Vegetation study

Traditionally, most of the vegetative studies in plant ecology have been based on two principal concepts. Firstly, the vegetation on the landscape is treated as made up of discrete units. Each unit is separated from the others by a more or less distinct boundary called a transition zone or ecotone (Oosting 1995; Spurr 1964; Drew and Shanks, 1965). This concept of vegetation has been called the "community-unit theory" or "association-unit theory" (Whittaker 1956, 1962, 1967, 1970; McIntosh, 1967). Associated with this concept is the "classification method" which has been thoroughly developed and popularized by European ecologists (Grieg-Smith, 1964; Kurshow, 1964; Noy-Meir, 1973). Secondly, the vegetational continumm (Curtis and McIntosh 1956; McIntosh 1967; Whittaker 1967, 1970). The approach has been based on Remensky's (1926) and Gleason's (1926, 1939). The main burden of this approach rests on the concept that each species has its own range of environmental tolerance or amplitude of tolerance and that the vegetative community of any particular landscape is the result of the joint occurrence of species due to overlapping of their amplitudes of tolerance (Ayyad and Dix 1964; Whittaker 1967, 1970; McIntosh 1967; Beals, 1973).

The continuum concept leads to a new method of vegetational analysis called "vegetational ordination" by Curtis or "gradient analysis" by Whittaker (Curtis and McIntosh 1951; Brown and Curtis 1952; Bray and Curtis 1957: Beals 1960, 1973; McIntosh 1967, Whittaker 1956,1967,1970; Gauch et al. 1974). Ordination is the process of arranging samples (any vegetative unit or species) in relation to one or more gradients or axes of variation (Goodall 1954). In a more mathematical sense, it is a summarization of information content of a matrix, whose elements composed of distances or angles, define the spatial relationship between ecological entities (Orloci, 1966). Gradient analysis is aimed at improving the understanding of vegetation by studying relationship among gradients of variables on three levels: environmental factors, species populations, and community characteristics. Accordingly, two type of gradient analysis may be used: (1) direct gradient analysis or arrangement and study vegetation along know magnitudes or indices of environmental gradients and (2) indirect gradient analysis where the vegetative samples (communities, stands, samples, species, or even quadrats) are compared and arranged in terms of their dissimilarity in species composition and/or other vegetative characteristics it may not correlate with environmental gradients but if it does it then becomes an indirect gradient analysis (Whittaker, 1967).

Environmental of plant communities differ in many and each species in each community responds to the whole environmental complex not to separate factors. Because the environmental factors are arranged in gradient patterns, it is logical that the continuum concept and ordination techniques can useful tools for vegetative study.

Environmental and Vegetation Relationships

Usually, the site quality is determined from the vegetation characteristics, but some forests, environmental factors have been used as the independent variables in mathematical equations for estimation of vegetation values (Greig-Smith 1964: Spurr 1964). Greig-Smith (1964) recommended that the influences of environmental factors be estimated by multiple linear regression. This method was also suggested by Suprr (1964) in an evaluation of forest site quality where vegetation data was unavailable. Wikum and Wali (1974) showed that stepwise multiple regression analysis is a useful technique in predicting the response of vegetation to environmental factors. Their results showed the altitude, aspect, and slope are the important factors in determining characteristics of communities and species distribution.

Day and Mong (1974) also used a stepwise multiple regression to analyze the relationships of vegetation and topographical gradients in North Carolina. They concluded that this technique could be successfully used for describing the relationships of site factors and species distribution in that region.

Ordination concept/ Ordination technique

Ordination was first used by Goodall (1954), means 'to set in order', here ordering means the arrangement of vegetation samples in relation to each other in terms of their similarity of species composition and/or their associated environmental controls. Ordination methods are also part of gradient analysis, which variation in species composition is related to variation in associated environment factors which can usually be represented by environment gradients. Within plant ecology, gradient analysis and ordination methods can help with one or more the following areas of research:

1) summarizing plant community data and providing an indication of the true nature of variation within the vegetation of the area under study.

2) enabling the distribution of individual species within different communities to be examined and compared.

3) providing summaries of variation within sets of vegetation samples which can then be correlated with environmental controls to define environmental gradients.

Two types of gradient analysis were used: direct gradient analysis and indirect gradient analysis. Direct gradient analysis or direct ordination is used to display the variation in relation to environmental factor by using environmental data to order the vegetation samples, or arrangement and study vegetation along know magnitudes or indices of environmental gradients. In the terms indirect ordination methods is applied to techniques which operate on a set of vegetation by first examining the variation within it, second stage is then performed once the major sources of variation in the vegetation data have been described and summarized. Then the environmental data compared and correlated with the summarized vegetation data in order to detect possible environmental gradients. The environmental interpretation is thus indirect, these methods can be used in situations where the underlying environmental gradients are unknown or are unclear, although they are equally applicable where environmental gradients are unknown, (Whittaker, 1967).

Methods of indirect gradient analysis are much more widely used than those of direct gradient analysis. The first reason is that species data usually very much easier to collect than environment data, although there are many environmental variables could be measured but it is often not easy to predict in advance which ones are going to be of importance. Also many environmental variables do not lend themselves easily to measurement. Finally environmental measurement is often expensive in terms of time, resources and money. For all this reasons, data on species composition is much easier and more rapid to collect and to analyze. Indirect ordination methods represent a more efficient means of displaying variation in plant community structure than attempting to correlate single species distributions with environmental factors.

Inventory on Ordination Techniques

The ordination was made by plotting the important values of each species on the continuum index. The continuum index of each stand was obtained by first assigning a climax adaptation number (or the ecological sequence number of Cain and Castro, 1959) to the species involved and then, the importance value of each species was multiplied by its climax adaptation number and the values for all species were added. Some of these methods can be applied with many kinds of coefficients or parameters such as used in the method of Bray and Curtis, in the importance projection method and in the similarity projection method. Coefficients commonly used are the percentage of similarity, Euclidean distance, and coefficient of community in various forms (Orloci 1966; Austin and Orloci 1966: Gauch and Whittaker 1972). The Bray and Curtis (1957) method with Euclidean distance, was to be highly recommended because it was superior to other techniques for giving the best performance with the least distortions. When applied with suitable coefficients, computation effort is simple and Iucid for vegetative studies based on environmental gradients.

Materials and Methods

Locations and Descriptions of study areas

The two selected Peat Swamp Forests are : Phru Toh Daeng PSF, Narathiwat province and Phru Kuan Kreng PSF, Nakorn Sri Thamarat province, Southern Thailand, (Figure7).Climate of four stations near by of these study areas were shown in figure 8.

I. Phru Toh Daeng

Geographical Setting of Narathiwat

The Narathiwat township lies approximately between latitude 6° 03'- 6° 30' N and longitude 101° 43' - 102° 01' E. The total area of the province is approximately 4,475 square kilometer.

The climate of Narathiwat province is fundamentally a Tropical Rainforest type Koppen's 'Af' climate) of B,A 'ra' type (according to Thornthawaite's). This province has a uniformly high temperature and heavy precipitation almost throughout of the year and no distinct dry season. The mean annual rainfall of 30 year (from 1961 to 1990) was 2,494 mm. The hottest month was April, 28.5 °C on average, and the coldest month occurs in December, 25.9 °C.

Narathiwat is composed of 2 swamp forests : primary PSF (8978 ha.) and secondary PSF (2199105 ha.) and divided to 3 zones : preservation, conservation and development zone. Toh Daeng located on Latitude 6°, 01′- 6°, 19′ N and Longitude 101°, 51′ - 102°,03′ E. Mostly areas were swampy, 0.5 -15.0 height at sea level, average year raining, 2327 mm., rainy day 13.9 days, related humidity 81.6 %, and average temperature 27.6 °C. Peat soil had high OM, > 30 % because of organic accumulated and flooding all the year. Average water level ~90 -100 cm, rather acidity, pH water ~4.0 - 5.5.

The present topography of the Narathiwat area basically shown remarkable higher level of the terrain in the western part and gradually decreasing to the coastal plain in the east. Geomorphologically, the landform of the higher elevation is comprised residual hills and mountainous, undulating to tolling denudational old

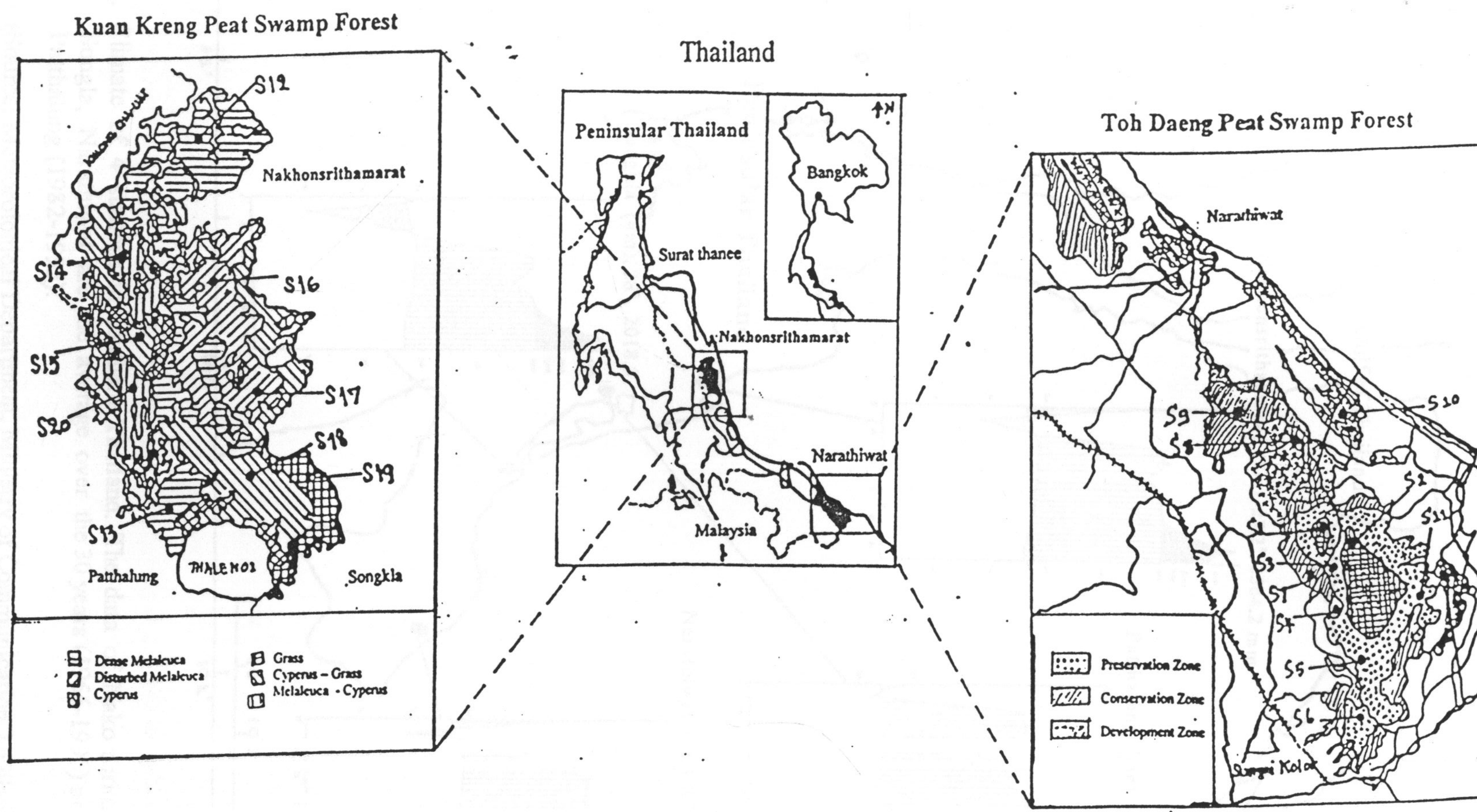


Figure 7. Location of the study sites in Southern Thailand

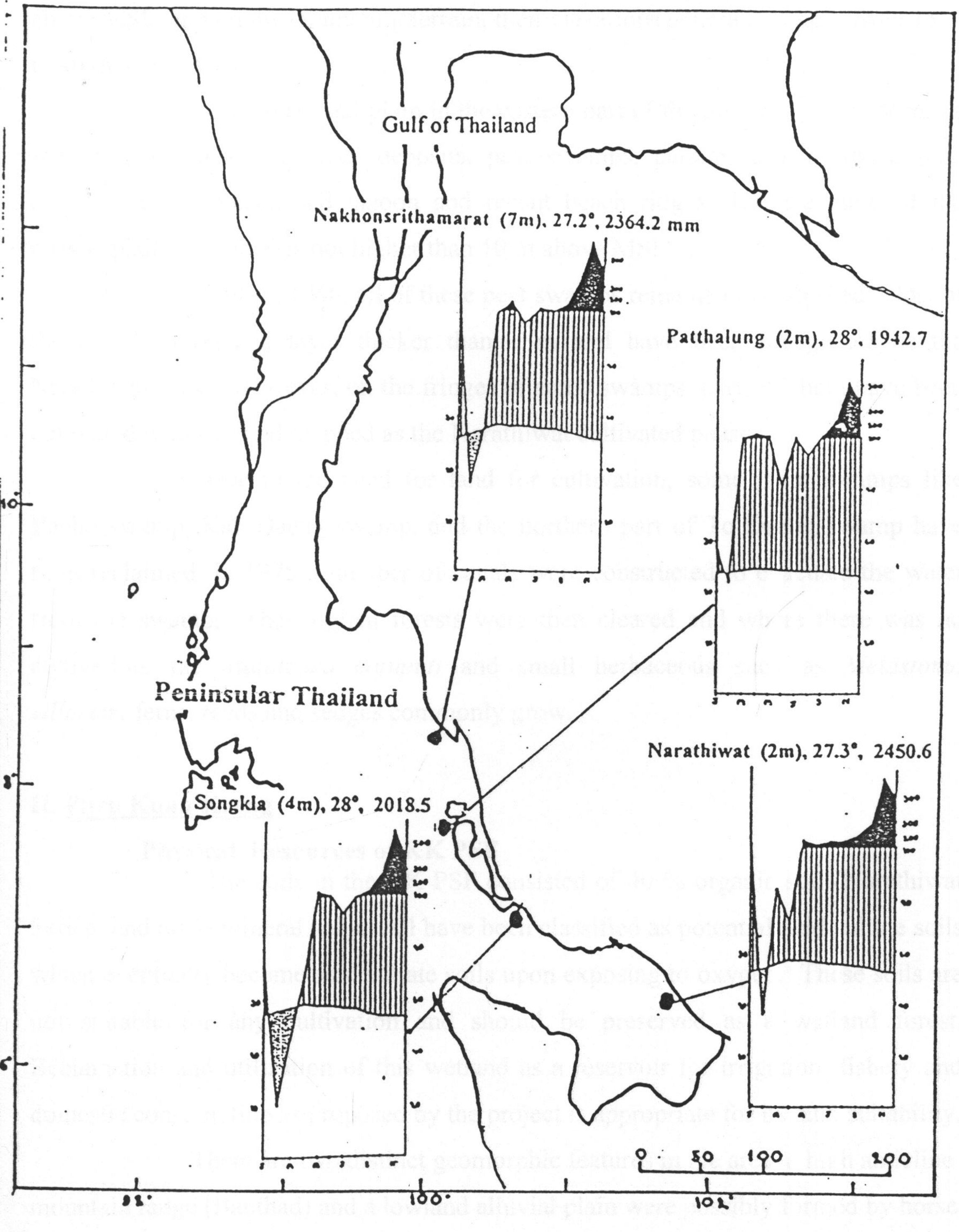


Figure 8. Climate of 4 stations in southern Thailand. The data of Nakornsrithamarat, Songla, Narathiwat are the average over the 30 years (1966-1995) and Patthalung (1982-1995).

(Source; Meteorological Department, Ministry of Communication Thailand, 1998) surface and undulating washed surface and fan. The highest elevation is 1,182 m above MSL, and on the undulating terrain, their elevations generally ranges from 15 to 40 m above MSL.

On the coastal plain in the eastern part of the province, there occurs a sequence of surficial alluvial deposits, peat swamps, parallel beach ridges, sand dunes, complex beach and lagoon and recent beach ridges. The elevation of the coastal plain in general is not higher than 10 m above MSL.

During 1968, all of these peat swamps remained undisturbed. Most of them had an organic layer thicker than 1 m and have been recognized as the Narathiwat series. However, on the fringes of some swamps, parts of them have been cultivated with rice and mapped as the Narathiwat cultivated phase.

Due to the need for land for cultivation, some main swamps like Bacho swamp, Kab Daeng swamp, and the northern part of To Daeng swamp have been reclaimed. In 1975 a number of canals were constructed to evacuate the water from the swamps. The original forests were then cleared and where there was no cultivation, the *Malaleuca cajuputi* and small herbaceous such as *Melastoma villosum,* ferns, reeds and sedges commonly grow.

II. Phru Kuan Kreng

Physical Resources of KK PSF

The soils in the KK PSF consisted of 40 % organic soil (Narathiwat Series) and 60 % mineral soils. All have been classified as potential acid sulfate soils which eventually become acid sulfate soils upon exposing to oxygen. These soils are not suitable for any cultivation and should be preserved as a wetland forest. Reclamation and utilization of this wetland as a reservoir for irrigation, fishery and domestic consumption as proposed by the project is appropriate for its land suitability.

There are two distinct geomorphic features in the area, a high anticline mountain range (Banthad) and a lowland alluvial plain were possibly formed by horse and garben structures. The mountain range, which trends north-south, borders the climate.

basin on the west. The bedrock in geological sequence in the area basin are Jurassic Cretaceous age that crop out sporadically as small monadnocks in the central part of the lowland. There mainly consist of white, red and reddish brown conglomerated sandstone conglomerate, silt stone with cross-bedding and graded bedding.

The study area is under the influence of tropical monsoon with constant high temperature. The heavy rainfall generally occurs from October to December during the north-east monsoon period.

The Kaun Kreng PSF Flood Plain is the part of both the origin of Pak-Panang River and Songkhla Lagoon connected to the top part of Talae Noi Non Hunting Area. There were very large swamp, 31287.2 ha, covering 3 provinces, Songkhla, Phattalung and Nakorn Sri Thamarat. It receives an average rainfall from 1900 to 2100 mm./year the area near to Phattalung receives 1900 mm./ year while the area adjacent to Nakorn Sri Thammarat receives 2100 mm./year. The mean monthly temperature at Songkhla varies from lowest 26.7 °C in December to the highest 29.0 ° C in April, with an average annual temperature of 27.3 C Nakorn Sri Thammarat has minimum temperature of 25.3°C in December. And maximum temperature of 29.3 °C in April and average annual temperature of 27.2 °C

Kuan Kreng PSF was divided to many characteristics based on vegetation : southern part connected to Thale Noi had Cyperus spp and grasses, central part was Melaleuca-cyperus and northern part was Melaleuca and grasses. Most of them were logged especially in November and December. Average water level was 0.80 m which declined in February, March and mostly dry in April. As a result, swamp ridge is always changed.

Methods of study

1. Survey and data collection

Surveyed sample study areas were selected by using satellite imageries consisting sample stand, peat swamp forest community.

1.1 Toh Daeng PSF, plots size 40 x 40 square meter by Releve' method of Mueller-Dombois and Ellnburg (1974). Stand 1- 11.

1.2 Kuan Kreng PSF selected by the same method, represent peat swamp forest community cover all vegetation : Dense Melaleuca, Distubed Melaleuca, Cyperus spp and grasses, Melaleuca-cyperus and Melaleuca and grasses. Stand 12- 20.

Sampling was assigned to cover many vegetation, 20 stands, size 40 x 40 m^2, (location shown in figure 8 and table 3) were studied by Releve' method as followed :

There were cover these vegetations :

Stand 1- stand 6 are in Preservation zone of Primary PSF, TD PSF.

Stand 7- stand 9 are in Conservation zone of Secondary PSF, TD PSF.

Stand 10- stand 11 are in Development zone of Secondary PSF, TD PSF.

Stand 12- stand 20 are in KK PSF which cover many vegetation :

Stand 12-13 , Dense Melaleuca forest.

Stand 14-15, Melaleuca-cyperus.

Stand 16-17, Distubed Melaleuca.

Stand 18, 20 Melaleuca and grasses.

Stand 19, Cyperus- Grasses

2. Physical and environmental factors studies

Collected data of geology, climate, meteorology, soil characteristics and water quality etc.. All chemical soil and water properties were analyzed at Pikul Thong Education and Development Center, Narathiwat.

2.1 Collected data of geology, climate, meteorology from related Organizations.

2.2 Soil from every sample plots were collected by burrow 125 cm depth. Physical characteristics were recorded. Soil sample were collected at eight different depths of 15, 30, 45, 60, 75, 90, 105 and 125 cm.. Chemical characteristic analysis were carried out on pH, OM, EC, Ca, Mg, K, Na, EA and CEC, etc. Paameters, method and instruments used are summarized below :

Table 3. Location of study stands of Phru Toh Daeng (stand 1-11) and Phru Kuan Kreng (stand 12-20).

Stand no.	site	Location	Latitude-longitude (UTM)
1	Padee2 (PD)	Su_ngui- Padee, Narathiwat (NW)	N 6° 00′ – 6° 15′ : E101° 45′-102° 00′ (255895)
2	KokKu (KU)	Takbai, Narathiwat (NW)	N 6° 15′ – 6° 30′ : E 6° 15′ – 6° 30′ (283863)
3	KokKala (KL)	Su_ngui- Padee, Narathiwat (NW)	N 6° 00′ – 6° 15′ : E101° 45′ -102° 00′ (245876)
4	Pawaiy (PW)	Su_ngui- Padee, Narathiwat (NW)	N 6° 00′ – 6° 15′ : E101° 45′-102° 00′ (232841)
5	TohDaeng (TD)	Su_ngui- Kolok, Narathiwat (NW)	N 6° 00′ – 6° 15′ : E101° 45′-102° 00′ (286732)
6	Luobo Sarma (LB)	Su_ngui- Kolok, Narathiwat (NW)	N 6° 00′ – 6° 15′ : E101° 45′-102° 00′ (303712)
7	KokSataw (KS)	Su_ngui- Padee, Narathiwat (NW)	N 6° 15′ – 6° 30′ : E101° 45′-102° 00′ (221 913)
8	KaoKampan (KP)	Su_ngui- Padee, Narathiwat (NW)	N 6° 15′ – 6° 30′ : E101° 45′-102° 00′ (154985)
9	ThungBaya (BY)	Su_ngui- Padee, Narathiwat (NW)	N 6° 15′ – 6° 30′ : E101° 45′-102° 00′ (173015)
10	KokMairua (MR)	Takbai, Narathiwat (NW)	N 6° 15′– 6° 30′ : E101° 45′-102° 00′ (255980)
11	Munao,(MN)	Takbai, Narathiwat (NW)	N 6° 15′ – 6° 30′ : E101° 45′-102° 00′ (283773)
12	Salatakein (SL)	Cha-uat, Nakorasrithamarat (NKS)	N 7° 45′ – 8° 00′ : E100° 00′-100° 15′ (234864)
13	HuaPakhaew (HP)	Cha-uat, Nakorasrithamarat (NKS)	N 7° 45′ – 8° 00′ : E100° 00′-100° 15′ (223673)
14	Kuantin (KT)	Cha-uat, Nakorasrithamarat (NKS)	N 7° 45′ – 8° 00′ : E100° 00′-100° 15′ (191792)
15	KuanKreng (KR)	Cha-uat, Nakorasrithamarat (NKS)	N 7° 45′ – 8° 00′ : E100° 00′-100° 15′ (211741)
16	Samet_Ngam(SM)	Cha-uat, Nakorasrithamarat (NKS)	N 7° 45′ – 8° 00′ : E100° 00′-100° 15′ (252791)
17	KuanTalayMong (TM)	Chienyai, Nakorasrithamarat (NKS)	N 7° 45′ – 8° 00′ : E100° 00′-100° 15′ (270745)
18	Kuwa (KW)	RaNod, Songkla (SK)	N 7° 45′ – 8° 00′ : E100° 00′-100° 15′ (311694)
19	Banpran (BP)	RaNod, Songkla (SK)	N 7°45′ – 8° 00′ : E100° 00′-100° 15′ (223663)
20	YuanNok (YN)	RaNod, Songkla (SK)	N 7°45′ – 8° 00′ : E100° 00′-100° 15′ (203714)

Item	Analytical method or instrument
pH	pH meter, Beckman Zeromatic IV
OM	Walkay and Black Rapid Titration
EC	Conductivity meter
Ca, Mg, K, Fe	Atomic absorption spectrophotometer
Cation Exchange Capacity (CEC>)	Mehlich and Coleman

2.3 Water quality studied, comparative studied by collecting water both within and out of sample stands on both seasons : wet and dry season.

Water collecting and water analysis were done following the process of Standard Methods for the Examination of Water and Waste Water of American Public Health Association (APHA), American Waste Water Association (AWWA); and Water Environment Federation (WEF)(1992). Parameters of water quality were dissolved oxygen, pH, turbidity, alkalinity, phosphate, temperature and electricity analysis etc..

3. Plant community Studies

Sample of study plot size 40 x40 square meter studying plant community by releve' method of Mueller-Dombois and Ellnburg (1974) is categorize as follow :

3.1 Divided plot size 10 x 10 square meter in every sample study plot to collect all plant diameter > 4.5 cm at 1.3 meter height and to record the species and number.

3.2 establish plot size 4 x 4 square meter on the right hand corner of the main 10 x 10 square meter plot size to collect saplings and to record species and number.

3.3 establish plot size 1 x 1 square meter on the right hand corner of plot size 4 x 4 square meter to collect seeding and undergrowth and to record species and number.

2.3 Sample plot size 10 x 50 meter was selected to study the structural profile of plant community.

4. Surveying on species and density of wild animal

Species and density animals such as birds, mammals, reptiles, amphibians and fishes are surveyed as the follows :

1. Information on species and density of animal in the past and present in peat swamp forest by interviewing the local people.

2. Direct observation was make in order to gathering general information with emphasis on bird and fish.

5. Data analysis

5.1 Vegetation :- Plants samples from the study area were identified with specimens at collection Center of Research and Nature studied of Sirithorn PSF.

Vegetation description

Peat swamp forest of the study sites were visually assessed and characterized by dominant community types based on the species association of dominant and co-dominant trees with some consideration given to the lower layers. The environmental factors associated with each community type were first investigated to determine the direction of species distribution and the vegetation was then extensively described. Consequently the quantitative characteristics of each stand were considered and the vegetation was again classified into community types according to the three most important dominant tree species. Stands having close quantitative characteristics were grouped together to form community types. These quantitative community types were compared on the basis of their associated environments, structure, and their relation to each other.

5.2 Plant community analysis : all collected data will be analyzed as follows:

5.2.1 The importance value index (IVI)

The importance value index (IVI) (Cottam, 1949) of each species in each sample stand were determined by :

IVI = % relative density + % relative frequency + % relative dominance

where, $\% \text{ relative density} = \frac{\text{density of species i}}{\text{total tree density}} \times 100$

$$\% \text{ relative frequency} = \frac{\text{frequency of species i}}{\text{total frequency of all species}} \times 100$$

$$\% \text{ relative dominance} = \frac{\text{total basal area of species I}}{\text{total basal area of all species}} \times 100$$

I = 1,2, 3, 4, 5,...................N

N = total number of species

5.2.2. Species diversity indices

1). The Shannon-Wiener index of species diversity, (H′) (Shannon-Weaver, 1949) is adopted as :

$$H' = -\sum_{i=1}^{N} p_i \log_2 p_i$$

where, p_i = proportion of the number of individuals of species I to the total number of individuals of all species (i= 1,2,3,.....,N)

N = total number of species in the sample stand

H′ = Shannon-Wiener index of species diversity

2). The Simpson' index of species diversity (D′) (Simpson, 1949; Pielou, 1969; Gini,1972) is given as :

$$D' = 1 - \sum_{i=1}^{N} \frac{n_i (n_i - 1)}{n(n-1)}$$

where, n_i = total number of individuals of each species

n = total number of individuals of all species

D′ = Simpson' index of species diversity

Diversity and species richness

Species richness, meaning a count of the number of plant species in a quadrate, area or community is often equated with diversity. High diversity means a community containing a large number of different species. Magurran (1988) has provided that most methods for measuring diversity actually consist of two components, species richness and the relative abundance (evenness or unevenness) of species within the sample or community.

Whittaker (1965, 1975) made a distinction between two types of diversity : alpha and beta diversity. Alpha diversity is the number of species within a chosen area or community such as one type of woodland or grassland. Beta diversity is the difference in species diversity between area or communities, thus sometime it called habitat diversity. There are various indices but the most widely used that combine species richness with relative abundance is Shannon diversity index (H′), (Magurran, 1988).

5.2.3. Community classification :

5.2.3.1 Single Linkage Cluster Analysis (SLCA) : calculated by ranking IVI of each species and analyze by Single Linkage Cluster Analysis (SLCA) using Euclidean distance matrix.

Measurement of similarity and dissimilarity

Qualitative measures are based on presence/absence data, while quantitative work emphasis on abundance data. Similarity indices measure the degree to which the species composition of quadrates or sample matches is alike. Dissimilarity coefficients assess the degree to which two quadrates or samples differ in compose. The large choice available in particular are: the Jaccard coefficient and the Sorensen coefficient are generally applied to qualitative data and the Czekanowski coefficient and the coefficient of squared Euclidean distance, both of which are suitable for either quantitative or qualitative data.

The coefficient of squared Euclidean distance is based on the Euclidean properties of a right-angled triangle and the fact that the square on the hypotenuse is equal to the sum of the square on the opposite two sides. The lower the value of the squared Euclidean distance coefficient between two quadrates, the more similar they are in term of species composition. The lower limit of the coefficient is 0, representing complete similarity. However, there is no fixed upper limit for this coefficient, For this reason it is known as a coefficient of dissimilarity.

Correlation and regression analysis

An appreciate methods for correlation and regression is very important for straight forward analysis of floristic and environmental data and also as a basic for understanding of the more complex method of ordination and classification.

Correlation analysis is a set methods which is used to determine the strength of relationships between variables. Regression analysis takes this a stage further by measuring and describing the form of the relationship between two variables and allowing prediction of one variable in terms of variation in the other by fitting a mathematical function to the set of data. Both parametric and non-parametric methods exist for correlation and regression. For correlation, the major parametric method is Pearson's product-moment correlation coefficient and for regression, the equivalent is the least-squares technique. For non-parametric data, Spearman's rank correlation coefficient and the fitting of resistant lines of regression method, are most suitable used. The important thing involve the use of regression is to decide on dependent and independent variables (Walker, 1999).

5.2.3.2 Ordination : calculated by ranking IVI of each species and analyze by Non-metric multi-dimensional scaling (NMDS) method.

Ordination of the vegetation

Plant community Ordination was analyzed by Multidimensional scaling method, MDS (Shepard, 1962; Kruskal, 1964; Kenkal and Orlici, 1986) calculating from distance coefficient. The interstand relationships were analyzed by three dimensional ordination following the method of NMDS (Fasham, 1977).

Stands ordination was based only on the importance values of the component species of the tree layer (trees of over 10 cm dbh). This stands ordination was also used for determination of the structure and species distribution in the shrubs, and herbs and grasses layers.

Each sample stand was first compared with other stands using the importance values of the component species.

Ordination diagrams – the end product of indirect ordinations

Indirect ordinations examine the similarity or dissimilarity of floristic composition of vegetation samples. Which is expressed in graph form with plots of points in one, two or three dimensions where each point represents a vegetation sample or stand or quadrate. The distance between the points on the graph are taken as a measure of their degree of similarity or difference. Points which are close together will represent quadrates that are similar in species composition; the further apart any two points are, the more dissimilar or different the quadrats will be. This is known as a quadrate, sample, site or stand ordination.

Ordination can also be carried out for species producing a one-, two-, or three- dimensional graph, where each point represents a species and the distances between the points are expression of how similar the species are in their distribution across the quadrats. Such an Ordination is called a species ordination.

There are many techniques for indirect ordination, that differ in their approach to analysis The earliest method was that of Bray and Curtis (polar) ordination, devised originally in 1957. This was then followed by principal component analysis (Orloci, 1966; Austin and Orloci, 1966), reciprocal averaging and correspondence analysis (Benzecri,1969, 1973; Hill, 1793b, 1974) and then detrended correspondence analysis (Hill, 1979a; Hill and Gauch, 1980). However, other methods also exist, although they have not been extensively used; for example non-metric multi-dimensional scaling (Fasham, 1977; Pretentice, 1977) and canonical correspondence analysis (ter Braak, 1986a; 1988a,b).

Non-metric multi-dimensional scaling (NMDS)

NMDS was first used as an ordination method in plant ecology by Anderson (1971), and developed further by Austin (1976), Fasham (1977), Prentice (1977; 1980) and Kenkel and Orloci (1986). NMDS is really a set of related techniques that use the rank order information in a matrix of dissimilarities between species or quadrats. The earliest and most frequently used method is known as multidimensional scaling (MDS). In MDS, quadrats or samples are positioned within a few dimensions or axes, so that the distances between the points representing quadrats or species on the ordination diagram have the same rank order as the interpoint dissimilarities in the dissimilarity matrix calculated between all pairs of quadrats or all pairs of species. Various authors have test MDS and NMDS and their variants against other ordination methods, some have claimed superior results (Oksanen, 1983 and Minchin, 1987a), while others have found little advantage in using NMDS (Gauch et al, 1981). This seem to imply that in certain cases, NMDS will give better results, but this is not universal. NMDS is also good at recovering gradients of high beta (between habitat) diversity. A major problem with NMDS is that the computational procedures are very complex. Results have also been shown to be prone to the same 'horseshoe' or 'arch' effect as PCA and RA/CA.

5.2.4 Vegetation-environmental relationships

Stepwise multiple regressions were employed to detect and to establish models of vegetation in responding to environmental factors. A set of environmental factors consisted of potassium, iron contents, exchangeable calcium and magnesium, percent organic carbon, nitrogen-organic carbon ratio, soil pH, soil depth to C horizon. CEC and EA were treated as the independent variables. The importance values of major tree species, were used as the dependent variables The stepwise regression analysis computer program, STATISTICA, was employed for these analyses.

Stepwise regression analysis computes a sequence of multiple linear regression equations in a forward stepwise manner by using computer program, STATISTICA. At each step an independent variable which has the highest partial correlation with the dependent variable partial on the variables which have already been added or the one that has the greatest reduction in the error of sum square, this variable would have the highest F value. For this study, the F value was set at 95 percent level of significance. Therefore, the output includes the models consisting of only the significant independent factors.

Inclusion of the aspect data in the regression models to test the vegetation response on this factor did not seem to be appropriate, so the analysis of variance was used for these data. The importance value performance of the tree, shrubs, and herb and grass as used in regression analysis were tested based on the five aspect categories previously described. Comparisons were tested on the 95 percent level of significance for the chi-square values.

Results and Discussions

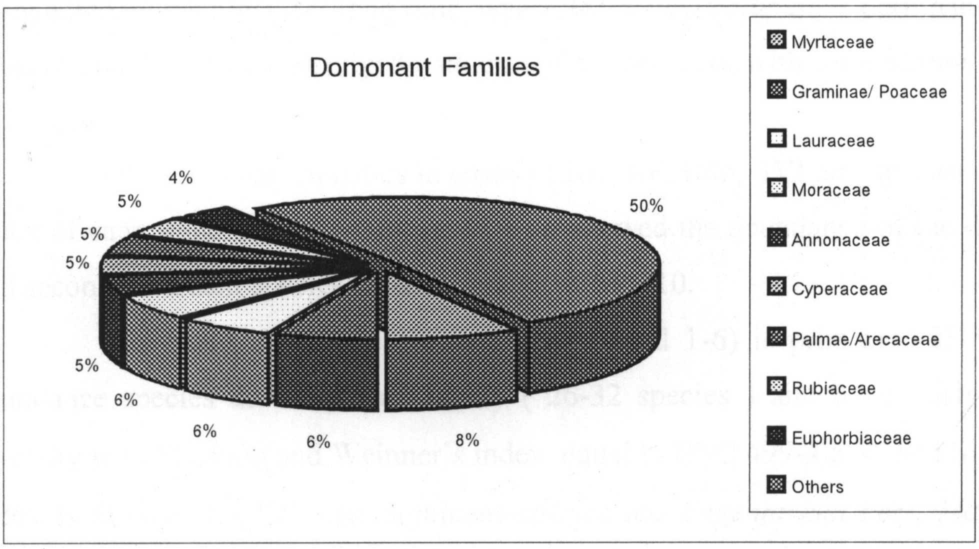
I. Phru Toh Daeng

1.1 Species Composition

Plant communities from 11 sample stands at Phru Toh Daeng, size 40 X 40 square meter (= 0.16 ha), consisted of vegetation of 75 species in 26 families and 5 unidentified tree species (dbh >4.5 cm). There were 56 species and 2 unidentified of small trees/shrubs (dbh < 4.5 cm), and the ground covers consist of 48 species and 3 unidentified of herbs/grasses. The dominant families of all vegetation are shown in Figure 9. The species lists with the Family name and species present of TD PSF and KK PSF are shown in appendix I. It indicated that the most dominant family is Myrtaceae, 11 species equal to 8 % of all species, including important/dominant species such as *Melaleuca cajupute, Eugenia kunstleri, Eugenia grandis,* and *Eugenia tumida,*. The second dominant families composing of 8 species are Lauraceae (*Endiandra mycrophylla*), Moraceae and Gaminae/Poaceae. Consequence important families which composed of 6 species were Annonaceae (*Goniothalamus gianteus*), Cyperaceae, Palmae/Arecaceae and Rubiaceae. Another family is Euphorbiaceae and its dominant species are *Macaranga pruinosa*, *Baccauria bracteata*, and *Blumeodendron kurzii* which are the native species and the pioneer species when the primary PSF has been opened. *Ganua motleyana* is another dominant species belonging to Sapotaceae.

1.2 Abundance of Vegetation

The abundance of vegetation (see appendix II, III and IV) showed the distribution of primary PSF, Stand 1-6, demonstrating the distribution of diversity of swampy species; *Ganua motleyana, Eugenia kunstleri, Macaranga pruinosa, Endiandra mycrophylla, Goniothalamus gianteus, Endiandra macrophylla, Polyalthia lateriflora* and *Eugenia grandis.* The distribution of secondary PSF consists of 2 groups. First group (stand 7,10,11) has many species which were similar to primary PSF due to gradually substitute by pioneer species and also fast growing



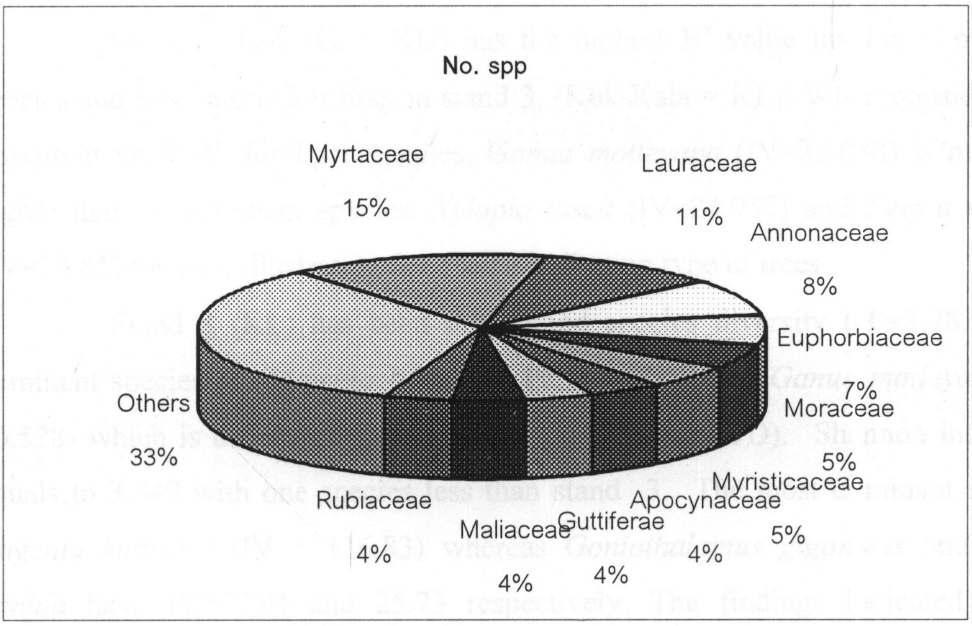


Figure 9 Species composition in Phru Toh Daeng

species such as *Polyalthia lateriflora, Stemonurus secundiflorus, Eugenia tumida,* and *Symplocos adenophylla.* Second group are secondary PSF that had many changeable by disturbed for long time, where *Melaleuca cajupute* is dominant species (stand 8 and 9). It has been mixed with other few species or with some shrubs or herbs and grasses.

Quantity characteristics in terms of RD, RF, Rdo, IVI and species diversity index of each stand are shown in Table 4. It showed the abundance of the dominant and second dominant species with important value > 10.

The stand in the preservation zone (stand 1-6) is primary PSF with the abundance species diversity are highly (26-32 species) and have fairly species diversity with Shannon and Weinner's index equal to H′=2.499-4.574 and Simpson's index is D′=0.650-0.958. The dominant species are *Eugenia kunstleri, Macaranga pruinosa, Ganua motleyana, Goniothalamus giganteus, Eugenia grandis* and *Endiandra mycrophylla,* except stand 6 having 11 species and less diversity, H′=2.499, due to edge of PSF adjacent to the developing community area.

Stand 2 (Kok Ku = KU) has the highest H′ value inspite of number of species and trees are lower than in stand 3, (Kok Kala = KL). When considering the important value of dominant species, *Ganua motleyana* (IV=32.038) is moderately higher than co-dominant species, *Xylopia fusca* (IV=24.957) and *Neesia malayana* (IV=23.813), which illustrating the even distribution type of trees.

Stand 3 (KL) has been the second species diversity (H′=3.781). The dominant species are *Eugenia kunstleri* (IV = 81.399) and *Ganua motleyana* (IV = 60.528) which is difference from stand 5 (Toh Daeng =TD). Shannon index value equals to 3.549 with one species less than stand 3. The most dominant species is *Eugenia kunstleri* (IV = 116.83) whereas *Goniothalamus giganteus* and *Eugenia tumida* have IV=27.94 and 25.73 respectively. The findings indicated different structure in term of the even of tree type which is similar to the structure of stand 1 (Padee = PD) that has less species (24 species) but the number of trees are higher (227 species), H′=2.795. Again *Eugenia kunstleri* is the most dominant species, IVI is very high, 149.546 while *Goniothalamus giganteus* and *Macaranga pruinosa,* are lower IV ~ 25.79.

Table 4 Quantity characteristics of Sample Stands in Toh Daeng and Kuan Kreng PSF (species with IV > 10).

Stand No.	Species	No.	f	D	F	RD	RF	Rdo	IVI
1. Padee	no. of species = 24 Shannon Index = 2.7954 Simpson Index = 0.724								
	Eugenia kunstleri	113	16	7.06	100.00	49.78	21.05	78.71	149.55
	Goniothalamus giganteus	23	9	1.44	56.25	10.13	11.84	3.82	25.79
	Macaranga pruinosa	22	7	1.38	43.75	9.69	9.21	6.86	25.76
	Eugenia grandis	20	7	1.25	43.75	8.81	9.21	1.72	19.74
	Gymnacranthera eugeniifolia	6	5	0.38	31.25	2.64	6.58	5.47	14.69
	Endiandra macrophylla	9	6	0.56	37.50	3.96	7.89	1.38	13.24
2. KokKu	no. of species = 29 Shannon Index = 4.5743 Simpson Index = 0.958								
	Ganua motleyana	7	4	0.44	25.00	7.00	4.49	20.57	32.07'
	Xylopia fusca	5	5	0.31	31.25	5.00	5.62	14.39	25.01
	Neesia malayana	7	5	0.44	31.25	7.00	5.62	11.28	23.90
	Blumeodendron kurzii	8	5	0.50	31.25	8.00	5.62	8.25	21.87
	Sandoricum beccarianum	7	6	0.44	37.50	7.00	6.74	8.06	21.80
	Endiandra macrophylla	9	7	0.56	43.75	9.00	7.87	3.65	20.52
	Olea brachiata	8	7	0.50	43.75	8.00	7.87	4.25	20.12
	Alstonia spathulata	5	5	0.31	31.25	5.00	5.62	7.48	18.10
	Eugenia kunstleri	6	5	0.38	31.25	6.00	5.62	3.75	15.37
	Carophyllum pisiferum	3	3	0.19	18.75	3.00	3.37	5.72	12.09
3. KokKala	no. of species = 30 Shannon Index = 3.7811 Simpson Index = 0.878								
	Eugenia kunstleri **	46	15	2.88	93.75	26.44	13.89	41.07	81.40
	Ganua motleyana	20	11	1.25	68.75	11.49	10.19	38.85	60.53
	Stemonurus secundiflorus	18	9	1.13	56.25	10.34	8.33	3.99	22.67
	Endiandra macrophylla	14	9	0.88	56.25	8.05	8.33	5.69	22.07
	Blumeodendron kurzii	12	8	0.75	50.00	6.90	7.41	3.10	17.40
	Goniothalamus giganteus	12	8	0.75	50.00	6.90	7.41	0.65	14.95
	Olea brachiata	10	7	0.63	43.75	5.75	6.48	2.38	14.61
4. Pawaly	no. of species = 26 Shannon Index = 2.5778 Simpson Index = 0.6634								
	Macaranga pruinosa ***	110	16	6.88	100.00	55.84	25.00	93.36	174.20
	Eugenia grandis	27	7	1.69	43.75	13.71	10.94	1.96	26.61
	Eugenia kunstleri	16	4	1.00	25.00	8.12	6.25	0.38	14.75
	Olea brachiata	6	5	0.38	31.25	3.05	7.81	0.18	11.03
5. TohDaeng	no. of species = 28 Shannon Index = 3.5491 Simpson Index = 0.8592								
	Eugenia kunstleri	75	16	4.69	100.00	30.86	13.11	72.87	116.85
	Goniothalamus giganteus	32	13	2.00	81.25	13.17	10.66	4.12	27.94
	Eugenia tumida	32	8	2.00	50.00	13.17	6.56	6.00	25.73
	Ganua motleyana	15	10	0.94	62.50	6.17	8.20	4.78	19.15
	Macaranga pruinosa	12	8	0.75	50.00	4.94	6.56	4.54	16.04
	Endiandra macrophylla	13	8	0.81	50.00	5.35	6.56	2.78	14.68
	Campnosperma coriaceum	9	7	0.56	43.75	3.70	5.74	1.57	11.01

Stand No.	Species	No.	f	D	F	RD	RF	Rdo	IVI
6. Laubosarma	no. of species = 11 Shannon Index = 2.4985 Simpson Index = 0.6498								
	Macaranga pruinosa	48	14	3.00	87.50	61.54	35.90	97.92	195.35
	Baccauria bracteata	7	6	0.44	37.50	8.97	15.38	1.75	26.11
	Euodia roxburghiana	5	5	0.31	31.25	6.41	12.82	0.05	19.28
	Glochidion littorale	4	3	0.25	18.75	5.13	7.69	0.07	12.89
	Eugenia gageana	4	2	0.25	12.50	5.13	5.13	0.03	10.29
7. KokSataw	no. of species = 22 Shannon Index = 3.6914 Simpson Index = 0.8943								
	Melaleuca cajuputi	50	12	3.13	75.00	22.83	13.64	86.49	122.96
	Eugenia gageana	32	9	2.00	56.25	14.61	10.23	2.64	27.47
	Unknown	24	10	1.50	62.50	10.96	11.36	3.52	25.84
	Ilex cymosa	24	9	1.50	56.25	10.96	10.23	2.32	23.50
	Eugenia longiflora	18	7	1.13	43.75	8.22	7.95	2.50	18.67
	Elaeocarpus griffithii	14	9	0.88	56.25	6.39	10.23	1.04	17.66
	Garcinia bancana	14	7	0.88	43.75	6.39	7.95	0.57	14.92
8. KaoKampan	no. of species = 1 Shannon Index = 0 Simpson Index = 0								
	Melaleuca cajuputi	454	16	28.38	100.00	100.00	100.00	100.00	300.00
9. ThungBaya	no. of species = 1 Shannon Index = 0 Simpson Index = 0								
	Melaleuca cajuputi	167	16	10.44	100.00	100.00	100.00	100.00	300.00
10. KolkMalrau	no. of species = 2 Shannon Index = 0.2228 Simpson Index = 0.0616								
	Melaleuca cajuputi	368	16	23.00	100.00	99.46	88.89	100.00	288.35
	Macaranga pruinosa	2	2	0.13	12.50	0.54	11.11	0.00	11.65
11. Munao	no. of species = 7 Shannon Index = 0.8893 Simpson Index = 0.2717								
	Melaleuca cajuputi	118	16	7.38	100.00	84.89	57.14	98.81	240.85
	Symplocos adenophylla	13	6	0.81	37.50	9.35	21.43	1.06	31.84
12.Salatalkein	no. of species = 1 Shannon Index = 0 Simpson Index = 0								
	Melaleuca cajuputi	167	16	10.44	100.00	100.00	100.00	100.00	300.00
13.HauPakaew	no. of species = 3 Shannon Index = 0.0407 Simpson Index = 0.0078								
	Melaleuca cajuputi	511	16	31.9375	100.00	99.61	88.89	99.99	288.50
14. Kauntin	no. of species = 1 Shannon Index = 0 Simpson Index = 0								
	Melaleuca cajuputi	143	16	8.94	100.00	100.00	100.00	100.00	300.00
15.Kuankreng	no. of species = 1 Shannon Index = 0 Simpson Index = 0								
	Melaleuca cajuputi	69	12	4.31	75.00	100.00	100.00	100.00	300.00
16. Samet-Ngam	no. of species = 1 Shannon Index = 0 Simpson Index = 0								
	Melaleuca cajuputi	374	16	23.38	100.00	100.00	100.00	100.00	300.00
17. Talaymong	no. of species = 1 Shannon Index = 0 Simpson Index = 0								
	Melaleuca cajuputi	289	16	18.06	100.00	100.00	100.00	100.00	300.00
18. Kuwa	no. of species = 1 Shannon Index = 0 Simpson Index = 0								
	Melaleuca cajuputi	73	11	4.56	68.75	100.00	100.00	100.00	300.00
19. Banpran	no. of species = 1 Shannon Index = 0 Simpson Index = 0								
	Melaleuca cajuputi	41	4	2.56	25.00	100.00	100.00	100.00	300.00
20. Yuannok	no. of species = 1 Shannon Index = 0 Simpson Index = 0								
	Melaleuca cajuputi	126	16	7.88	100.00	100.00	100.00	100.00	300.00

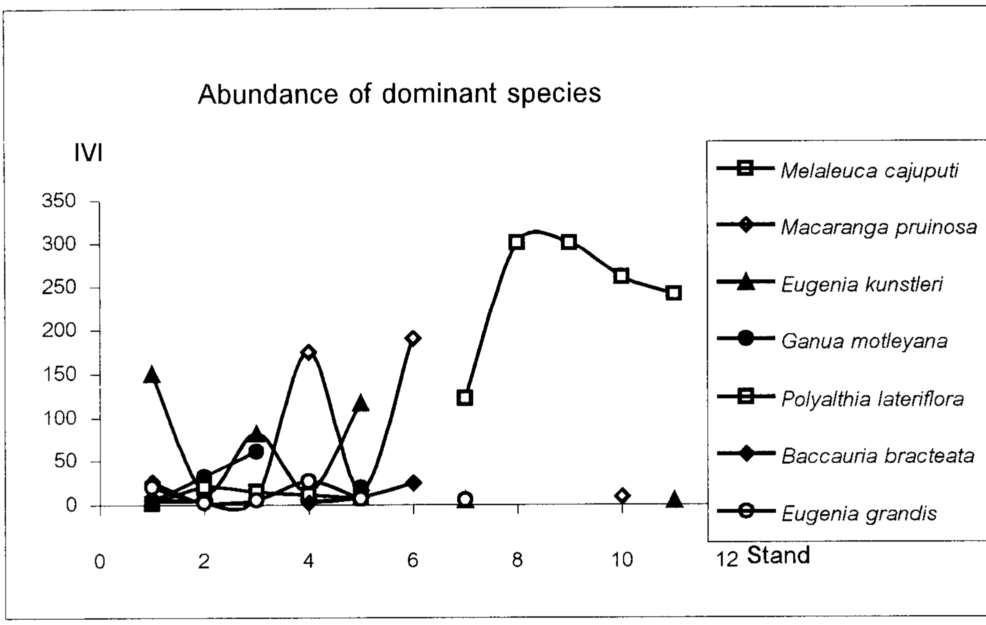
Stand 4 (Pawaiy = PW) has more species and trees when comparing to the other sample stand, H'=2.578. is *Macaranga pruinosa* IV=174.20, the dominant species whereas other species are very low. The important value, for instance, *Eugenia oblata* (IV= 26.605) which is similar to stand 6 (Laubo Sarma =LB), H' = 2.498 and *Macaranga pruinosa* is the most dominant species while *Baccauria bracteata* has IV = 24.73, and only LB has 11 species which the quality and type of tree are rather low.

The three sample stands in the conservation zone of TD PSF (Stand 7-9), are highly different. Stand 7, (Kok Sataw = KS) has 22 species and the diversity is high. The dominant species, *Melaleuca cajuputi* is IV =122.188 and the second dominant are *Eugenia gageana, Ilex cymosa*, with its IV lower than 30. This structure was similar to the plant stand in conservation zone, but the Shannon's index, H' = 3.6514 and Simpson's index, D' = 0.8943 are higher than some stands within the preservation zone. Other 2 stands, stand 8 (Kao Kampan = KP) and stand 9 (Thung Baya =TB), have only one species, *Melaleuca cajuputi*. The condition of this forest has been changed and it supports the dividing of the conservation zone into the pre-preservation and the pre-development zone.

Two stands of plant community within the development zone, stand 10 (Munao =MN), and stand 11 (Kok Mairua = MR), have 7 and 3 species respectively, which are higher than KP and TB in the conservation zone. *Melaleuca cajuputi* is the dominant species, however, other species are also found. In stand 10, the IV of *Melaleuca cajuputi* is 220 and IV of the important other species, *Symplocos adenophylla* is 31.838. The other species of stand 11 is *Macaranga purinosa* which is the pioneer species of the disturbed PSF.

The structure and distribution of TD PSF are higher and more stability than Kuan Kreng PSF. The abundance of dominant and the second dominant species of sample stand in Toh Daeng PSF are shown as Figure 10.

According to species composition and distribution from above illustrated together with Profile and Quantitative characteristics of each stand that shown in Figure 11 – 21 and Figure 26-34, indicated the structure of Toh Daeng and Kuan Kreng PSF. These 20 studied sites covered various kinds of vegetation which represented the structure and vegetation composed of Peat Swamp Forest.



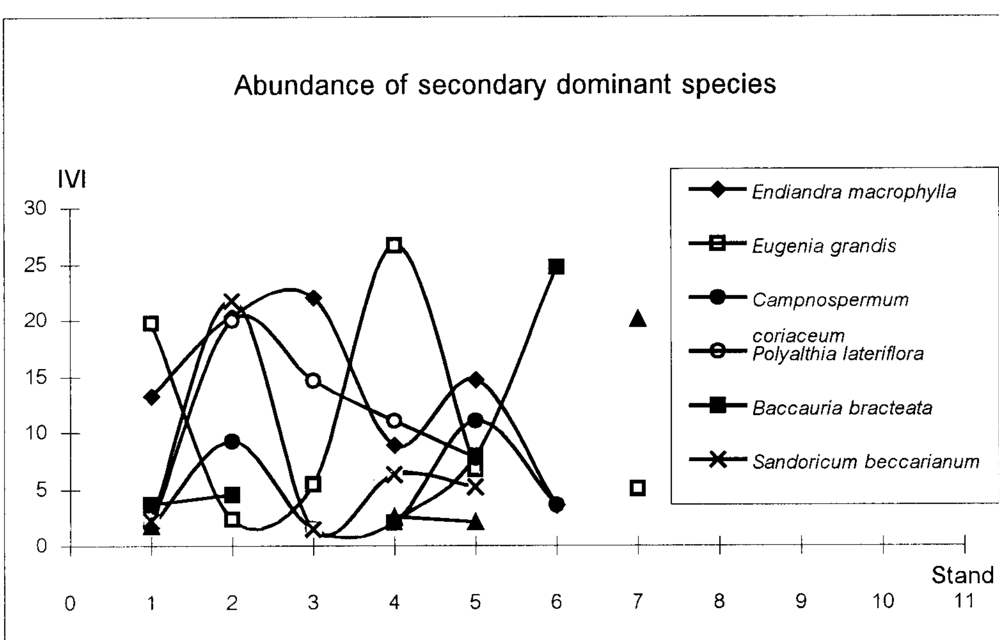


Figure 10 Abundance of the dominant and secondary dominant species in the study site of Phru Toh Daeng

1.3. Structure and vegetation composed of Toh Daeng PSF

There were eleven stands of Toh Daeng covering 2 swamp forests both primary and secondary PSF which are divided into three zones : preservation, conservation and development zone. The structures of stands are different in many characteristics. It is varied from high diversity with many species slightly to lower diversity thoroughly monopolization forest.

Stand 1, Padee (PD), is composed of 24 species and dominated by *Eugenia kunstleri* which substituted growing from lower layer with 78.7 % covered. Comprising of *Macranga pruinosa* and *Goniothalamus giganteus*, which has 6.86 and 3.82 % covered respectively. It has 3 stratums/crown cover layers. Top crown cover comprise with only few species such as *Sandoricum beccarianum, Baccauria bracteata, Stemonurus secundiflorus,* with average height of 23.33 m., and distinguished with 2 emerged trees, *Endiandra macrophylla, Gymnacranthera eugeniifolia.* The second layer is the substratum of dominant species, *Eugenia kunstleri* and *Goniothalamus giganteus, Eugenia grandis, Eugenia caudata* (~ ht. 12.32 m.). That is continuous with the lower layer (~ ht. 7.06 m.), that growing with substituted species *Macranga pruinosa..*

Undergrowth layer is dominated with palms: *Licuala longecalycata* distributed almost throughout the stand according to *Pandanus humilis* and some *Eugenia kunstler* saplings. Ground cover are distributed with many of *Stenochlaena palustris.*

On the ground, large trees were logged and covered with many dry leaves and dead stems. OM of upper soil is 46.3 % and lower soil is 5.34 % OM. Soil pH is 4.24.

Stand 2, Kok Ku (KU), is occupied with 29 species that showed high diversity of many species in all 4 layers. Top canopy layer is composed with emerge trees of *Xylopia fusca* and *Sandoricum beccarianum* and swampy/old species such as *Ganua motleyana, Blumeodendron kurzii, Campnospermum coriaceum, Neesia malayana* with average height, 32.25 m.. The first canopy layer has continuous canopy with diversity of many swampy species *: Horsfieldia crassifolia, Myristica elliptica Endiandra macrophylla Eugenia grandis* and *Blumeodendron kurzii* (23.35 ht.)

Stand no. 1 : PD
Location : Padee2, NW
UTM : 255895
No. of Species : 24
No. of trees (S) : 227
Shannon Index : 2.7954
Simpson Index : 0.724
Evenness Index : 0.8795

Sciencitific Name	RD	RF	RDo	IVI	Sciencitific Name	RD	RF	RDo	IVI
1.*Eugenia kunstleri*	49.780	21.053	78.714	149.546	13.*Macaranga griffithiana*	1.762	1.316	0.225	3.303
2.*Goniothalamus giganteus*	10.132	11.842	3.816	25.791	14.*Sandoricum beccarianum*	0.881	1.316	0.058	2.254
3.*Macaranga pruinosa*	9.692	9.211	6.858	25.760	15.*Diospyros lancifolia*	0.881	1.316	0.020	2.216
4.*Eugenia grandis*	8.811	9.211	1.720	19.741	16.*Dillenia pulchella*	0.441	1.316	0.246	2.003
5.*Gymnacranthera eugenifolia*	2.643	6.579	5.473	14.695	17.*Horsfieldia crassifolia*	0.441	1.316	0.115	1.871
6.*Endiandra macrophylla*	3.965	7.895	1.379	13.239	18.*Eugenia curtisii*	0.441	1.316	0.023	1.780
7.*Stemonurus secundiflorus*	1.762	5.263	0.276	7.301	19.*Canthium congestiflorum*	0.441	1.316	0.017	1.774
8.*Eugenia caudata*	1.762	2.632	0.308	4.702	20.*Carophyllum pisiferum*	0.441	1.316	0.016	1.773
9.*Ganua motleyana*	1.322	2.632	0.551	4.504	21.*Litsea johorensis*	0.441	1.316	0.014	1.770
10.*Baccauria bracteata*	0.881	2.632	0.123	3.636	22.*Campnospermum coriaceum*	0.441	1.316	0.010	1.767
11.*Polyalthia sclorophylla*	0.881	2.632	0.019	3.532	23.*Polyalthia lateriflora*	0.441	1.316	0.003	1.759
12.*Crudia caudata*	0.881	2.632	0.013	3.526	24.*Ilex cymosa*	0.441	1.316	0.002	1.758
					24 spp.	100	100	100.000	300.000

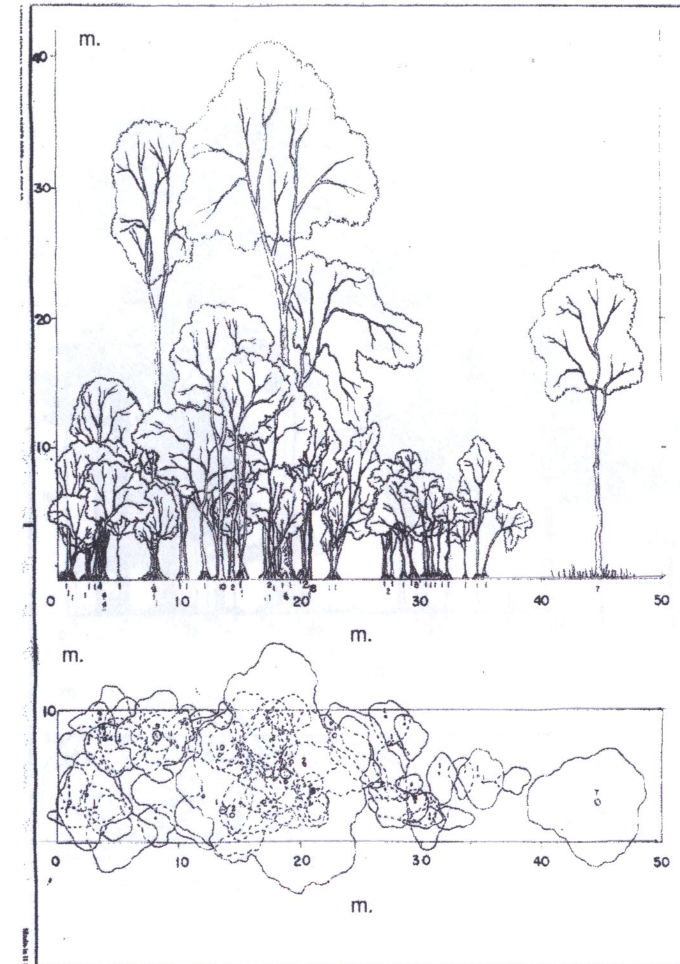


Figure 11 **Structure, profile, and quantity characteristics of stand 1 (PD)**

Stand no. 2 : KU
Location : Kokku, NW
UTM : 283863
No. of Species : 30
No. of trees (S) : 101
Shannon Index : 4.5743
Simpson Index : 0.958
Evenness Index : 1.3584

Sciencitific Name	RD	RF	Rdo	IVI	Sciencitific Name	RD	RF	Rdo	IVI
1.*Ganua motleyana*	7.000	4.494	20.573	32.068	16.*Horsfieldia crassifolia*	2.000	2.247	2.984	7.231
2.*Xylopia fusca*	5.000	5.618	14.388	25.006	17.*Polyalthia sclerophylla*	2.000	2.247	0.181	4.429
3.*Neesia malayana*	7.000	5.618	11.277	23.895	18.*Cinnamomum rhynchophyllum*	2.000	2.247	0.096	4.343
4.*Blumeodendron kurzii*	8.000	5.618	8.249	21.867	19.*Litsea monopetala*	2.000	2.247	0.083	4.330
5.*Sandoricum beccarianum*	7.000	6.742	8.062	21.804	20.*Myristica elliptica*	2.000	1.124	0.533	3.656
6.*Endiandra macrophylla*	9.000	7.865	3.652	20.518	21.*Polyalthia glauca*	2.000	1.124	0.350	3.474
7.*Polyalthia lateriflora*	8.000	7.865	4.253	20.118	22.*Goniothalamus giganteus*	2.000	1.124	0.047	3.171
8.*Dialium patens*	5.000	5.618	7.484	18.102	23.*Eugenia grandis*	1.000	1.124	0.262	2.385
9.*Eugenia kunstleri*	6.000	5.618	3.751	15.369	24.*Northaphoebe coriacea*	1.000	1.124	0.166	2.290
10.*Carophyllum pisiferum*	3.000	3.371	5.720	12.091	25.*Macaranga pruinosa*	1.000	1.124	0.052	2.175
11.*Stemonurus secundiflorus*	4.000	4.494	0.858	9.353	26.*Chisocheton patens*	1.000	1.124	0.020	2.143
12.*Campnospermum coriaceum*	3.000	3.371	2.884	9.255	27.*Olea brachiata*	1.000	1.124	0.012	2.136
13.*Eugenia caudata*	3.000	3.371	2.792	9.163	28.*Elaeocarpus macrocerus*	1.000	1.124	0.012	2.136
14.*Alstonia spathulata*	1.000	6.742	0.075	7.816	29.*Uvaria cordata*	1.000	1.124	0.008	2.132
15.*Baccaurea bracteata*	3.000	3.371	1.177	7.548	30. Unknown 1	0.990	1.111	0.199	2.301
					29 spp.	100.000	100.000	100.000	300.000

Figure 12 Structure, profile, and quantity characteristics of stand 2 (KU)

The second canopy (16.67 m. ht.) shows the similarity to the lower layer which present diversity of the same old species with height from 6-10.5 m..

The undergrowth layer are dominated with palms: *Eleiodoxa conferia* were many numbers and *Pandanus humilis, Licuala longecalycata, Caryota urens,* respectivetly. Many stems had *Stenochlaena palustris* climbing and some *Asplenium nidus* attached. Ground cover are *Homalomena griffithii* and *Aglaonema marantifolium.*

This stand has highest species diversity index (H'=4.5743), distributed with the swampy species in every layer which were the same species that substituted growing from the lower layer. It indicates stationary or development to climax community, shown with the IV of dominant species, *Ganuo motlyana* , IV= 32.068 while IV of co-dominant species, *Xylopia and Neesia* were 25.01 and 23.89 that close to other old species such as *Blumeodendron kurzii, Campnospermum coriaceum, Endiandra macrophylla, Polyalthia lateriflora,* (IV 20-22). These indicate the characteristic of the climax community that present with many species with close IV and quite low.

Stand 3, Kok Kala (KL), comprised with the swampy species (30 spp.) within 4 layers. These were stationary success of the same species from the lower to the upper layer. There are 2-3 trees of emerge species such as *Ganuo motlyana, Sterculia bicolor, Endiandra macrophylla and Eugenia kunstleri* (30 m. ht.). The top crown cover (23.2 m. ht.) is continuous cover of old species : *Ganuo motlyana, Blumeodendron kurzii, Endiandra macrophylla, Carophyllum pisiferum,* dominated by, *Eugenia kunstleri.* Second layer with 15.96 m. average height, are slightly divers of many species same as the upper one including some other swampy species: *Polyalthia lateriflora, Aglaia rubiginosa* The third layer (9.87 m. ht.) has high substituted growing of many species, and crowding with *Eugenia kunstleri, Ganuo motlyana,* competing with *Endiandra macrophylla, Polyalthia lateriflora, Eugenia tumida* and *Parastemon urophyllus.*

The lower layer (5.07 m. ht.) is the substituted growth of many trees of *Eugenia kunstleri* and *Goniothalamus giganteus* and *Stemonurus secundiflorus, Eugenia tumida, Polyalthia lateriflora* as well.

Stand no. 3 : KL
Location : KokKala, NW
UTM : 245867
No. of Species : 30
No. of trees : 174
Shannon Index: 3.7811
Simpson Index: 0.878
Evenness Index: 1.1116

Sciencttific Name	RD	RF	Rdo	IVI
1.*Eugenia kunstleri*	26.437	13.889	41.073	81.399
2.*Ganua motleyana*	11.494	10.185	38.849	60.529
3.*Stemonurus secundiflorus*	10.345	8.333	3.994	22.672
4.*Endiandra macrophylla*	8.046	8.333	5.693	22.072
5.*Blumeodendron kurzii*	6.897	7.407	3.097	17.401
6.*Goniothalamus giganteus*	6.897	7.407	0.650	14.954
7.*Polyalthia lateriflora*	5.747	6.481	2.381	14.610
8.*Macaranga pruinosa*	3.448	3.704	0.610	7.762
9.*Eugenia tumida*	2.299	3.704	1.048	7.050
10.*Aglaia rubiginosa*	2.299	3.704	0.080	6.082
11.*Eugenia grandis*	1.724	3.704	0.026	5.454
12.*Parastemon urophyllus*	1.724	2.778	0.340	4.842
13.*Carophyllum pisiferum*	1.149	1.852	0.788	3.789
14.*Artocarpus kemendo*	1.149	1.852	0.766	3.768
15.*Dialium patens*	0.575	1.852	0.045	2.471
16.*Crudia caudata*	0.575	1.852	0.002	2.429
17.*Sterculia bicolor*	1.149	0.926	0.334	2.410
18.*Eugenia caudata*	1.149	0.926	0.012	2.087
19.*Decaspermum fruticosum*	0.575	0.926	0.101	1.602
20.*Canthium congestiflorum*	0.575	0.926	0.056	1.556
21.*Xylopia fusca*	0.575	0.926	0.019	1.520
22.*Artocarpus elasticus*	0.575	0.926	0.012	1.513
23.*Eugenia oblata*	0.575	0.926	0.007	1.507
24.*Northaphoebe coriacea*	0.575	0.926	0.004	1.505
25.*Cinnamomum rhynchophyllum*	0.575	0.926	0.003	1.504
26.*Sandoricum beccarianum*	0.575	0.926	0.002	1.503
27.*Gynotroches axillaris*	0.575	0.926	0.002	1.503
28.*Campnospermum coriaceum*	0.575	0.926	0.002	1.503
29. *Polyalthia sclorophylla*	0.575	0.926	0.002	1.502
30.*Chisocheton patens*	0.575	0.926	0.001	1.502
30 spp.	100	100	100	300

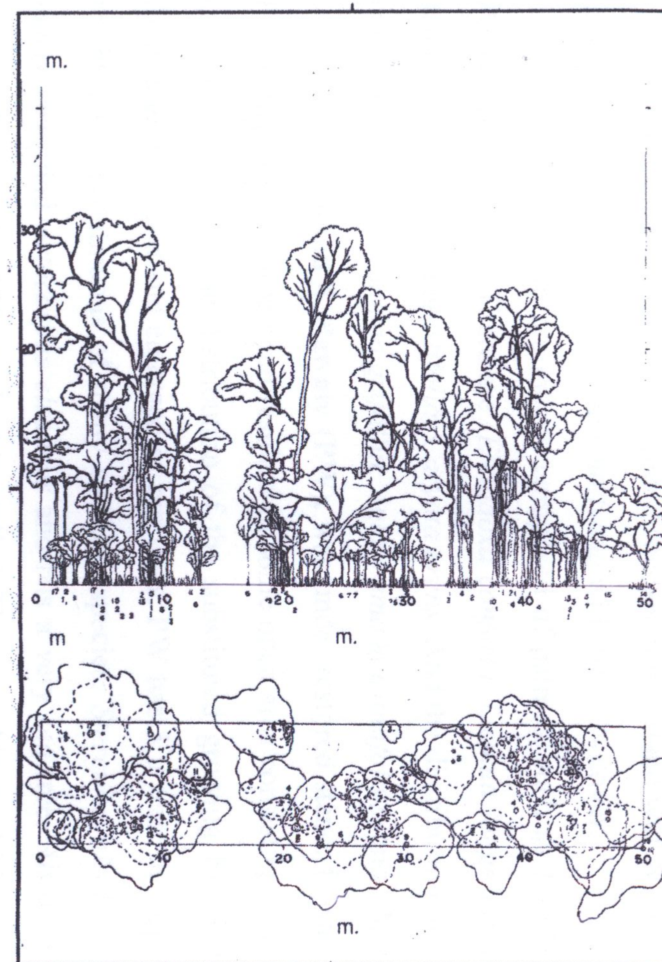


Figure 13 Structure, profile, and quantity characteristics of stand 3 (KL)

Eugenia kunstleri is dominant species of this stand with 81.40 % covered and co-dominant species is *Ganuo motlyana* with 60.52 % cover.

Undergrowth are mostly composed of palmes, such as *Pandanus humilis, Pandanus immersus.* There are *Eleiodoxa conferia, Licuala longecalycata* and next some *Daemonorops angustifolia, Caryota urens.* And the distribution of ground cover is sparse with *Homalomena griffithii, Aglaonema marantifolium* and *Piper miniatum*

Stand 4, Pawaiy (PW), was under restored stand. It was the Primary PSF which was disturbed and resulted in some open area consisting of discontinuous canopy. It presents the distribution of the substituted growing by pioneer species, *Macranga pruinosa* and emerged of big trees. PW has 3 layers: the top layer (25.33 m. ht.), is discontinuous of many swampy species, *Sterculia bicolor, Elaeocarpus macrocerus* and *Artocarpus elasticus* and has a very big tree, *Alstonia angustiloba* with the largest dbh, 298 cm., in this studied. The second layer (12.87 m. ht.) was also dense growing of *Macranga pruinosa*, distributed with old species of *Sandoricum beccarianum Neesia malayana Polyalthia lateriflora* and *Endiandra macrophylla.*

Similar to the lower layer of this stand (5.96 m. ht.), *Macranga pruinosa* was the growing substitute with old species *Polyalthia lateriflora, Litsea johorensis, Campnospermum coriaceum, Sterculia bicolor.* Though this stand has beenseverely disturbed, it still has many trees of old species.

The pioneer species of disturbed primary PSF, *Macranga pruinosa,* is the dominant species with 93.37 % covered whereas others old species are rather low.

Most of undergrowth are *Pandanus humilis* and *Eleiodoxa conferia,* whereas some *Stenochlaena palustris* are distributed with many lianas and grasses.

Eventhough it has been disturbed, this stand still has a lot of big trees of old swampy species and show 125 cm thick peat. One of the biggest tree of this study is in this stand.

Stand 5, Toh Daeng(TD), is under developed to the old primary PSF, it presents many species with the same size class of middle dbh class. There are many old species and pioneer sp., *Macranga pruinosa* in every layer, observably in the large stems of the top layer. The first layer (22 m. ht.) is the dominant stratum of *Eugenia kunstleri* distributed with the old species, *Ganua motleyana Litsea costada, Sandoricum beccarianum* and *Macranga pruinosa* the lower upper layer has high

Stand no. 4 : PW
Location : Pawaiy, NW
UTM : 232841
No. of Species : 26
No. of trees (S) : 197
Shannon Index: 2.5778
Simpson Index : 0.6634
Evenness Index: 0.4611

Scienctific Name	RD	RF	Rdo	IVI	Scienctific Name	RD	RF	Rdo	IVI
1*Macaranga pruinosa*	55.838	25.000	93.365	174.202	14.*Carophyllum teysmannii var.inophylloide*	0.508	1.563	0.097	2.167
2.*Eugenia grandis*	13.706	10.938	1.962	26.605	15.*Lophopetalum javanicum*	0.508	1.563	0.022	2.092
3.*Eugenia kunstleri*	8.122	6.250	0.379	14.751	16.*Blumeodendron kurzii*	0.508	1.563	0.022	2.092
4.*Polyalthia lateriflora*	3.046	7.813	0.177	11.035	17.*Neesia malayana*	0.508	1.563	0.013	2.083
5.*Alstonia angustiloba*	1.523	4.688	3.308	9.518	18.*Morinda eliptica*	0.508	1.563	0.005	2.076
6.*Endiandra macrophylla*	2.538	6.250	0.074	8.862	19.*Cinnamomum rhynchophyllum*	0.508	1.563	0.004	2.074
7.*Sandoricum beccarianum*	1.523	4.688	0.103	6.313	20.*Northaphoebe coriacea*	0.508	1.563	0.003	2.074
8.*Artocarpus elasticus*	2.030	3.125	0.093	5.249	21.*Ficus sp*	0.508	1.563	0.003	2.074
9.*Elaeocarpus macrocerus*	1.523	3.125	0.243	4.891	22.*Ficus aurantiacea*	0.508	1.563	0.003	2.073
10.*Horsfieldia irya*	0.508	3.125	0.002	3.634	23.*Eugenia gageana*	0.508	1.563	0.003	2.073
11.*Sterculia bicolor*	1.015	1.563	0.069	2.646	24.*Alstonia spathulata*	0.508	1.563	0.002	2.072
12.*Litsea costada*	1.015	1.563	0.030	2.607	25.*Baccauria bracteata*	0.508	1.563	0.001	2.071
13.*Ilex cymosa*	1.015	1.563	0.016	2.594	26.*Campnospermum coriaceum*	0.508	1.563	0.001	2.071
					26 spp.	100.000	100.000	100.000	300.000

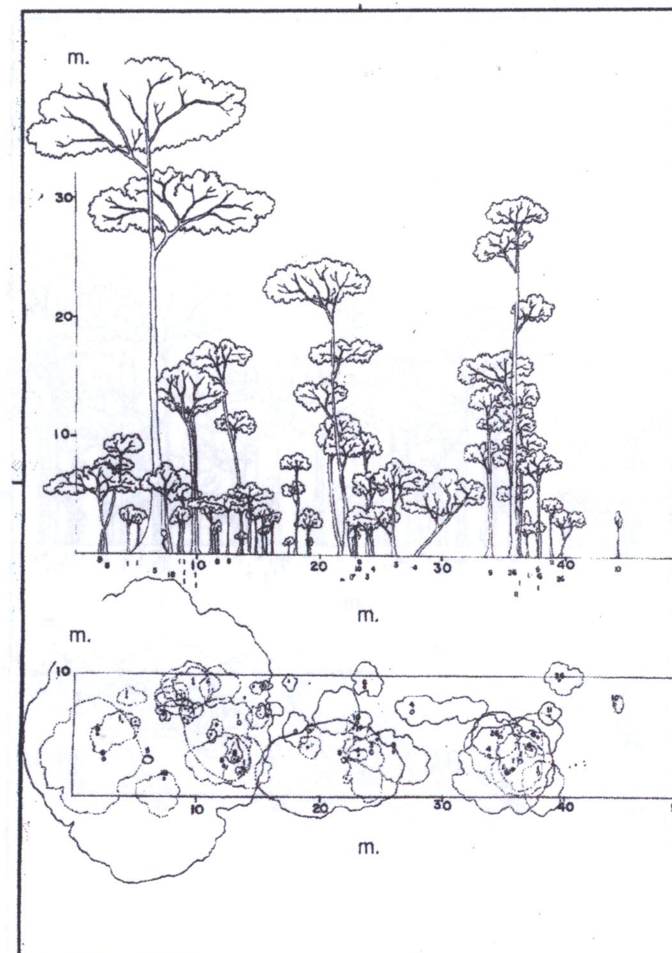


Figure 14 **Structure, profile, and quantity characteristics of stand 4 (PW)**

Stand no. 5 : TD
Location : Toh Daeng, NW
UTM : 286732
No. of Species : 28
No. of trees (S) : 243
Shannon Index: 3.5491
Simpson Index : 0.8592
Evenness Index: 1.0680

Sciencttific Name	RD	RF	Rdo	IVI	Sciencttific Name	RD	RF	Rdo	IVI
1.*Eugenia kunstleri*	30.864	13.115	72.873	116.85	15.*Eugenia longiflora*	0.823	1.639	0.042	2.504
2.*Goniothalamus giganteus*	13.169	10.656	4.116	27.940	16.*Carophyllum pisiferum*	0.823	1.639	0.019	2.481
3.*Eugenia tumida*	13.169	6.557	6.000	25.727	17.*Euodia roxburghiana*	0.823	1.639	0.014	2.476
4.*Ganua motleyana*	6.173	8.197	4.775	19.145	18.*Ilex cymosa*	0.412	1.639	0.049	2.099
5.*Macaranga pruinosa*	4.938	6.557	4.541	16.037	19.*Myristica elliptica*	0.823	0.820	0.062	1.705
6.*Endiandra macrophylla*	5.350	6.557	2.776	14.683	20.*Elaeocarpus macrocerus*	0.412	0.820	0.036	1.267
7.*Campnospermum coriaceum*	3.704	5.738	1.566	11.008	21.*Polyalthia glauca*	0.412	0.820	0.012	1.243
8.*Baccauria bracteata*	2.469	4.918	0.492	7.880	22.*Horsfieldia crassifolia*	0.412	0.820	0.012	1.243
9.*Polyalthia lateriflora*	2.058	4.918	0.715	7.691	23.*Litsea costada*	0.412	0.820	0.012	1.243
10.*Blumeodendron kurzii*	2.469	4.098	0.256	6.823	24.*Neesia malayana*	0.412	0.820	0.011	1.242
11.*Eugenia grandis*	2.881	3.279	0.555	6.714	25.*Dacryodes costata*	0.412	0.820	0.004	1.235
12.*Sterculia bicolor*	1.646	4.098	0.487	6.231	26.*Eugenia gageana*	0.412	0.820	0.003	1.234
13.*Elaeocarpus griffithii*	2.058	3.279	0.274	5.610	27.*Dacryodes incurvata*	0.412	0.820	0.002	1.233
14.*Sandoricum beccarianum*	1.646	3.279	0.295	5.219	28.*Stemonurus secundiflorus*	0.412	0.820	0.002	1.233
					28 spp.	100	100	100	300

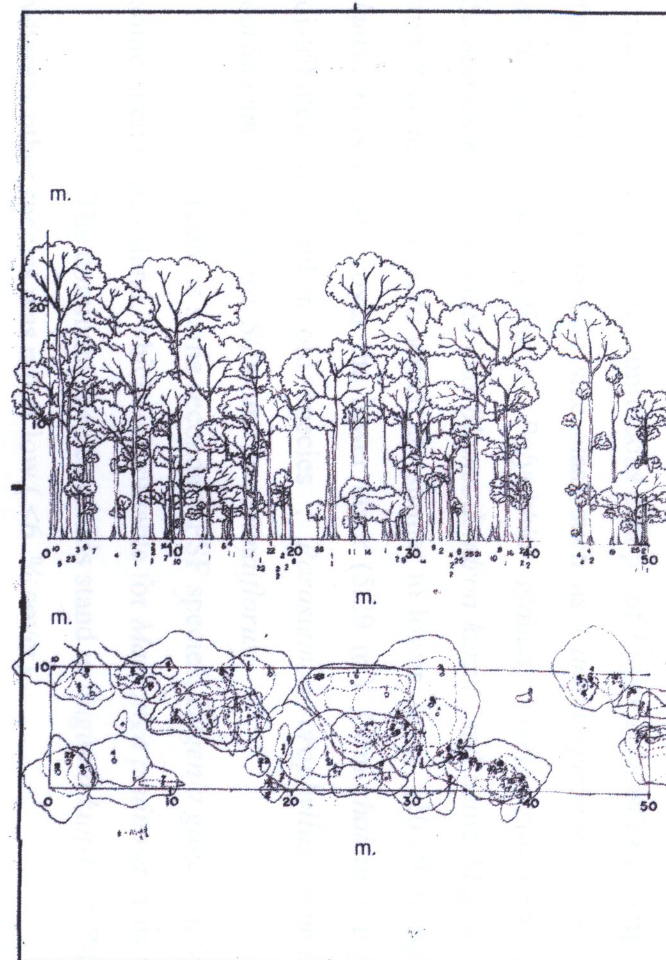


Figure 15 Structure, profile, and quantity characteristics of stand 5 (TD)

diversity species showing continuous canopy of *Eugenia kunstleri*, composing with the old species in middle size class such as *Campnospermum coriaceum, Ganua motleyana, Litsea costada, Polyalthia glauca, Gymnacranthera eugeniifolia, Sandoricum beccarianum* and *Blumeodendron kurzii* and some *Macranga pruinosa* and *Baccauria bracteata* which are similar to lower layer (10.29 m. hgt). *Eugenia kunstleri* is highly cover the lower layer (5.29 m.). *Goniothalamus giganteus* also distributed with other old species : *Parastemon urophyllus, Campnospermum coriaceum, Ilex cymosa, Stemonurus secundiflorus.*

There is some secondary PSF species; *Eugenia gageana*, that indicated some open in this stand, which was suitable for *Macranga pruinosa* growing.

The dominant species of this stand is *Eugenia kunstleri*, 78.87 % cover whereas other species was rather low (<6 % cover).

Most of the area covers with *Pandanus humilis*, and has some *Eleiodoxa conferia* and *Licuala longecalycata.* On the ground is water logged and composing with *Stenochlaena palustris* and *Pteridium aquilinum* and many stags and roots.

Stand 6, Luabo Sarma (LB), is the primary PSF under changes. Since it is close to the village, the primary PSF has been severely disturbed. There is discontinuous canopy with a few species (14 sp.) in low number of each species and lower than other stands in primary PSF zone. It comprises of medium height and middle size class trees. Top canopy layer (15.57 m. ht.) is comprised with *Macaranga pruinosa* and *Baccauria bracteata.* It has the characters of primary PSF, the diversity of swampy species mostly in the small size classes such as *Endiandra macrophylla*, *Blumeodendron kurzii*, *Baccauria bracteata*, *Euodia roxburghiana and Gynotroches axillaris.*

Undergrowth has present of palms: mostly *Daemonorops angustifolia* and some *Caryota urens*, together distributed with *Flagellaria indica.* Ground cover has many *Stenochlaena palustris* and *Thelypteris dentata.*

Stand 7-9, are secondary PSF dividing into conservation zone of Toh Daeng PSF. These stands appeare to have different characters that considered to be adjusted to zoning again.

Stand no. 6 : LB
Location : Laubo Sarma, NW
UTM : 303712
No. of Species : 14
No. of trees (S) : 82
Shannon Index: 2.4985
Simpson Index : 0.6498
Evenness Index: 1.0419

Sciencitific Name	RD	RF	Rdo	IVI	Sciencitific Name	RD	RF	Rdo	IVI
1.*Macaranga pruinosa*	61.5385	35.8974	97.9151	195.351	8.*Gynotroches axillaris*	2.5641	5.12821	0.01846	7.71077
2.*Baccauria bracteata*	8.97436	15.3846	1.8806	26.1088	9.*Macaranga griffithiana*	2.5641	2.5641	0.02592	5.15413
3.*Euodia roxburghiana*	6.41026	12.8205	0.0532	19.284	10.*Campnospermum coriaceum*	1.28205	2.5641	0.01925	3.8654
4.*Glochidion littorale*	5.12821	7.69231	0.07416	12.8947	11.*Endiandra macrophylla*	1.28205	2.5641	0.00264	3.84879
5.*Eugenia gageana*	5.12821	5.12821	0.03032	10.2867	12. Unknown 2	2.439	2.381	0.100	4.920
6.*Eugenia longiflora*	2.5641	5.12821	0.072	7.76431	13. Unknown 3	1.220	2.381	0.003	3.603
7.*Alstonia pneumatophora*	2.5641	5.12821	0.03902	7.73133	14. Unknown 4	1.220	2.301	0.009	3.609
					11 spp.	100	100	100	300

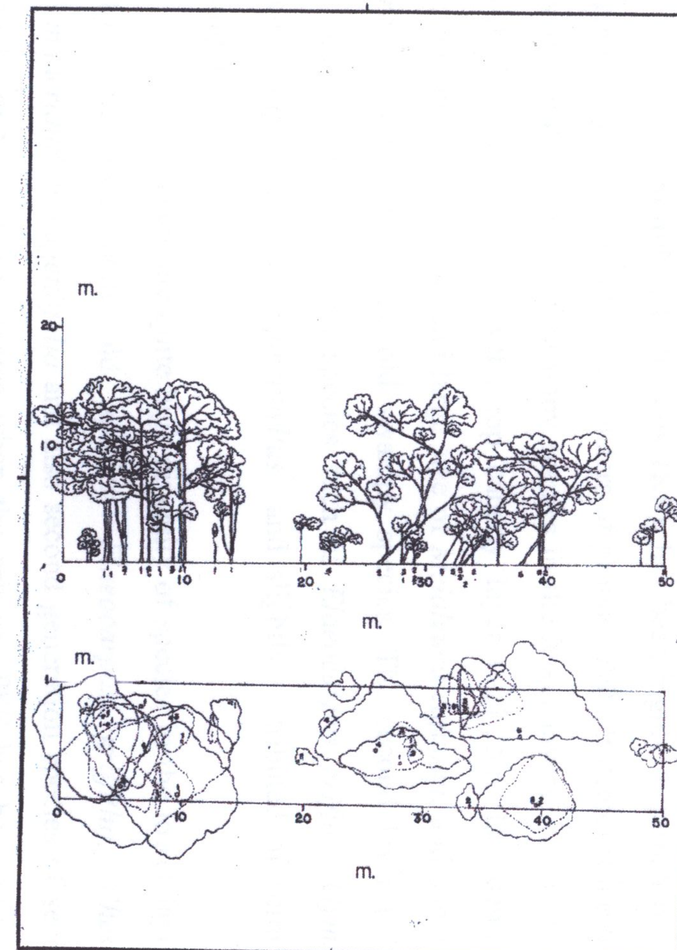


Figure 16 **Structure, profile, and quantity characteristics of stand 6 (LB)**

Stand 7, Kok Staw (KS), has been highly disturbed but it has an opportunity to restore to old characters of primary PSF. It demonstrate the reforestry by substituted growth of swampy species in the lower layers. There are composed with 22 species in 3 layers, top canopy layer (~21.55m. ht.) demonstrated by discontinuous of middle and large size of *Melaleuca cajuputi*, and some *Horsfieldia crassifolia* which are the old swampy species. The second layer (~11.71m. ht.) comprises with many old species such as *Elaeocarpus griffithii,Gymnacranthera eugeniifolia, Parastemon urophyllus* and slightly distributed of some *Melaleuca cajuputi.*

There are quite high diversity of species in the lower layer (~9.79 m. ht.) which are both old species, *Elaeocarpus griffithii, Phesa robusta, Gymnacranthera eugeniifolia* and also second generation species of secondary PSF, which are the pioneer species when the primary PSF has been opened, such as *Archidendron clypearia* , *Litsea costada, Ilex cymosa, Eugenia longiflora, Eugenia gageana.* These species are substituted growth to the upper layer. However they have only few *Melaleuca cajuputi.*

Undergrowth is dominated by Cyperaceae, *Scleria sumatrensis* and composed with *Stenochlaena palustris* and *Lygodium microphllylum.* Furthermore, it present with *Flagellaria indica* and *Melastoma candidum,* including sprase distributed of *Pandanus humilis, Thelypteris dentata.* On ground cover has *Nepenthes gracilis* distributed with *Scleria sumatrensis* and *Stenochlaena palustris.*

This stand comprises of high species density Index, H' = 3.6914, that is very close to stands in preservation of primary PSF. However some gap occurred that gave opportunity for pioneer species growing and possibility for restoration to primary PSF if not disturbed.

Stand 8, Kao Kampan (KP), is also secondary PSF in conservation zone which restlessly disturbed again and again until it became the Melaleuca forest that has only one dense distributed species *Melaleuca cajuputi,* managed to reforestry by planting.

There are 3 canopies, Top layer is 13.8 m. height with continuous of middle, tall and large stems. The lower layer is smaller size class with slightly equal

Stand no. 7 : KS
Location : KokStaw, NW
UTM : 221913
No. of Species : 23
No. of trees (S) : 223
Shannon Index : 3.6941
Simpson Index : 0.8943
Evenness Index : 1.1942

Scienctific Name	RD	RF	Rdo	IVI
1.*Melaleuca cajuput*	22.8311	13.6364	86.4944	122.962
2.*Eugenia gageana*	14.6119	10.2273	2.63565	27.4748
3.*Unknown*	10.9589	11.3636	3.51799	25.8405
4.*Ilex cymosa*	10.9589	10.2273	2.31703	23.5032
5.*Eugenia longiflora*	8.21918	7.95455	2.49946	18.6732
6.*Elaeocarpus griffithii*	6.39269	10.2273	1.03747	17.6574
7.*Garcinia bancana*	6.39269	7.95455	0.57013	14.9174
8.*Polyalthia sclerophylla*	2.28311	4.54545	0.09148	6.92004
9.*Eugenia kunstleri*	3.19635	2.27273	0.13359	5.60266
10.*Gymnacranthera eugeniifolia*	1.82648	3.40909	0.07788	5.31346
11.*Eugenia grandis*	2.73973	2.27273	0.16878	5.18123
12.*Parastemon urophyllus*	1.36986	2.27273	0.12543	3.76802
13.*Barringtonia racemosa*	0.91324	2.27273	0.04759	3.23356
14.*Northaphoebe coriacea*	0.91324	2.27273	0.01736	3.20333
15.*Archidendron clypearia*	1.82648	1.13636	0.06502	3.02787
16.*Alstonia spathulata*	0.91324	1.13636	0.08434	2.13394
17.*Sterculia bicolor*	0.91324	1.13636	0.05597	2.10558
18.*Polyalthia glauca*	0.91324	1.13636	0.0119	2.0615
19.*Horsfieldia crassifolia*	0.45662	1.13636	0.03086	1.62384
20.*Phesa robusta*	0.45662	1.13636	0.01159	1.60458
21.*Litsea grandis*	0.45662	1.13636	0.00362	1.59661
22.*Cinnamomum rhynchophyllum*	0.45662	1.13636	0.00246	1.59544
23. Unknown1	1.794	3.261	0.183	5.15736
22 spp.	100	100	100	300

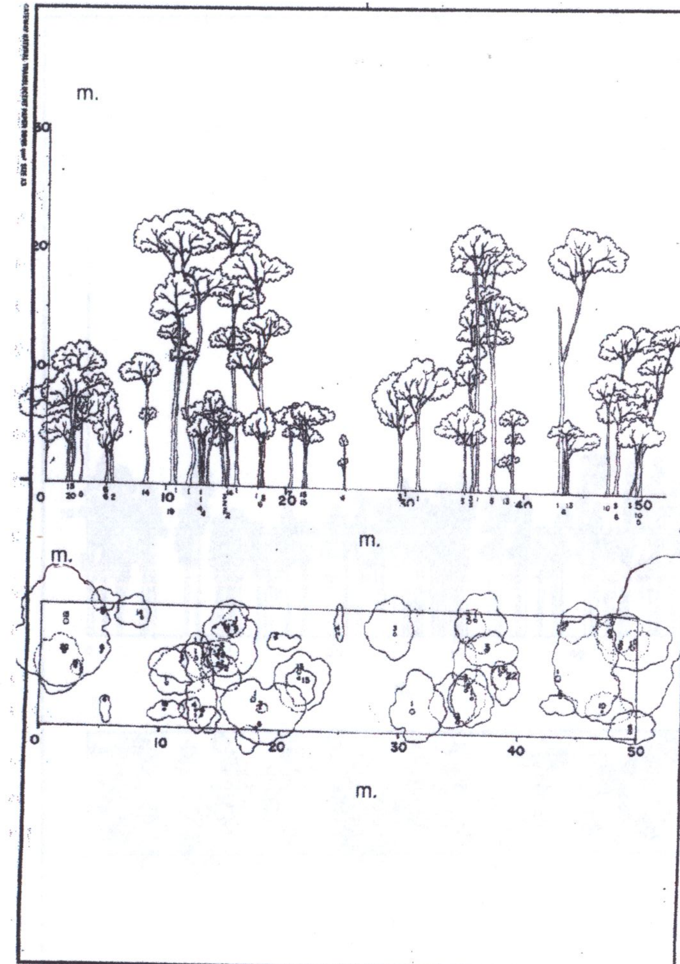


Figure 17 **Structure, profile, and quantity characteristics of stand 7 (KS)**

Stand no. 8 : KP
Location : Kao Kampan, NW
UTM : 154985
No. of Species : 1
No. of trees (S) : 454
Shannon Index : 0
Simpson Index : 0
Evenness Index: ∝

Scienctific Name	RD	RF	Rdo	IVI
1.*Melaleuca cajuputi*	100	100	100	300
1 sp.	100	100	100	300

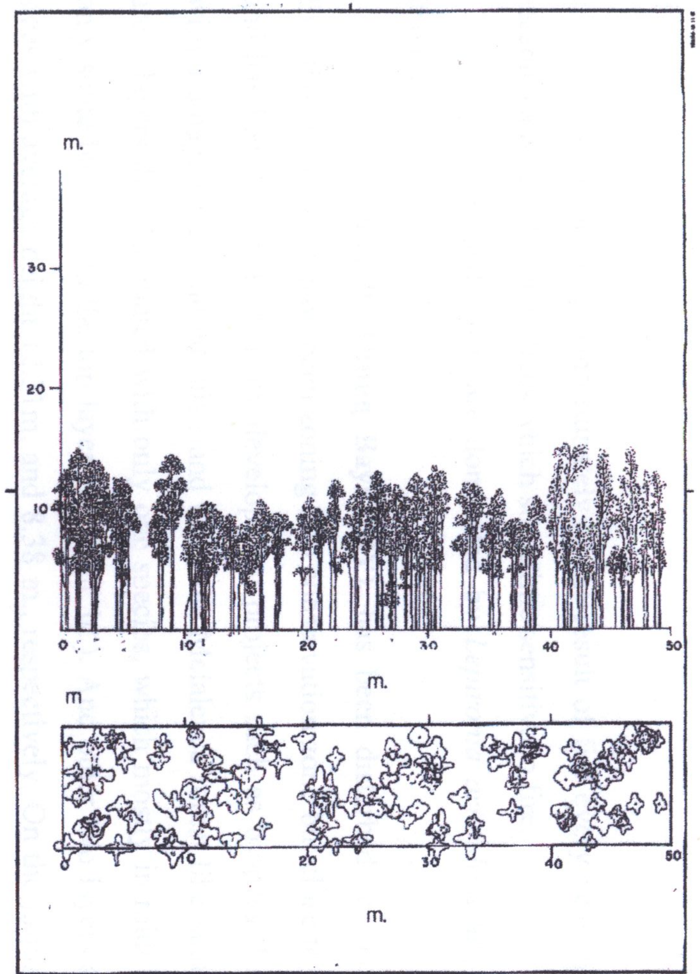


Figure 18 Structure, profile, and quantity characteristics of stand 8 (KP)

size because of planting. Unfortunately as the result of fire every year in the dry season, caused to be small trees which sometime sensitive to fire.

Ground cover are dominated by *Lepironia articulata* and some dry leaves.

Stand 9, Thung Baya (BY), has been disturbed for a long time. Eventhough it has already been zoning into conservation zone but close to the village and has been situated on many development projects such as by-passed road along with drainage canal, caused this stand to be the Melaleuca forest like stand 8. There are 3 layers that distributed with only one species, which mostly in middle size and only some big trees in the top layer (18.17 m. ht.). And other two layers are smaller sizes with average height 12.31m. and 8.38 m., respectively. On the ground floor, is Dense distribution of many smaller *Melaleuca cajuputi.*

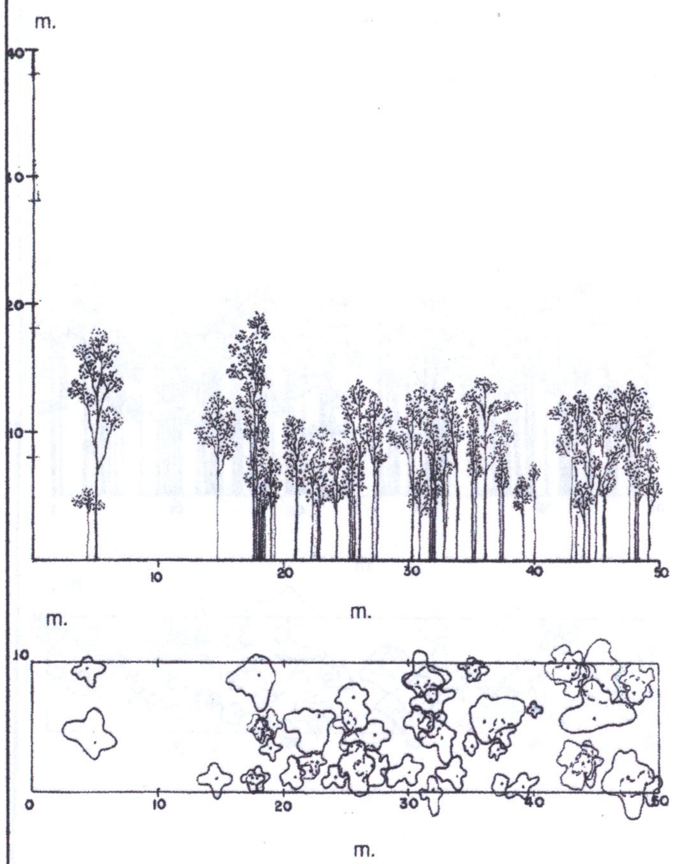
Stand 10, Kok Maurua (MR), is the secondary PSF in development zone of Toh Daeng PSF. It is also continuously disturbed and changed to be Melaleuca forest. It ss surrounded with drainage canal and has been reforested by artificial planting with fast growing species, *Acacia sp.* Top canopy layer is 17.58 m. height with rather large and tall *Melaleuca cajuputi* that has *Stenochlaena palustris* tightly climbed, following with lower layer, on dense smaller trees (~13.38 m. ht.) In the lower layer besides *Melaleuca cajuputi* fast growing species *Acacia sp.* has been developed. Interestingly, it has *Macaranga pruinosa,* the pioneer species of open primary PSF in MR. This indicate the possibility to rehabilitate this stand to the old PSF if not disturbed and if it has been helped to restore with the old species.

Undergrowth is composed of a large number of *Melastoma candidum* and some *Flagellaria indica* while ground cover is dominated by *Stenochlaena palustris* twistly growing with *Lygodium salicifolium, Pteridium aquilinum,* and *Gynochthodes sublanceolata.*

Stand 11, Monoh (MN), is also the secondary PSF in development zone. Inspite of locating in Munoh Co-operative, it has been severely disturbed both from fire and human activities and become Melaleuca forest. Interestingly, MR presents the substituted growth of the second generation species of 2 PSF. There are 2 layers, the top layer (~11.35 m. ht.) is open canopy with sparse distribution of *Melaleuca cajuputi* and some second generation species of 2 PSF; *Eugenia*

Stand no. 9 : BY
Location : ThungBaya, NW
UTM : 173015
No. of Species : 1
No. of trees (S) : 167
Shannon Index : 0
Simpson Index : 0
Evenness Index: ∝

Sciencttific Name	RD	RF	Rdo	IVI
1.*Melaleuca cajuputi*	100	100	100	300
1 sp.	100	100	100	300



<u>Figure 19</u> **Structure, profile, and quantity characteristics of stand 9 (BY)**

Stand no. 10 : MR
Location : KokMairou, NW
UTM : 255980
No. of Species : 3
No. of trees (S) : 380
Shannon Index: 0.2228
Simpson Index : 0.0616
Evenness Index: 0.321

Sciencttfic Name	RD	RF	Rdo	IVI
1.*Melaleuca cajuputi*	96.842	64	99.973	260.815
2.*Macaranga pruinosa*	0.5263	8	0.0029	8.529
3. Acacia mangium	2.6316	28	0.024	30.656
2 spp.	100	100	100	300

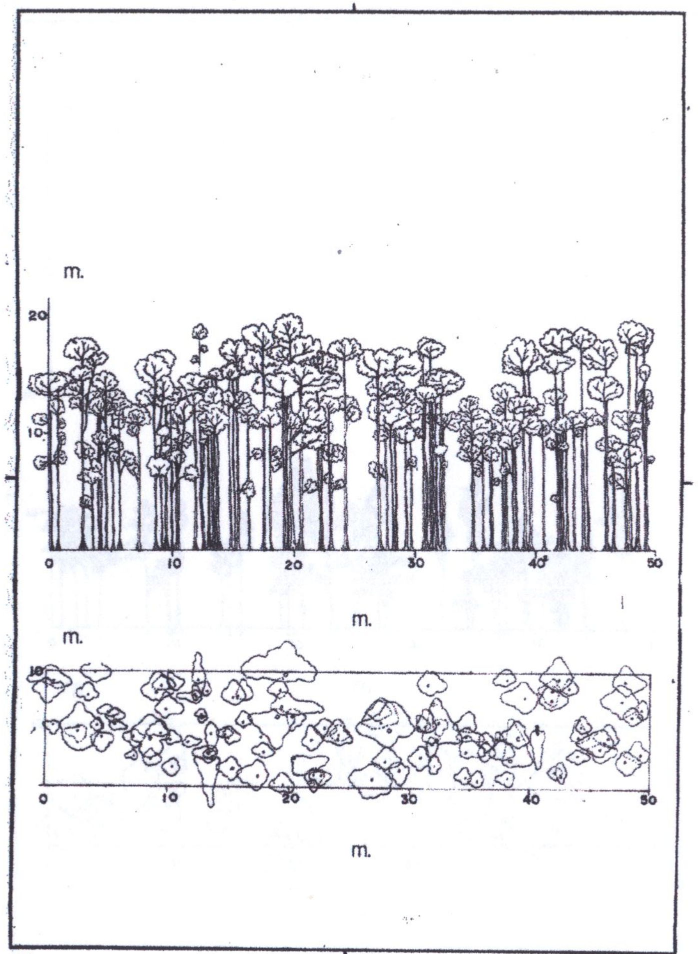


Figure 20 Structure, profile, and quantity characteristics of stand 10 (MR)

Stand no. 11 : MN
Location : Munou, NW
UTM : 283773
No. of Species : 7
No. of trees (S) : 139
Shannon Index: 0.8893
Simpson Index : 0.2717
Evenness Index: 0.4570

Scienctific Name	RD	RF	Rdo	IVI
1.*Melaleuca cajuputi*	84.8921	57.1429	98.8109	240.846
2.*Symplocos adenophylla*	9.35252	21.4286	1.05673	31.8378
3.*Eugenia pseudosubtillis*	2.15827	7.14286	0.05949	9.36063
4.*Barringtonia racemosa*	1.43885	3.57143	0.02891	5.03918
5.*Ilex cymosa*	0.71942	3.57143	0.04109	4.33195
6.*Gynotroches axillaris*	0.71942	3.57143	0.00175	4.2926
7.*Eugenia*	0.71942	3.57143	0.00111	4.29197
7 spp.	100	100	100	300

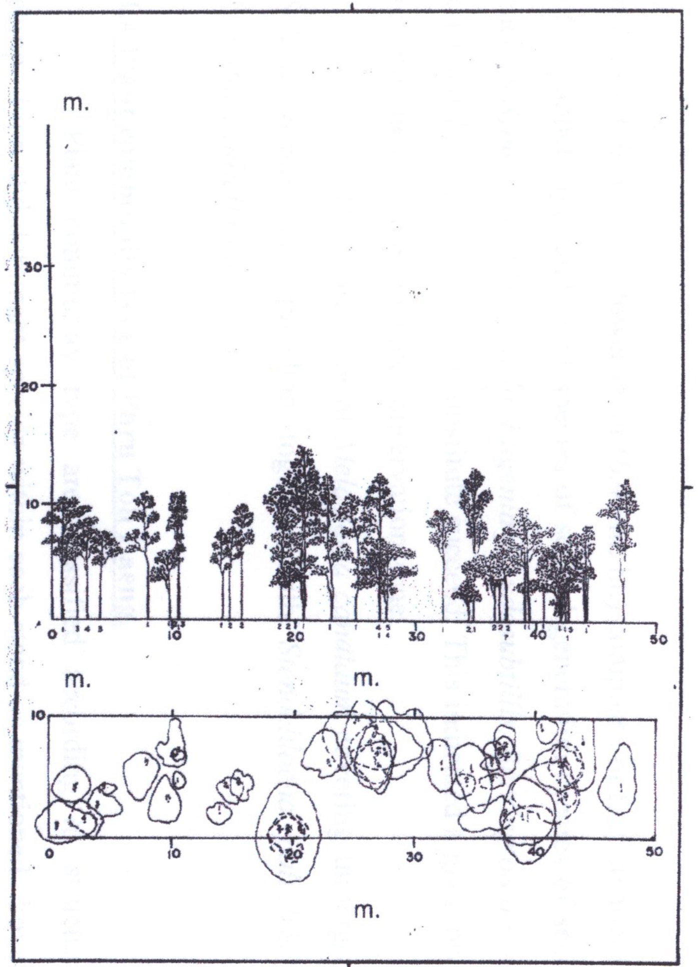


Figure 21 **Structure, profile, and quantity characteristics of stand 11 (MN)**

pseudosubtillis. In the lower layer (6.49 m. ht.) composes of half smaller size trees of the upper layer and more species of second generation species of secondary PSF such as *Symplocos adenophylla, Eugenia pseudosubtillis, Barringtonia racemosa,* and *Gynotroches axillaris*, which substitute succeed. This indicated a great opportunity to rehabilitate this area to be the conservation zone.

There are a lot of *Melastoma candidum* covering undergrowth where *Scleria sumatrensis* spreading together with *Stenochlaena palustris* and some *Lygodium salicifolium.*

1.4 Plant community type of Phru Toh Daeng.

Plant community type are classified according to structural, species composition and dominant species within each stand as mentioned above. Dominant species were classified by density, frequency, basal area and important value. Table 7 concluded the quantitative characteristics such as density, frequency, basal area and IVI, of 20 stands. Plant communities of these study stands were categorized into four community types based on the first and second leading dominant tree species in each stand shown in Table 5.

Plant community types in Toh Daeng PSF are diversified and classified into four community types as follow :

1). *Eugenia kunsteri* Community Type

This type is dominated by *Eugenia kunsteri,* generally it forms 2 sub-type by secondary dominant species :

First sub-type *Eugenia kunsteri* is dominant species with greater IV more than 100. This showed very strong dominated in stand 1 (PD) and stand 5 (TD) that has IV 149.55 and 116.85 respectively. Secondary dominant species are *Goniothalamus gianteus* and *Macaranga pruinosa* showed only a quarter IV of them, 25.79, 25.76 in stand 1 and showed IV 28.94, 16.04 in stand 5. *Eugenia kunstleri* covers 78.71 and 72.87 % in stand 1,5 respectively while the % cover of other species are very low (only from 1 to 6 % cover).

Macaranga pruinosa, Eugenia tumida, Ganua motleyana, Endiandra mycrophylla are the third generations of plants in this type. Furthermore, *Eugenia kunstleri* and *Macaranga pruinosa* are also shrubs and small trees of lower layer.

Table 5 The dominant tree species in the study site based on importance value.

1st Dominant Species	2nd Dominant Species	3rd Dominant Species	Stand No.
1. *Eugenia kunstleri* community type			
Eugenia kunstleri	*Goniothalamus gianteus*	*Macaranga pruinosa*	1,5
	Macaranga pruinosa	*Eugenia grandis*	
		Eugenia tumida	
		Ganua motleyana	
		Endiandra macrophylla	
Eugenia kunstleri	*Ganua motleyana*	*Stemonurus secundiflorus*	3
		Endiandra macrophylla	
		Blumeodendron kurzii	
		Goniothalamus gianteus	
2. *Ganua motleyana* community type			
Ganua motleyana	*Xylopia fusca*	*Neesia malayana*	2
		Blumeodendron kurzii	
		Sandoricum beccarianum	
		Endiandra macrophylla	
3. *Macaranga pruinosa* community type			
Macaranga pruinosa	*Eugenia grandis*	*Eugenia kunstleri*	4
	Baccauria bracteata	*Polyalthia lateriflora*	6
		Euodia roxburghiana	
4. *Melaleuca cajuputi community type*			
Melaleuca cajuputi	*Eugenia gageana*	*Ilex cymosa*	7, 10
	Symplocos adenophylla	*Elaeocarpus griffithii*	11, 13,
Melaleuca cajuputi			8, 9,1 2, 14, 15
			16,17,18,19, 20

pH of upper soil is about 3.8 while the lower soil pH is ~ 4.4. The organic matters are fairly high especially in stand 5, OM of upper soil = 83.30 %, whereas OM of upper soil and lower soil of stand 1 are 55.97 and 30.35 % respectively. Water pH is about 4.4 in both wet and dry seasons.

Second sub - type : *Eugenia kunstleri - Ganua motleyana* : Stand 3 (KL), *Eugenia kunstleri* is the dominant species with IV=81.40, and *Ganua metleyana* is the second dominant species with IV = 60.58. The % cover of *Eugenia kunstleri* is 41.07 %, it is close to the covering of *Ganua motleyana* (38.85%), *Stemonurus secundiflorus*, *Endiandra mycrophylla*, *Blumeodendron kurzii* and *Goniothalamus giganteus* are the third dominant species while other species have low percentage of cover (~0.65 - 5.69%).

Soil of this community type is fertility. The OM percentage of upper soil and upper lower soil are 66.28 and 69.5. While OM of lower soil is low ~22.04 %, soil pH of upper soil is ~ 4.2. However, pH of lower soil is ~ 3.58, it indicate acidic soil.

2). *Ganua motleyana* Community Type

The dominant species of this community type is *Ganua motleyana* with IV = 32.07 while mostly similar to the co-dominant species, *Xylopia fusca* and *Neesia malayana*, with IV = 25.01 and 23.90 respectively. This type occurred at stand 2 (KU) where *Blumeodendron kurzii*, *Sandoricum beccarianum*, *Endiandra mycrophylla* are the third growing trees. However, the cover of this stand cloud not be classified clearly. The cover of dominant species was close to co-dominant species, 20.57%, 14.39% and 11.28 % respectively, which are very similar to other species of third dominant species.

This community type shows characteristics of climax community with high species diversity, H′ = 4.5743, while the important value of dominant species is not so high and close to others species.

pH of upper soil is similar to lower soil ~3.6 - 3.78 while OM is fairly high both upper soil and upper lower soil, 68.55% and 64.84%, but rather low at the lower soil, 24.54 %OM.

3). *Macaranga pruinosa* Community Type

This type presents in 2 stands (stand 4,6), *Macaranga pruinosa* has been the dominant species in both with the greater IV with the value of 174.20 and 195.35 respectively, whereas others are species present very low IV, from 10 to 28, that is about 10% of dominant species. *Eugenia grandis* is the second dominant species of stand 4 (PW), IV = 26.61 whereas *Eugenia kunstleri* is the third dominant species followed by *Polyalthia lateriflora.* The second dominant species of stand 6 (LB) is *Baccauria bracteata* (IV=26.11), and followed by *Euodia roxburghiana.* The percentage cover of dominant species is very high, 93.36% and 97.92% while the cover of other species is very low, 0.03-1.96 %.

Macaranga pruinosa is the dominant and pioneer species of primary PSF when the forest has been opened. This event indicates that when the primary PSF had been once disturbed and later the forest can be again rehabilitated.

Compared with other stands in preservation zone, %OM of this type is slightly low. OM of stand 4 is similar to all intervals ~ 35.64 - 48.06 % while in the stand 6, OM of the upper soil and upper lower soil equal to 37.38 and 28.16% respectively. The lower soil has very low %OM, 2.36%.

The range of soil pH is 4.3 where as the upper soil is more acidity than the lower soil, pH = 4.0.

The three community types as mentioned above represent the primary PSF of Toh Daeng , that composed of swampy species growing in their next generations. They indicated the succession of *Macaranga pruinosa* community, when primary PSF has been opened then community is under succession by lower tree such as *Eugenia kunsteri* community. Finally they can be succeeded to be the climax community like *Ganua motleyana* community which composed of many swampy species with close IV that was not so high.

4). *Melaleuca cajuputi* Community Type

This type is dominated by *Melaleuca cajuputi* that wildly distributed in many areas of secondary PSF. This community included 5 stands of Toh Daeng PSF. They can be divided into two sub-types according to the distribution of other species.

First sub-type, is represented by the stand that *Melaleuca cajuputi* is the dominant species and mixed distribution with other species, varying from few species to many species (3-22 species).

Stand 7 (ST), *Melaleuca cajuputi* is dominant species with IV=122.96, whereas secondary dominant species are *Eugenia gageana and Ilex cymosa* which IV =27.95 and 23.50 respectively. *Melaleuca cajuputi* covers 86.49 % and 75 % frequency. Other 21 species are only 1-3 % though they showed closely percent of frequency, (43.75 - 56.25 %). There are 2 interesting stands of this sub-type mixed with other species. Stand 10 (MR), is interesting of presenting of *Macaranga pruinosa* which is the pioneer species of open primary PSF and *Melaleuca cajuputi* also showed strong dominated with IV=288.35. Stand 11 (MN), has 98.81 % cover of *Melaleuca cajuputi* with high IV (240.85) while other 6 species were only 1.09 percents. *Symplocos adenophylla* is second dominant species, IV = 31.84 though it has low percent of covering.

Second sub-type, There are 2 single species stands that has only *Melaleuca cajuputi* which showed the highest IV=300 (stand 8, 9). These stands showed differences in frequency and density of *Melaleuca cajuputi*, furthermore their differences in the lower plants, such as *Medinilla crassifolia, Melastoma decemfidum* while ground covers are *Stenochlaena palustris, Lygodium microphyllum, Nepenthes gracilis, Cyperus spp., Lepironia articulata* and grasses.

The soil pH range of the single species stand of *Melaleuca cajuputi* are very low (pH 2.7 - 3.85). The organic matter are also very low, in the other words it is rather poor soil condition. The average % OM of upper soil, upper lower soil and lower soil, are 12.25 , 2.36 and 1.33 respectively.

Plant community of Toh Daeng composes and presents of higher diversity and stability than plant community of Kuan Kreng. *Eugenia kunsteri* community type (stand 1,5 and 3), *Ganua motleyana* community type (stand 2), *Macaranga pruinosa* community type (stand 4,6) are located in preservation zone of primary PSF. The other 5 stands (stand 7, 8, 9, 10 and 11) of both sub-types of *Melaleuca cajuputi* community are in conservation and development zone of secondary PSF. As the result this forest area would be rezoned the land use because the vegetation composition have been changed.

1.5 <u>Characterictics of Soil in PhruToh Daeng.</u>

In Thailand, peat refers to soils that have an organic matter content of more than 20 percent and the organic layer is commonly thicker than 40 cm which commonly occur in association with acid sulfate soils. According to Department of Land Development (1984, 1995) the survey of soil classification of peatland are divided into 4 groups base on organic matter content. Soils of eight different depth within 125 cm. depth of this studied stands were categorized into 3 groups, thick peat that has peat layer thicker than 120 cm., moderate or shallow peat that has peat layer between 40-120 cm. and acid sulfate soil that has peat layer < 40 cm.. The distribution of organic matter contents of these soils and soil data analysis were shown in Table 6 and Figure 22.

1.5.1. Thick peat

This soil group represents the soils containing a peat layer thicker than 120 cm. This soil was classified as the Narathiwat series and considered to be part of the dysic, isohyperthermic family of Typic Tropofibrists (Vijarnsorn, 1995). The peat layers were more or less undecomposed, mainly consisting of fibers or woody fragments of various sizes, and extremely acidic.

Thick peat was found only one stand of Phru Toh Daeng :

1) Stand 4 (PW) show peat layer as deep as 125 cm. depth. Average OM content is 41.82, and at a layer at 31-45 cm. depth, it has the highest OM content. Peat consists of fibers and woody fragments of various sizes. The average soil pH was 4.3.

1.5.2 Shallow to moderately thick Peat

This group includes soils which have a peat layer as thick as 40 to 120 cm. The underlying materials mainly consist of unripe marine clay which is rich in pyrite content. At present, these soils are classified as the Kab Daeng series and belong to the family of loamy, dysic, isohyperthermic, Terric Tropohemists (Vijarnsorn, 1995). The peat layer is somewhat well decomposed and extremely acidic. The pyretic mudclay is generally found at the depth of between 50-100 cm from the soil surface.

Table 6 Data Analysis of environmental variable of 20 study stands of TD and KK PSF.

	Star	DIM.	DIM.	DIM.	OM1	OM2	OM3	OM4	OM5	OM6	OM7	OM8	pH	Conc	Ca	Mg	K	Na	EA	CEC	S %(B/C	W-pH	W-EC	W-Al	W-Ca	W-Mg	W-Fe	W-Mr	W-Cu	W-Zn	W-Al	W-SO4	W-NH	W-NC	W-DC	W-Hard	W-Turb
PD	1	-0.95	-0.53	-0.05	55.97	43.48	39.45	8.12	5.08	4.67	4.66	4.16	4.24	0.62	3.92	7.49	0.22	0.44	44.38	30.45	52.52	6.20	271.50	0.07	28.55	4.93	2.17	1.01	0.00	0.05	0.22	78.00	0.43	0.00	5.48	91.47	11.11
KU	2	-0.86	0.12	0.06	62.55	72.31	63.54	58.78	42.90	29.66	16.42	10.77	3.80	0.42	0.96	0.55	0.28	0.28	104.50	67.55	5.33	4.75	87.00	0.06	3.24	0.79	1.17	0.02	0.03	0.01	1.41	65.25	1.29	0.43	4.28	11.24	61.53
KL	3	-0.91	-0.14	0.04	66.28	62.26	64.57	82.48	51.47	14.22	12.29	10.18	3.90	0.79	3.41	4.35	0.20	0.31	80.25	47.61	23.75	6.13	71.25	0.03	3.83	1.92	4.83	0.07	0.00	0.05	0.19	24.75	0.43	0.19	7.10	15.13	163.05
PW	4	-0.96	0.07	-0.56	47.83	49.13	59.73	35.33	46.92	40.51	30.79	24.33	4.34	0.14	1.82	1.33	0.18	0.18	69.63	46.84	7.47	6.33	97.50	0.06	1.73	1.74	6.12	0.31	0.00	0.06	0.23	138.00	3.02	0.00	7.10	15.05	66.80
TD	5	-0.94	-0.37	0.14	83.30	68.99	71.50	46.93	65.42	61.94	33.84	10.71	4.44	0.12	3.06	1.26	0.10	0.23	98.38	46.04	9.97	5.70	33.75	0.02	1.75	0.41	1.41	0.52	0.04	0.01	0.07	12.25	0.62	0.96	6.90	6.02	7.46
LB	6	-0.89	0.18	-0.18	37.38	32.65	38.06	16.64	5.36	1.44	1.59	1.04	4.23	0.10	1.36	2.96	0.07	0.08	61.38	0.00	0.00	5.05	348.50	0.09	5.13	5.75	6.64	0.05	0.03	0.02	0.81	62.00	29.75	0.43	3.78	36.48	117.81
KS	7	-0.59	0.17	0.28	41.97	6.09	4.13	2.80	3.44	5.11	5.38	5.87	3.89	0.81	1.74	4.18	0.16	0.52	16.58	6.56	42.37	5.65	114.50	0.03	3.29	2.11	1.26	1.23	0.00	0.06	0.09	15.75	0.86	1.15	5.98	16.88	10.69
KP	8	1.85	-0.07	-0.06	3.20	1.20	0.54	1.98	0.62	0.19	0.14	2.77	3.29	0.68	0.42	0.40	0.06	0.12	9.64	0.99	10.72	4.90	167.00	0.02	3.81	3.55	3.85	0.04	0.02	0.08	0.44	51.50	0.43	0.29	8.00	24.10	160.85
BY	9	1.33	-0.03	-0.03	2.99	0.78	0.82	0.62	1.19	1.86	4.70	5.93	3.29	1.39	1.02	3.50	0.07	0.31	13.15	4.90	35.02	4.43	696.00	0.01	23.15	12.40	6.47	0.11	0.02	0.07	1.02	237.50	3.02	0.00	8.15	108.72	7.04
MR	10	-0.16	0.08	0.01	17.91	2.11	2.63	2.49	2.94	4.19	2.67	1.54	3.09	1.73	0.61	0.55	0.20	0.16	10.21	1.37	4.63	5.43	1425.00	0.02	12.98	11.27	25.21	0.06	0.02	0.04	1.68	139.75	0.43	0.00	7.95	78.71	10.43
MN	11	0.12	0.06	0.01	13.73	14.42	4.93	7.66	13.04	5.06	5.81	4.65	3.85	1.24	2.52	5.71	0.17	0.27	72.38	17.10	54.55	4.93	272.00	0.01	4.76	4.34	32.94	0.25	0.03	0.08	0.93	97.50	1.30	0.00	6.48	29.72	114.80
SL	12	0.12	0.05	0.01	23.54	20.92	3.66	9.13	14.29	14.83	13.88	11.14	3.54	0.93	1.99	5.03	0.34	0.63	68.32	34.71	23.32	5.70	349.75	0.08	6.02	12.22	1.10	0.45	0.01	0.01	1.46	157.25	3.84	1.48	7.13	65.22	9.94
HP	13	2.21	-0.09	-0.04	71.27	68.66	17.00	61.77	63.99	65.87	56.03	69.46	3.91	0.93	4.76	2.99	0.24	0.47	115.83	63.89	14.61	6.30	104.25	0.03	3.90	2.17	2.05	0.33	0.03	0.00	0.00	79.25	0.86	0.21	5.65	18.60	13.74
KT	14	-0.02	0.07	0.10	31.30	33.79	42.14	28.75	53.15	11.68	12.88	33.61	4.66	0.17	12.42	2.85	0.16	7.52	72.20	43.00	54.30	6.13	3227.50	0.03	37.86	59.74	1.45	0.09	0.03	0.01	0.02	240.75	4.96	0.21	7.15	340.28	63.98
KR	15	-0.43	0.11	0.07	46.58	27.30	31.02	24.34	48.98	49.19	60.50	61.05	3.53	2.00	11.17	5.00	0.17	0.59	111.70	50.93	31.29	5.68	215.25	0.04	10.16	3.73	1.31	1.28	0.01	0.02	0.87	93.00	1.73	0.53	5.80	40.68	111.00
SM	16	1.37	-0.01	-0.01	34.63	27.58	15.41	1.40	2.10	0.86	0.81	1.08	3.66	0.86	2.25	4.45	0.25	0.59	59.03	18.69	51.22	5.30	291.00	0.03	8.22	11.10	2.41	0.29	0.02	0.00	1.23	110.50	1.71	0.64	7.30	66.20	124.56
TM	17	0.86	0.01	0.01	50.56	36.85	28.50	11.96	6.82	9.90	8.95	7.84	3.06	3.20	3.62	5.40	0.08	0.20	94.96	26.21	44.28	5.40	441.10	0.04	19.54	14.32	5.73	0.24	0.02	0.02	1.05	205.50	0.65	0.00	5.38	107.68	99.97
KW	18	-0.42	0.12	0.07	19.88	13.50	12.57	12.88	11.47	11.27	10.22	6.17	2.86	4.02	4.80	10.03	0.04	0.10	75.43	17.55	88.19	6.43	209.00	0.04	4.54	6.48	6.85	0.12	0.04	0.00	0.01	97.00	2.65	0.96	6.45	37.96	179.60
BP	19	-0.61	0.13	0.05	24.25	8.94	20.31	11.80	4.55	5.07	5.23	4.82	3.28	2.28	5.42	8.83	0.18	0.35	49.31	21.59	72.21	6.60	128.75	0.06	3.37	3.82	5.22	0.07	0.04	0.02	0.00	57.75	1.69	0.53	6.35	22.27	231.25
YN	20	-0.12	0.10	0.07	20.44	33.45	36.59	41.41	17.52	38.10	0.99	0.74	4.69	0.25	8.47	2.26	0.15	0.35	65.67	29.38	46.00	6.43	147.75	0.07	6.58	3.31	3.28	1.04	0.01	0.01	0.00	29.00	3.01	0.00	4.58	29.96	296.98

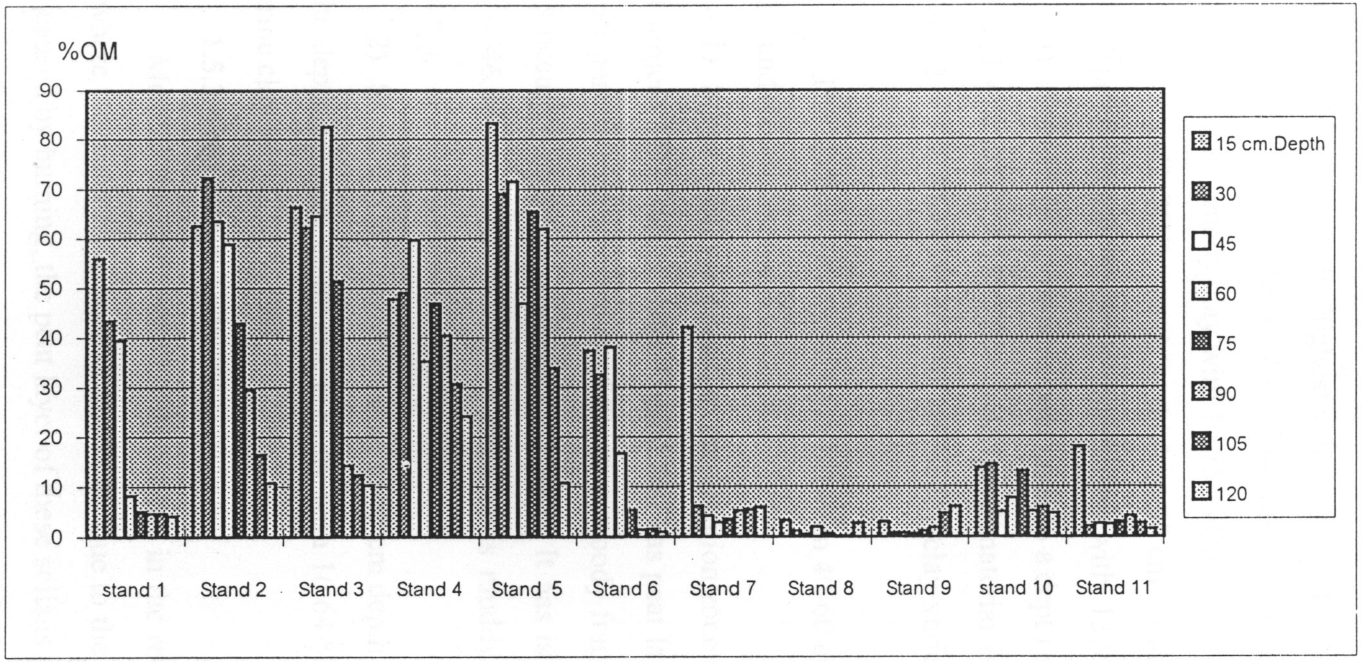


Figure 22 Soil OM Distribution in Toh Daeng PSF.

The moderate peat (peat layer between 60-120 cm.) was found in stand 5, 2 and stand 3.

1) Stand 5 (TD) has peat layer yp to 105 cm. depth with average OM content about 51.70 % which is the highest value for Toh Daeng PSF. Soil pH is 3.98. Upper peat layer consists mainly of fibers or woody fragments. The underlying material below 106 cm. is muddy clay with 10.75 % OM.

2) Stand2 (KU), peat is as thick as 90 cm. It has 54.95 % OM and soil pH is 3.25. The soil below 90 cm. is muddy clay with 13.96 %OM.

3) Stand 3 (KL) contains peat layer to a depth of 75 cm. It has 64.41% OM and soil pH is 4.18. The underlying material is muddy clay with pH rangeing from 3.2 – 3.9. The OM content of muddy clay varied from 10.18 to 13.25 %.

The shallow peat (peat layer between 40-60 cm.) is found in 2 stands (stand 1 and 6).

1) Stand 1 (PD) is located in preservation zone but closed to irrigation development project. The soil is water-logged and has peat layer as thick as 45 cm., while the upper part (0-15 cm.) consists of fibers or woody fragments of various sizes. Loose peat is occurred at the depth between 16-45. It has is dark brown color and contant OM ~ 46.30 %. The underlying material is muddy clay with a low OM content (5.34 %).

2) Stand 6 (LB) contain peat up to 45 cm depth with % OM, 36.03. The soil at the depth between 46-60 cm. is peaty with 16.64 % OM. The soil below 61 cm. is marine clay with 2.36 % OM.

1.5.3 Acid sulfate soils

Most of the acid sulfate soils occupy in the reclaimed swampy areas or the areas where the water have been drained out. Due to the subsidence of the peat layer mainly caused by burning, the peat layer of these soils is somewhat thin, usually less than 40 cm thick. As a consequence, a pyritic mud clay is commonly found within 1 m. from the soil surface. Thus, upon oxidation, the soils become extremely acidic and jarosite mottles appear from place to place.

Acid sulfate soil is found in 5 stands, this indicates the severe disturbance of peat swamp forest. Brief description for the soil of 5 given stands can be made as follows.

1) Stand 7 (KS), peat layer is very thin (15 cm. thick). It contains OM 41.97 %. The underlying material is marine clay with 4.65 %OM.

2) Stand 8 (KP) is a typical acid sulfate soil with very thin peat layer.

3) Stand 9 (BY) is also a typical acid sulfate soil with clayey texture. The surface soil is mostly covered by Melaleuca leaves.

4) Stand 10 (KR) consists of the soil having a thin peat layer (< 15 cm. thick) which inturn overlies a stiff light grey clay to a detph of 60 cm. The underlting material is marine clay with 2.65 % OM. Litters are found in abundance over the soil surface.

5) Stand 11 (MN) contains peaty clay to a depth of 30 cm. It has 124.48 % O.M. The soil is rather compact. The underlying material is marine clay with 5.80 % OM.

1.6 Classification of Plant Community of Phru Toh Daeng.

1.6.1. Plant Community Classification by SLCA

Classification by importance value of 11 stands in Toh Daeng PSF value shown in the Figure 23, demonstrated three groups of plant community. First group show the close relation pair of BY and KP, representing the only one species of *Melaleuca cajuputi* with 0% Euclidean distance or it mean 100% similarity. They also present a close relation to the pair of MN and MR which have more species with *Melaleuca cajuputi* whereas they have close relation to KS which have high species diversity. Therefore, this group is called Melaleuca group. The second group are the pair of PD and TD dominated by *Eugenia kunstieri* which is similar to KL and show high species diversity. This *Eugenia kunstleri* group has the similarity to KU which dominated by *Ganua motleyana* and has the highest H′. At this moment, the third group including PW and LB shows the longer distance.

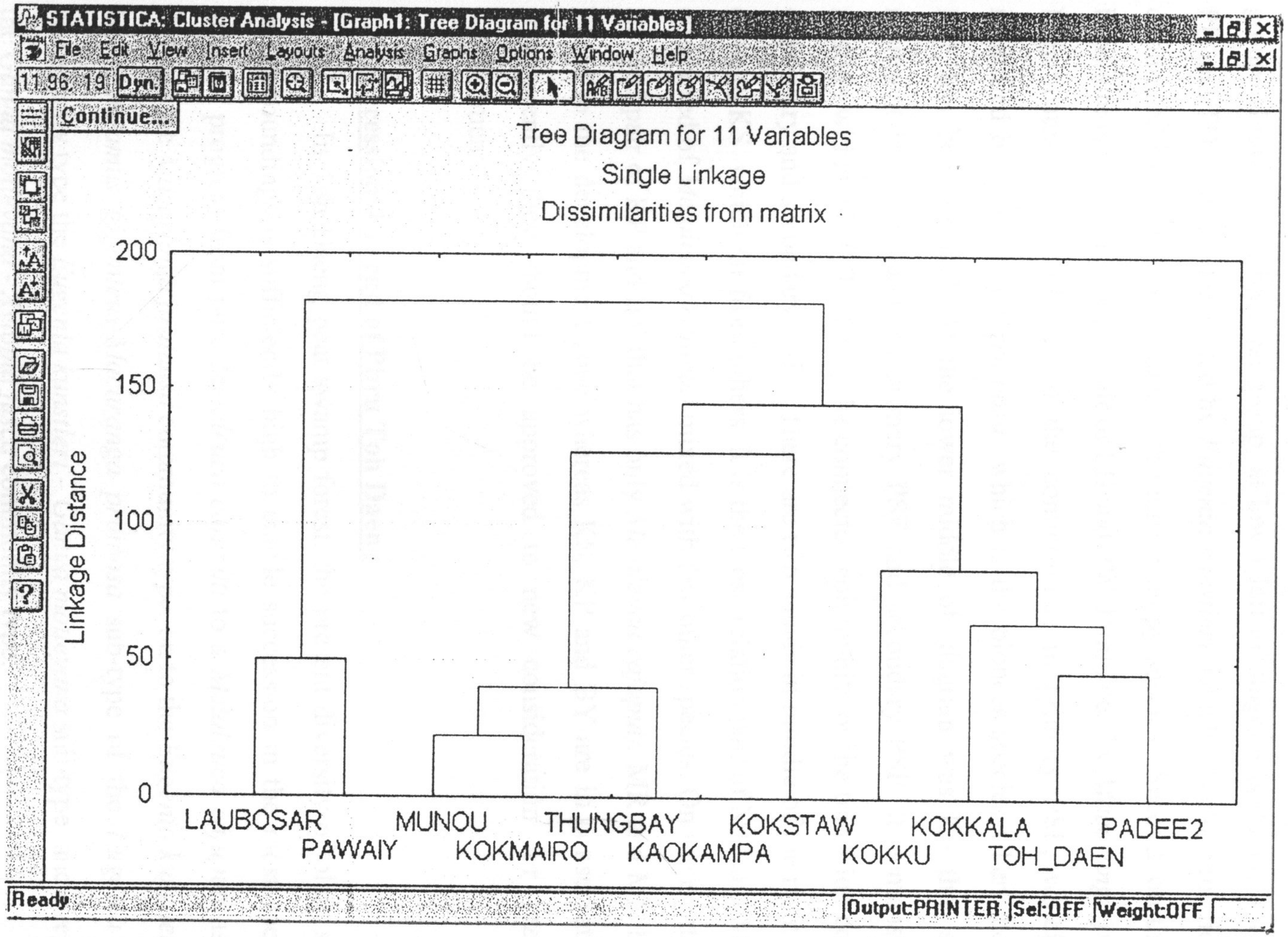


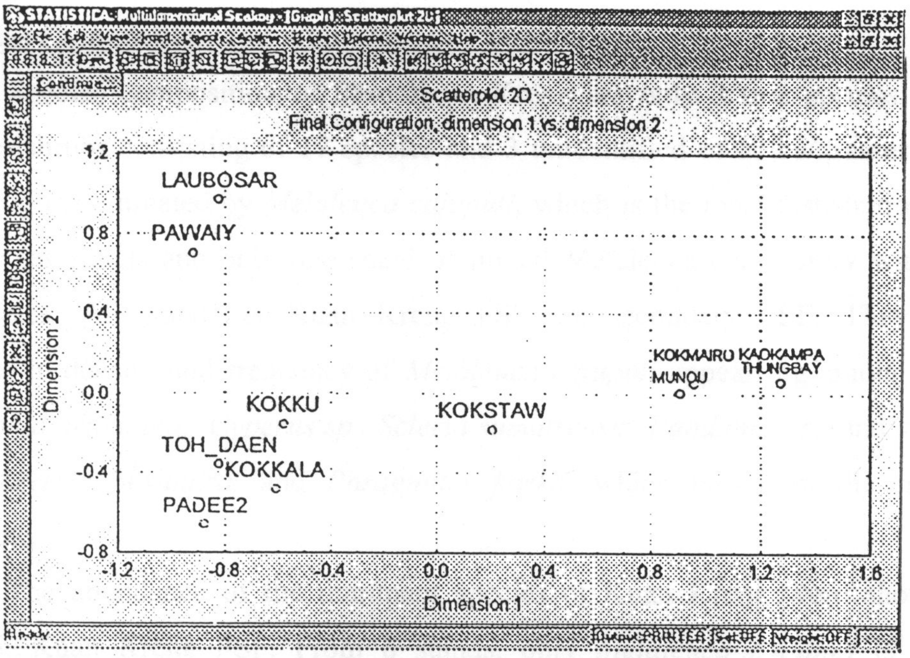
Figure 23 Classification of 11 stands of Toh Daeng PSF(SLCA)

1.6.2 Stand Ordination of Phru Toh Daeng.

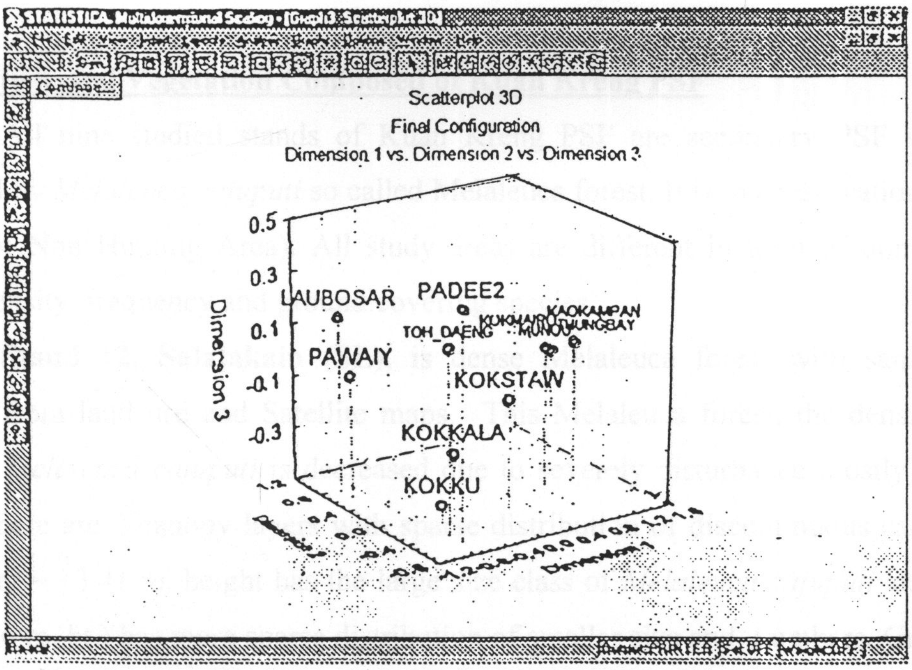
The results showed the close relation which can be divided into 4 groups (Figure 24 a, b). First group, at lower left of diagram is the close relation of PD and TD, and KL dominated by *Eugenia kunstleri*, which has close relation to KU, dominated by *Ganua motleyana* with more swampy species. Second, on the top left hand site is the close relation pair of LB and PW dominated by *Macaranga pruinosa*. It indicates the disturbance of the communities in primary PSF, which can be identified by *Macaranga pruinosa* which is the pioneer species when the primary PSF has been opened. At the lower middle of diagram was KS that separately represent between stands of primary PSF and secondary PSF. It demonstrates the relation within TD PSF. KS is the connected community or the transition community of primary and secondary PSF. There are two stands in middle of the right hand site close to KS which far from others. It is the close relation pair of MN and MR, which composed of *Melaleuca cajuputi* mixed with few other species. On the right diagram, showed pair of KP and BY that has only *Melaleuca cajuputi.* MR and MN have been zoned to the development zone whereas KS, KP and BY are in conservation zone, consequently they should be approved to new consideration for rezoning or development.

1.7 Successional Trend of Phru Toh Daeng

In Toh Daeng peat swamp forest, the present diversity of plant species in the surroundings is sufficiently high to enable succession in the most species-poor areas to progress from pure *Melaleuca cajuputi* to a *Melaleuca cajuputi* association through the *Macaranga pruinosa* community type, on to the *Eugenia kunstleri - Goniothalamus giganteus-Macaranga pruinosa* sub-type of the *Eugenia kunstleri* community type the *Eugenia kunstleri – Ganua motleyana* sub-type and eventually to the *Ganua motleyana - Xylopia fusca* community type.



a)



b)

<u>Figure 24</u> Stand ordination of NMDS of Toh Daeng PSF:
a) two dimension b) three dimension

II. Phru Kuan Kreng

2.1. Species Composition and Abundance of Vegetation

Species composition of Phru Kuan Kreng are only 3 tree species and 3 small trees/shrubs consisting of 17 species and 3 unidentified of herbs/grasses. Phru Kuan Kreng is dominated by *Melaleuca cajuputi*, which is the most distribution of 8 single species stands and only one stand of mixed Melaleuca community with two other species. All stands of Kuan Kreng PSF are secondary PSF. They have differences in density and frequency of *Melaleuca cajuputi* appearring among herbs are *Lepironia articulata, Cyperus sp., Scleria sumatrensis, Pandanus sp.*, and grasses such as *Leersia hexandra,* and *Phragmites karka,* which based on the rate of disturbance.

The abundance of the dominant species of Kuan Kreng were shown in Figure 25. Kuan Kreng PSF. From 8 stands, only *Melaleuca cajuputi* is found (Shannon Index, H′ = 0) except stand 13 (Hua Pakaew = HP) having two other species, *Bombax sp.* and *Mitragyna javanica.*

2.2. Structure and Vegetation Composed of Kuan Kreng PSF

All nine studied stands of Kuan Kreng PSF are secondary PSF which dominated by *Melaleuca cajuputi* so called Melaleuca forest. It is in conservation area (Taley Noi Non Hunting Area). All study areas are different in term of dominant species, density, frequency and ground covering species.

Stand 12, Salatakain (SL), is dense Melaleuca forest with sampling identified from land use and Satellite maps. This Melaleuca forest, the density of large size *Melaleuca cajuputi* is decreased due to severely disturbance mostly from cutting. There are 2 canopy layers with sparse distribution of discontinuous canopy. Upper layer ~ 13.41 m. height has the large size class of *Melaleuca cajuputi* and the lower (~5.6 m. ht.) has more sparse distribution of smaller size and numbers. Ground cover is mainly composed of *Scleria sumatrensis* and *Eleocharia ochrostachys* with some *Stenochlaena palustris, Lygodium microphllylum* and *Phragmites karta.*

Stand 13, Hua Pakaiew (HP), is a dense Melaleuca forest with a large number of *Melaleuca cajuputi.* Most of the upper layer were middle size class and

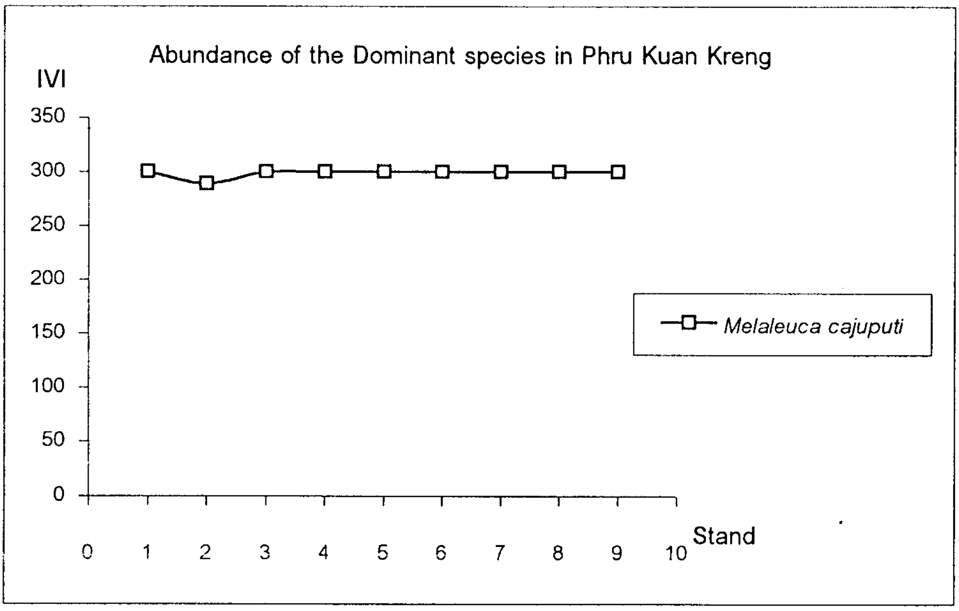


Figure 25 Abundance of the Dominant species in Phru Kuan Kreng.

Stand no. 12 : SL
Location : Salatakain, (NKS)
UTM : 234864
No. of Species : 1
No. of trees (S) : 167
Shannon Index : 0
Simpson Index : 0
Evenness Index: ∝

Sciencttific Name	RD	RF	Rdo	IVI
1. *Melaleuca cajuputi*	100	100	100	300
1 sp.	100	100	100	300

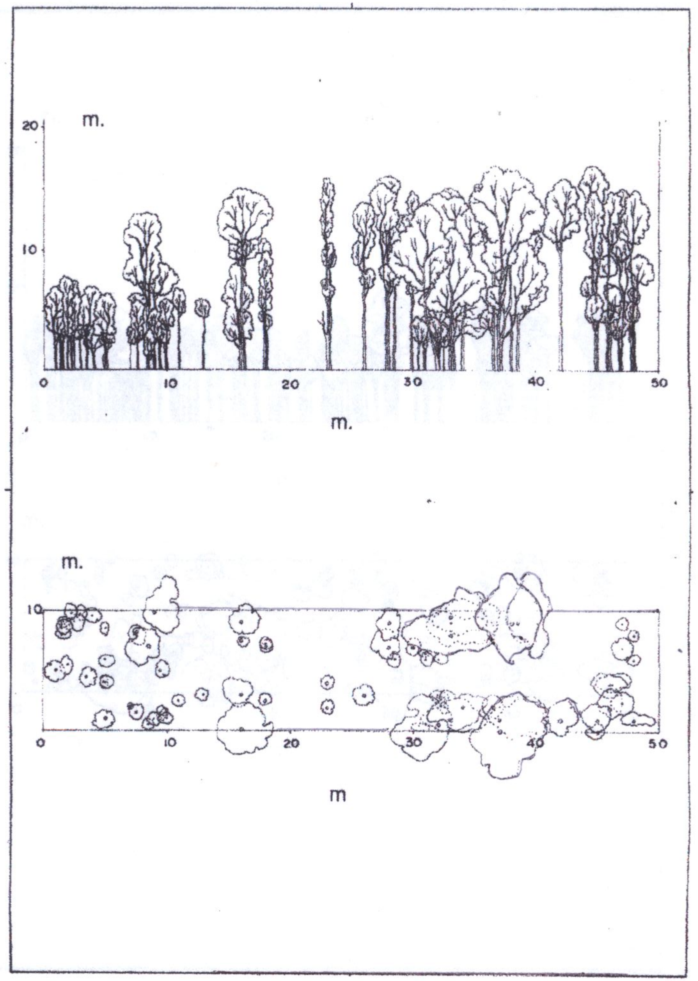


Figure 26 Structure, profile, and quantity characteristics of stand 12 (SL)

Stand no. 13 : HP
Location : HuaPakaew, NW
UTM : 223673
No. of Species : 3
No. of trees (S) : 514
Shannon Index : 0.0407
Simpson Index : 0.0078
Evenness Index : 0.0370

Sciencetific Name	RD	RF	Rdo	IVI
1.*Melaleuca cajuputi*	99.610	88.889	99.999	288.498
2.*Bombax sp*	0.195	5.556	0.000	5.751
3.*Mitragyna javanica*	0.195	5.556	0.001	5.752
1 sp.	100	100	100	300

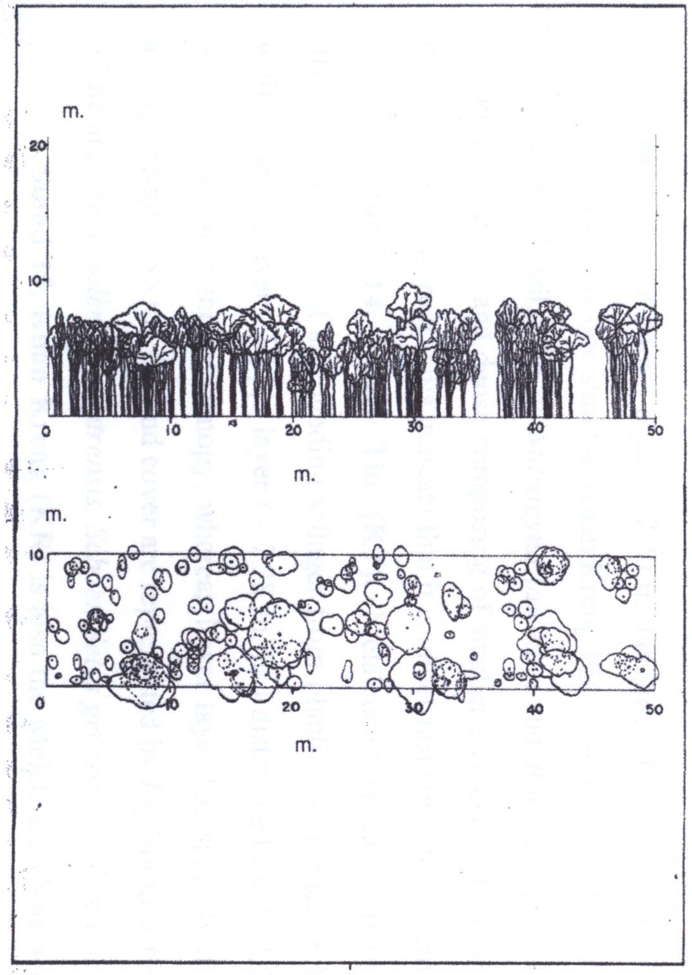


Figure 27 Structure, profile, and quantity characteristics of stand 13 (HP)

rather smaller and medium high (~ 7.20 m. height), while lower layer was ~ 5.73 m.high. It is the only one stand of Kuan Kreng PSF that mixed with two more species with sparsely distribution of *Mitragyna javanica* and *Bombax sp.*. Undergrowth is continuous canopy and dense composing of smaller size class of sapling and seeding of *Melaleuca cajuputi.* This indicate that it is under fast substituted growth.

Stand 14, Kuan Tin (KT), Melaleuca-Cyperace stand, is formerly disturbed because of surrounding villager from planting Cyperace. KT is composed with 2 canopy layers. Upper layer (~ 7.38 m. ht.) distributed by *Melaleuca cajuputi* which are open in the top canopy, whereas lower layer has sparsely distributed with average height 3.86 m.. Ground cover are represented by *Lepironia articulata.* Almost of the area have *Scleria sumatrensis, Schoenpletus grossus* and few *Phragmites karta.*

Stand 15, Kuan Kreng (KR) is also the Melaleuca-Cyperace stand which sparsely covered by small size class and low trees of *Melaleuca cajuputi* with average height only 3.37 m.. They were almost died because of water logged for a long period in wet season and consequently this site is suitable for Cyperace substitute growing. Ground cover is dominated by *Sceria poaeformis* and some *Schoenpletus grossus.* Unfortunately, this area was burned in the dry season. According to the frequent disturbance for a long time, the Disturbed-Melaleuca are gradually changed and finally become Cyperace-grasses, the common Grasses swamp.

Stand 16, Samed-ngam, (SM), a Disturbed-Melaleuca forest, is severely disturbed by cutting and burning every year. Therefore, it has distributed with only middle and small size class of *Melaleuca cajuputi* with height from 3-9.5 m.. SM is composed of 2 layers, upper and lower layer with average height 7.85 and 5.24 m. respectively. According to small sizes and cutting invasion, many gaps of crown cover occur. These gap therefore have once become suitable habitat for growth of cyperaces and grasses especially *Scirpus mucronatus* and *Leersia hexandra.*

Unfortunately these cyperaces and grasses are good materials for burning in the dry season, as the result, this area was frequently burning.

Stand 17, Kuan Taley Mong (TM) is a disturbed Melaleuca forest. There are 2 layers. The upper layer (9.98 m.) has continuous canopy of *Melaleuca cajuputi* nearly 80 % of the stand except the edge of stand. The lower layer has ~ 5.43 average height. Ground cover has a few species with dense distribution of *Stenochlaena*

Stand no. 14 : KT
Location : Kauntin, NKS
UTM : 191792
No. of Species : 1
No. of trees (S) : 143
Shannon Index : 0
Simpson Index : 0
Evenness Index: ∝

Sciencetific Name	RD	RF	Rdo	IVI
1.*Melaleuca cajuputi*	100	100	100	300
1 sp.	100	100	100	300

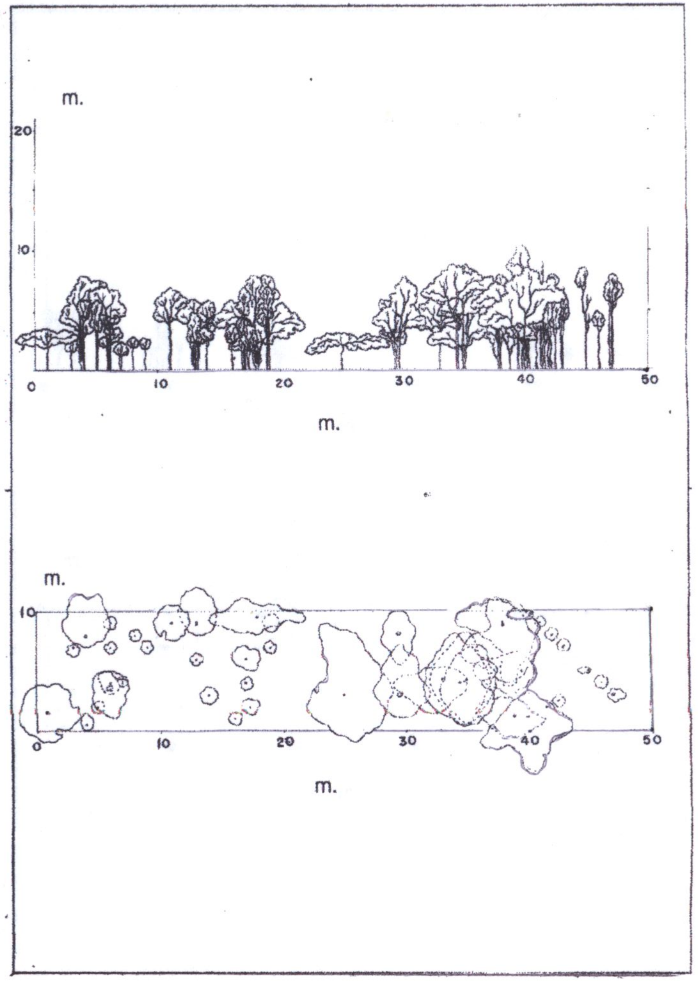


Figure 28 **Structure, profile, and quantity characteristics of stand 14 (KT)**

Stand no. 15 : KR
Location : KaunKreng, NKS
UTM : 211741
No. of Species : 1
No. of trees (S) : 69
Shannon Index : 0
Simpson Index : 0
Evenness Index: ∝

Sclenctific Name	RD	RF	Rdo	IVI
1.Melaleuca cajuputi	100	. 100	100	300
1 sp.	100	100	100	300

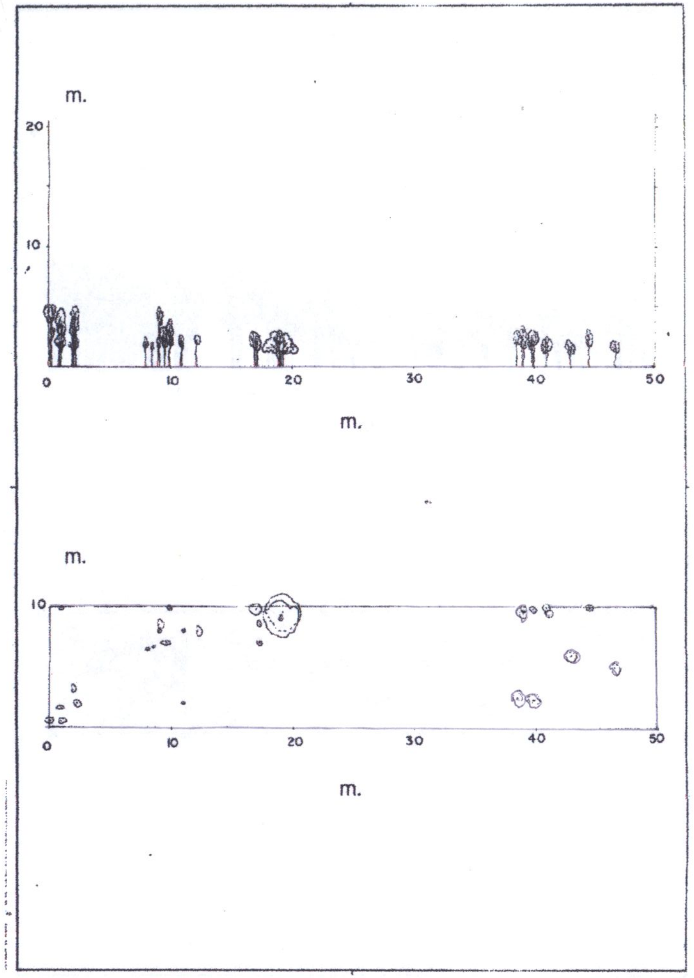


Figure 29 Structure, profile, and quantity characteristics of stand 15 (KR)

Stand no. 16 : SM
Location : Samet-ngam, NKS
UTM : 252791
No. of Species : 1
No. of trees (S) : 374
Shannon Index : 0
Simpson Index : 0
Evenness Index: ∝

Sclenctific Name	RD	RF	Rdo	IVI
1 *Melaleuca cajuputi*	100	100	100	300
1 sp.	100	100	100	300

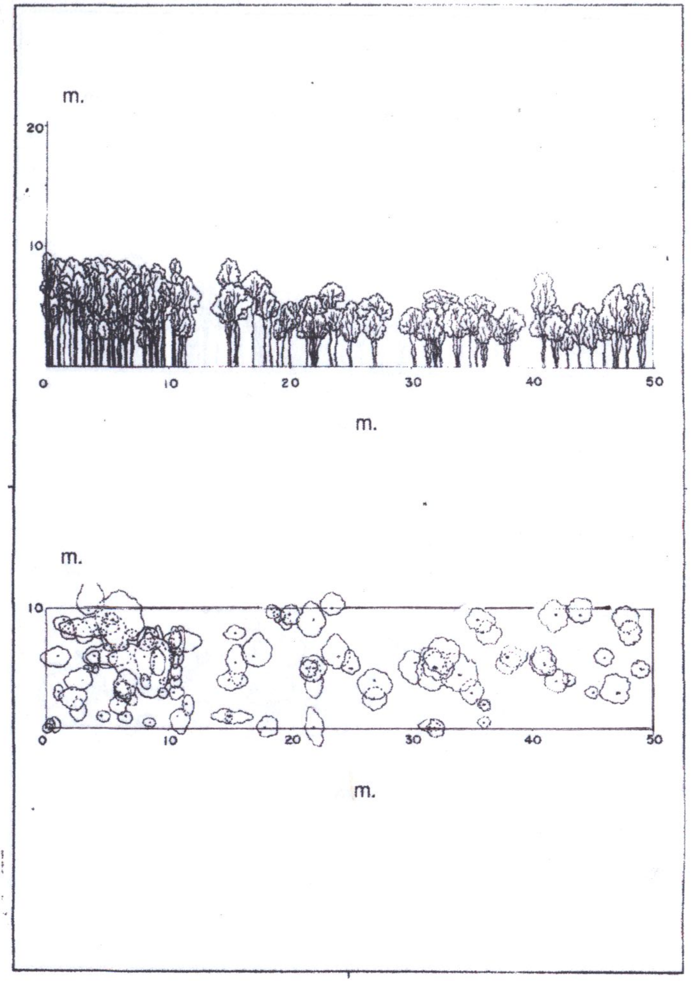
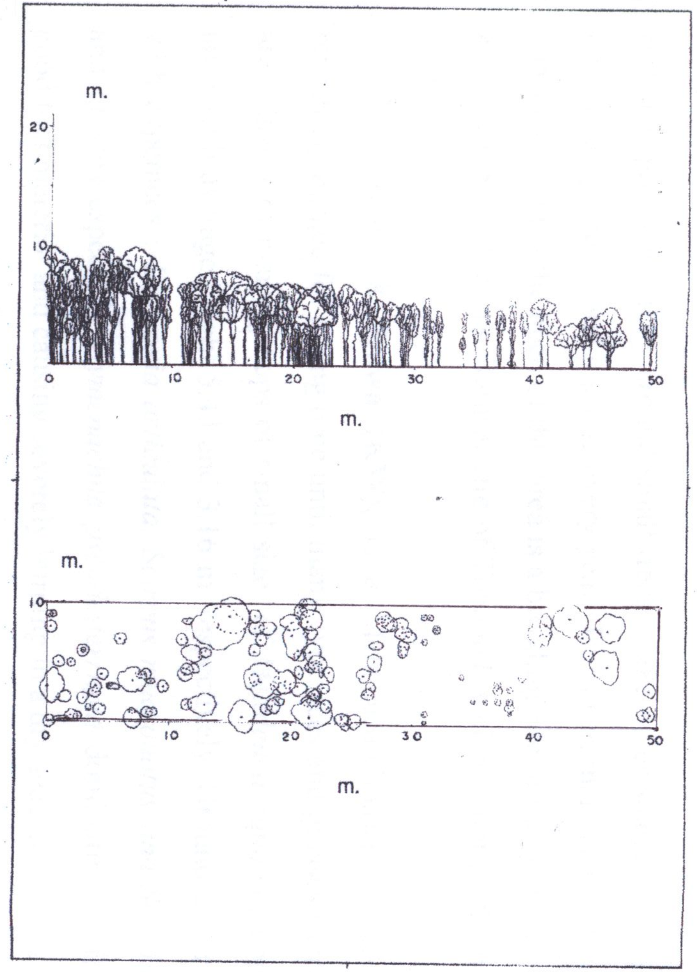


Figure 30 Structure, profile, and quantity characteristics of stand 16 (SM)

Stand no. 17 : TM
Location: Kaun Tlaymong, NKS
UTM : 270745
No. of Species : 1
No. of trees (S) : 289
Shannon Index : 0
Simpson Index : 0
Evenness Index : ∝



Scienctific Name	RD	RF	Rdo	IVI
1.Melaleuca cajuputi	100	100	100	300
1 sp.	100	100	100	300

Figure 31. **Structure, profile, and quantity characteristics of stand 17 (TM)**

palustris growing tightly around small trees. Like other stands, it is also severely disturbed by cutting and burning every year. However, there is an interesting point to consider. That is the open of this area is a breeding site of many waterbirds similar to Kuan Khi Sein, the first Ramsar site of Thailand, which is not so far from this study area.

Stand 18, Kuwa (KW), is a Melaleuca-Grasses stand. This area is repeatedly burned for a long time until many cyperaces and grasses succeeded . There are 2 layers of many groups of small size of *Melaleuca cajuputi,* upper and lower layer with average height 5.43 and 3.16 m. respectively. Ground cover is distributed with cyperaces : *Lepironia articulata, Scirpus mucronatus and Scleria sumatrensis* and grasses especially *Hymenachne pseudinterrupta* dominating in this stand is a good fuel material and causing severely burning in a dry season.

Stand 19, BanPran (BP), is represented with grasses covering all areas and dominated by *Phragmites karta,* and some other grasses. This stand has only 2-3 trees and some saplings of *Melaleuca cajuputi.*

Stand 20, YuanNok (YN), is another Melaleuca-Cyperace stand composing of 2 layers of *Melaleuca cajuputi* with average height 5.78 and 3.41 m., respectively. Ground cover is dense with *Lepironia articulata* and some *Sceria poaeformis.*

2.3 Plant community type of Phru Kuan Kreng.

Plant communities of Kuan Kreng are secondary PSF due to strongly disturbed for long time until all of preserve area covered by Melaleuca forest.

There is only *Melaleuca cajuputi* community type in all 9 stands of this PSF (stand 12-20). Eight stands of them are single species stands of *Melaleuca cajuputi.* Only stand 13 (HP) that has other two associated species, *Mitragyna javanica* and *Bombax sp.* (see table 5).

All communities show the differences in frequency and density of *Melaleuca cajuputi*, especially in the lower plants, such as *Medinilla crassifolia, Melastoma decemfidum,* while ground covers are *Stenochlaena palustris, Lygodium microphyllum, Nepenthes gracilis, Cyperus spp., Lepironia articulata* and grasses.

Stand no. 18 : KW
Location : Kuwa, SK
UTM : 311694
No. of Species : 1
No. of trees (S) : 73
Shannon Index : 0
Simpson Index : 0
Evenness Index: ∝

Sciencitific Name	RD	RF	Rdo	IVI
1.*Melaleuca cajuputi*	100	100	100	300
1 sp.	100	100	100	300

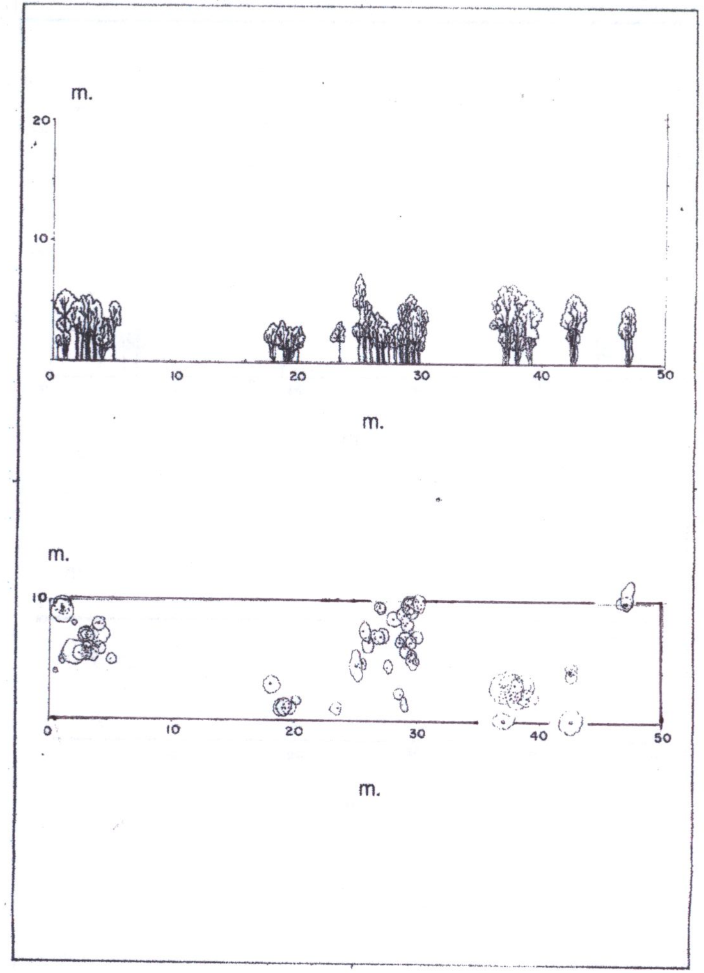
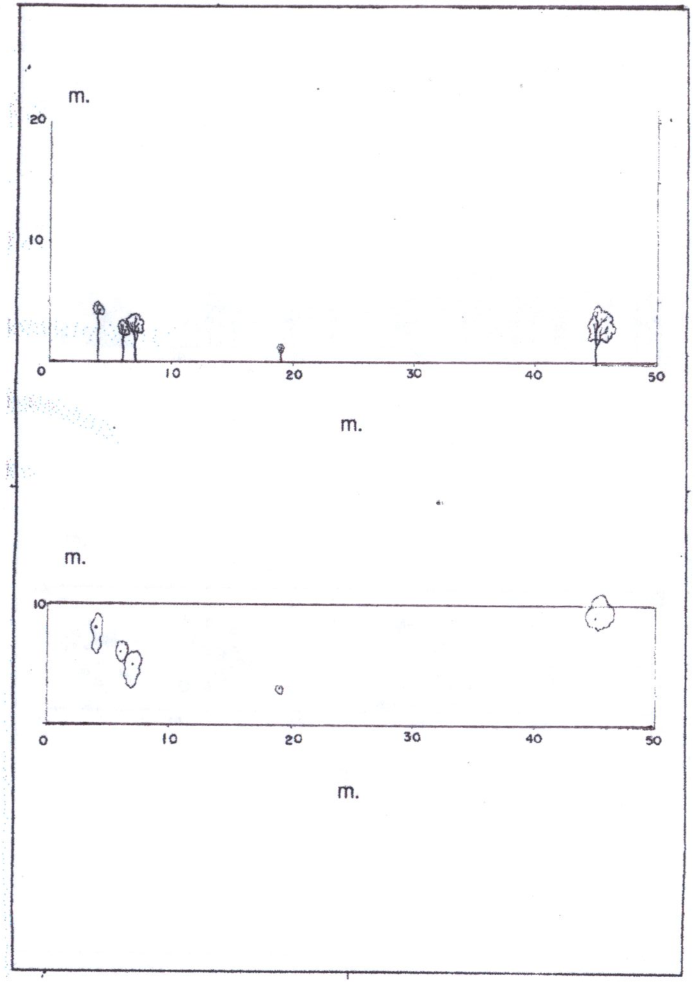


Figure 32. Structure, profile, and quantity characteristics of stand 18 (KW)

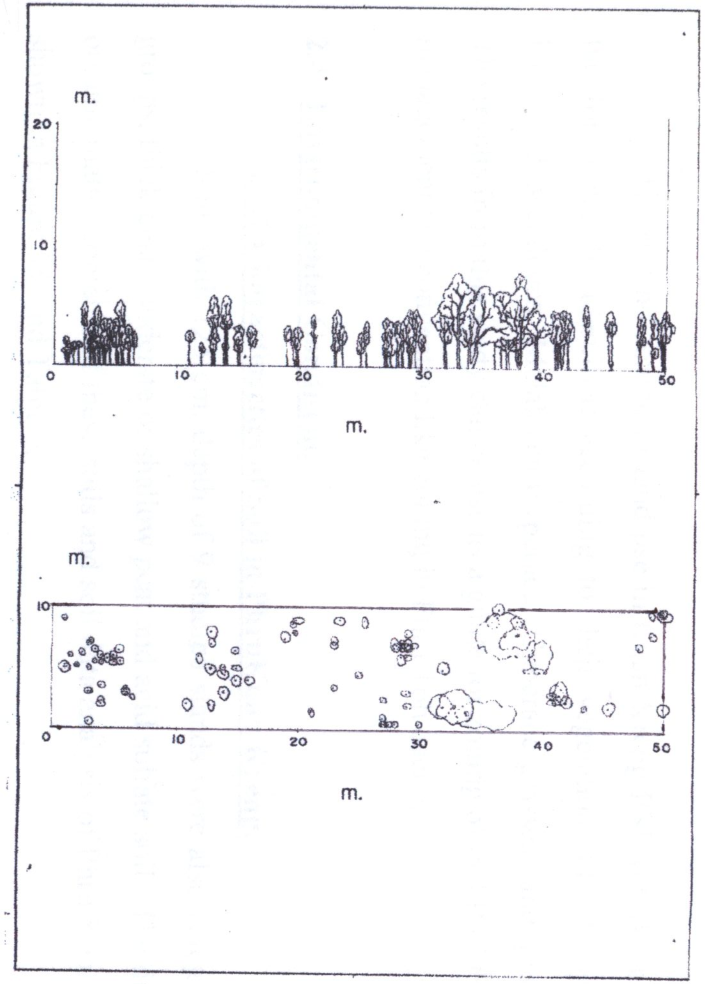
Stand no. 19 : BP
Location : BanPran, SK
UTM : 223663
No. of Species : 1
No. of trees (S) : 41
Shannon Index : 0
Simpson Index : 0
Evenness Index: ∝

Scienctific Name	RD	RF	Rdo	IVI
1.*Melaleuca cajuputi*	100	100	100	300
1 sp.	100	100	100	300



<u>Figure 33.</u> **Structure, profile, and quantity characteristics of stand 19 (BP)**

Stand no. 20 : YN
Location : Yuannok, NKS
UTM : 203714
No. of Species : 1
No. of trees (S) : 126
Shannon Index : 0
Simpson Index : 0
Evenness Index : ∝



Sciencetific Name	RD	RF	Rdo	IVI
1.*Melaleuca cajuputi*	100	100	100	300
1 sp.	100	100	100	300

Figure 34 **Structure, profile, and quantity characteristics of stand 20 (YN)**

There is no zoning of land use in Kuan Kreng PSF yet. At the moment, the forest can be identified according to their vegetation, like Dense-Melaleuca, Disturbed Melaleuca, Melaleuca-Cyperace, Cyperace-grasses, and grasses swamp. The results from this study can be use as a guide for zoning of this PSF for sustainable management and convention like zoning in Phru Toh daeng.

2.4 Environmental Condition.

2.4.1 Characterictics of Soil in PhruKuan Kreng.

Soils with 125 cm. depth of 9 studied stands were also categorized into 3 groups, thick peat, moderate or shallow peat and acid sulfate soil. The distribution of organic matter contents of these soils and soil data analysis of Phru Kuan Kreng were shown in Figure 35 and Table 6.

2.4.1.1. Thick peat (peat layer is thicker than 120 cm.)

1) Stand 13 (HP) shows peat layer all 125 cm depth with average % OM 59.26 and rather low in 31-45 cm depth. The soil is, dark brown and dark grey with pH 3.89.

2) Stand 15 (KR) is thick peat, with average % OM 43.62 and lower soil present better than upper soil. It is, dark brown to dark grey and dark and its pH was 3.53.

2.4.1.2 Shallow to moderate thick Peat

This group is distributed in 3 stands including moderate peat 2 stands and 1 stands of shallow peat. The moderate peat (peat layer is 60-120 cm. thick) is found in stand 14 and stand 20.

1) Stand 20 (YN) contains peat as thick as O.M of peat range from 17.52 to 38.10 %, with pH about 4.69. The underlying material is marine clay with 0.87 % O.M.

2) Stand 14 (KT), peat layer is 75 cm. thick with OM ~ 37.83 % and soil pH 4.55. The underlying material to a depth of 105 cm. consists of muddy clay with 12 % OM and pH 4.6. This inturn overlies a peat layer again to a depth of 125 cm.

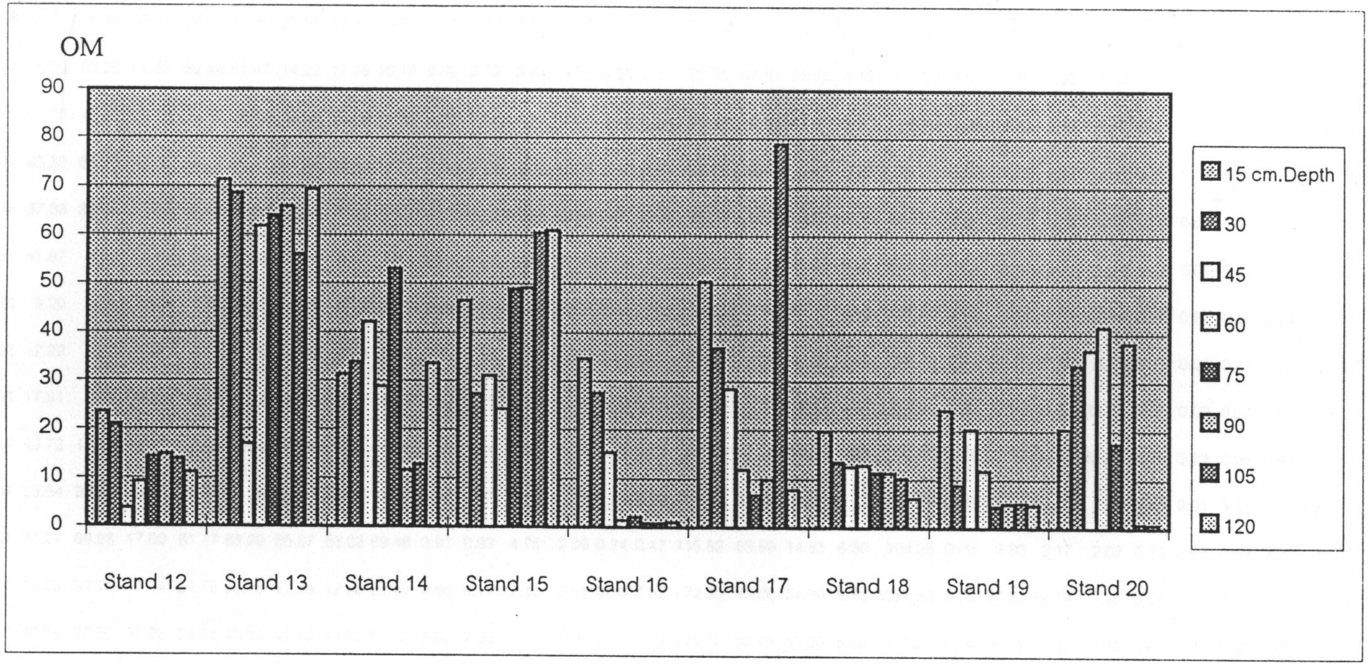


Figure 35 Soil OM Distribution in Kuan Kreng PSF.

Table 6 Data Analysis of environmental variable of 20 study stands of Toh Daeng and Kuan Kreng PSF.

	Sta	DIM	DIM	DIM	OM1	OM2	OM3	OM4	OM5	OM6	OM7	OM8	pH	Con	Ca	Mg	K	Na	EA	CEC	S %(B/	W-p	W-EC	W-Al	W-Ca	W-M	W-Fe	W-M	W-C	W-Zn	W-Al	W-SO*4	W-NH	W-N	W-D	W-Har	W-Turb
PD	1	-0.95	-0.53	-0.05	55.97	43.48	39.45	8.12	5.08	4.67	4.66	4.16	4.24	0.62	3.92	7.49	0.22	0.44	44.38	30.45	52.52	6.20	271.50	0.07	28.55	4.93	2.17	1.01	0.00	0.05	0.22	78.00	0.43	0.00	5.48	91.47	11.11
KU	2	-0.86	0.12	0.06	62.55	72.31	63.54	58.78	42.90	29.66	16.42	10.77	3.80	0.42	0.96	0.55	0.28	0.28	104.50	67.55	5.33	4.75	87.00	0.06	3.24	0.79	1.17	0.02	0.03	0.01	1.41	65.25	1.29	0.43	4.28	11.24	61.53
KL	3	-0.91	-0.14	0.04	66.28	62.26	64.57	82.48	51.47	14.22	12.29	10.18	3.90	0.79	3.41	4.35	0.20	0.31	80.25	47.61	23.75	6.13	71.25	0.03	3.83	1.92	4.83	0.07	0.00	0.05	0.19	24.75	0.43	0.19	7.10	15.13	163.05
PW	4	-0.96	0.07	-0.56	47.83	49.13	59.73	35.33	46.92	40.51	30.79	24.33	4.34	0.14	1.82	1.33	0.18	0.18	69.63	46.84	7.47	6.33	97.50	0.06	1.73	1.74	6.12	0.31	0.00	0.06	0.23	138.00	3.02	0.00	7.10	15.05	66.80
TD	5	-0.94	-0.37	0.14	83.30	68.99	71.50	46.93	65.42	61.94	33.84	10.71	4.44	0.12	3.06	1.26	0.10	0.23	98.38	46.04	9.97	5.70	33.75	0.02	1.75	0.41	1.41	0.52	0.04	0.01	0.07	12.25	0.62	0.96	6.90	6.02	7.46
LB	6	-0.89	0.18	-0.18	37.38	32.65	38.06	16.64	5.36	1.44	1.59	1.04	4.23	0.10	1.36	2.96	0.07	0.08	61.38	0.00	0.00	5.05	348.50	0.09	5.13	5.75	6.64	0.05	0.03	0.02	0.81	62.00	29.75	0.43	3.78	36.48	117.81
KS	7	-0.59	0.17	0.28	41.97	6.09	4.13	2.80	3.44	5.11	5.38	5.87	3.89	0.81	1.74	4.18	0.16	0.52	16.58	6.56	42.37	5.65	114.50	0.03	3.29	2.11	1.26	1.23	0.00	0.06	0.09	15.75	0.86	1.15	5.98	16.88	10.69
KP	8	1.85	-0.07	-0.06	3.20	1.20	0.54	1.98	0.62	0.19	0.14	2.77	3.29	0.68	0.42	0.40	0.06	0.12	9.64	0.99	10.72	4.90	167.00	0.02	3.81	3.55	3.85	0.04	0.02	0.08	0.44	51.50	0.43	0.29	8.00	24.10	160.85
BY	9	1.33	-0.03	-0.03	2.99	0.78	0.82	0.62	1.19	1.86	4.70	5.93	3.29	1.39	1.02	3.50	0.07	0.31	13.15	4.90	35.02	4.43	696.00	0.01	23.15	12.40	6.47	0.11	0.02	0.07	1.02	237.50	3.02	0.00	8.15	108.72	7.04
MR	10	-0.16	0.08	0.01	17.91	2.11	2.63	2.49	2.94	4.19	2.67	1.54	3.09	1.73	0.61	0.55	0.20	0.16	10.21	1.37	4.63	5.43	1425.00	0.02	12.98	11.27	25.21	0.06	0.02	0.04	1.68	139.75	0.43	0.00	7.95	78.71	10.43
MN	11	0.12	0.06	0.01	13.73	14.42	4.93	7.66	13.04	5.06	5.81	4.65	3.85	1.24	2.52	5.71	0.17	0.27	72.38	17.10	54.55	4.93	272.00	0.01	4.76	4.34	32.94	0.25	0.03	0.08	0.93	97.50	1.30	0.00	6.48	29.72	114.80
SL	12	0.12	0.05	0.01	23.54	20.92	3.66	9.13	14.29	14.83	13.88	11.14	3.54	0.93	1.99	5.03	0.34	0.63	68.32	34.71	23.32	5.70	349.75	0.08	6.02	12.22	1.10	0.45	0.01	0.01	1.46	157.25	3.84	1.48	7.13	65.22	9.94
HP	13	2.21	-0.09	-0.04	71.27	68.66	17.00	61.77	63.99	65.87	56.03	69.46	3.91	0.93	4.76	2.99	0.24	0.47	115.83	63.89	14.61	6.30	104.25	0.03	3.90	2.17	2.05	0.33	0.03	0.00	0.00	79.25	0.86	0.21	5.65	18.60	13.74
KT	14	-0.02	0.07	0.10	31.30	33.79	42.14	28.75	53.15	11.68	12.88	33.61	4.66	0.17	12.42	2.85	0.16	7.52	72.20	43.00	54.30	6.13	3227.50	0.03	37.86	59.74	1.45	0.09	0.03	0.01	0.02	240.75	4.96	0.21	7.15	340.28	63.98
KR	15	-0.43	0.11	0.07	46.58	27.30	31.02	24.34	48.98	49.19	60.50	61.05	3.53	2.00	11.17	5.00	0.17	0.59	111.70	50.93	31.29	5.68	215.25	0.04	10.16	3.73	1.31	1.28	0.01	0.02	0.87	93.00	1.73	0.53	5.80	40.68	111.00
SM	16	1.37	-0.01	-0.01	34.63	27.58	15.41	1.40	2.10	0.86	0.81	1.08	3.66	0.86	2.25	4.45	0.25	0.59	59.03	18.69	51.22	5.30	291.00	0.03	8.22	11.10	2.41	0.29	0.02	0.00	1.23	110.50	1.71	0.64	7.30	66.20	124.56
TM	17	0.86	0.01	0.01	50.56	36.85	28.50	11.96	6.82	9.90	8.95	7.84	3.06	3.20	3.62	5.40	0.08	0.20	94.96	26.21	44.28	5.40	441.10	0.04	19.54	14.32	5.73	0.24	0.02	0.02	1.05	205.50	0.65	0.00	5.38	107.68	99.97
KW	18	-0.42	0.12	0.07	19.88	13.50	12.57	12.88	11.47	11.27	10.22	6.17	2.86	4.02	4.80	10.03	0.04	0.10	75.43	17.55	88.19	6.43	209.00	0.04	4.54	6.48	6.85	0.12	0.04	0.00	0.01	97.00	2.65	0.96	6.45	37.96	179.60
BP	19	-0.61	0.13	0.05	24.25	8.94	20.31	11.80	4.55	5.07	5.23	4.82	3.28	2.28	5.42	8.83	0.18	0.35	49.31	21.59	72.21	6.60	128.75	0.06	3.37	3.82	5.22	0.07	0.04	0.02	0.00	57.75	1.69	0.53	6.35	22.27	231.25
YN	20	-0.12	0.10	0.07	20.44	33.45	36.59	41.41	17.52	38.10	0.99	0.74	4.69	0.25	8.47	2.26	0.15	0.35	65.67	29.38	46.00	6.43	147.75	0.07	6.58	3.31	3.28	1.04	0.01	0.01	0.00	29.00	3.01	0.00	4.58	29.96	296.98

The soil of this stand formerly is expected to be a thick peat then becoming moderate peat due to severe disturbance in a few years ago.

The shallow peat (peat layer is 40-60 cm. thick) is found only one stands (stand 17).

3) Stand 17 (TM) contains peat as thick as 45 cm. with 36.65 % OM. The upper peat layer consists of fibers and woody fragments of Melaleuca tree. The underlying material is marine clay with 9.56 % OM. It was noticed that soil below mud clay layer is peat with with 78.95 % OM. However, it is very loose and saturated with water.

2.4.1.3 Acid sulfate soils

Acid sulfate soil is found in 4 stands. This indicate the severe disturbance of Peat swamp forest.

1) Peat layer of stand 16 (SM) is as thick as 30 cm. with OM ~ 31.11 %. It consists mainly of dark brown Melaleuca fragment. This inturn overlies a layer of dark grey marine clay with 1.25 % O.M.

2) Stand 12 (SL) presents peat layer within 30 cm. It contains O.M. 22.33 %OM. The underlying material consists of dark brown clay loam overlying a dark grey mud clay to a depth of 125 cm.

3) The soil of stand 19 (BP) is the most interesting. It shows peat layer stratified with mud clay layer. The surface soil (0-15 cm.) shows very thin peat layer covering by many grasses. Soil at a depth 16-60 cm. is peaty clay loam with O.M. content ranging from 13.68 to 20.30 %. The underlyingmaterial is muddy clay with 4.92 % OM.

4) Stand 18 (KW) is acid sulfate soil with very thin peat layer (< 16 cm.). Peat layer contains 19.88 % OM. The underlying material is dark grey muddy clay, having O.M content varying from 9.84 to 12.90 %.

Upper soil is peat and muddy clay with ~ 19.88 %OM in dark grey. Upper lower soil between 16-60 cm. is muddy clay and peat and it is dark grey and quite sticky with 12.90 % OM. Lower soil is marine clay, % OM ~ 9.84.

2.6. Plant Classification of Phru Kuan Kreng.

2.6.1. Plant Classification by SLCA

Classification of 9 stands in Kuan Kreng PSF shown in Figure 36, has composed with only one group of *Melaleuca cajuputi* community type, that has only one stand. HP has mixed with other two species.

2.6.2. Stand Ordination of Kuan Kreng PSF.

The gradient arrangement of stands in KK PSF were shown in Figure 37. There are three characteristics of plant community. First group presents at the lower left corner, shows very close gradient relation from lower to upper of group 1. At the beginning, it is KT, Melaleuca-Cyperaces community, then is SM, Disturbed Melaleuca, accordingly to SL, BP, TM, KR and KW that have connecting relation upward to YN at the top left of diagram. At the lower right represented HP, Dense Melaleuca and mixing with other two species. It is the only one stand of Phru KK PSF that has other species.

2.7 Succession trend of Phru Kuan Kreng

In Kuan Kreng there is no prospect of succession beyond the *Melaleuca cajuputi* association sub-type because of the absence of reservoir of colonists from more advance stages in the succession.

III. Peat Swamp Forest

(PhruToh Daeng and Phru Kuan Kreng)

3.1 Species Composition

Plant communities from 20 sample stands area at Toh Daeng and Kuan Kreng PSF, size 40 X 40 square meter (= 0.16 ha), consist of 130 species of 29 families and 5 unidentified. There are 75 species in 26 families and 5 unidentified tree species (dbh >4.5 cm). There are 56 species and 2 unidentified of small trees/shrubs (dbh < 4.5 cm), consequently for the ground covers consisting of 51 species and 3 unidentified of herbs/grasses. The dominant families of all vegetation

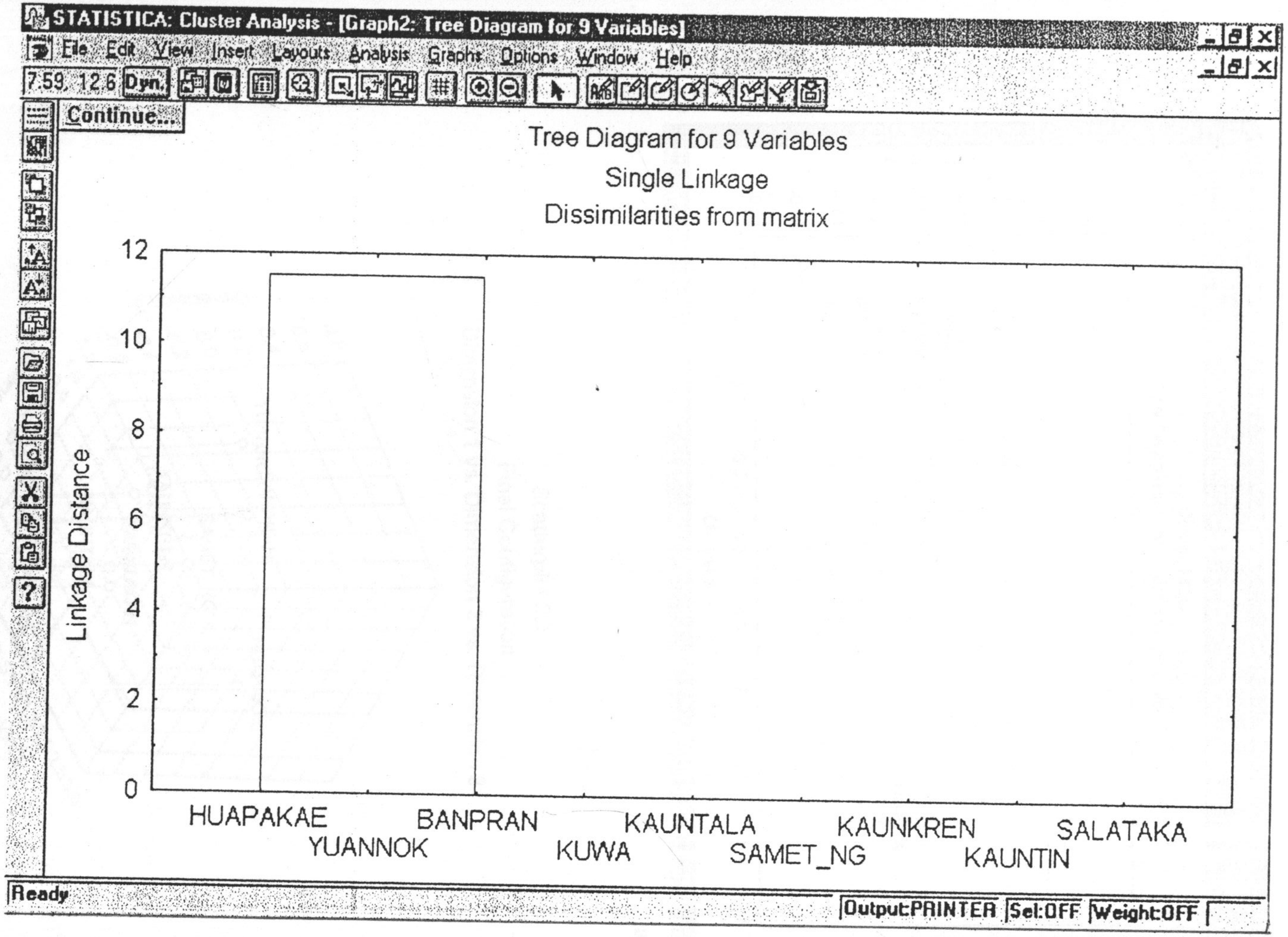
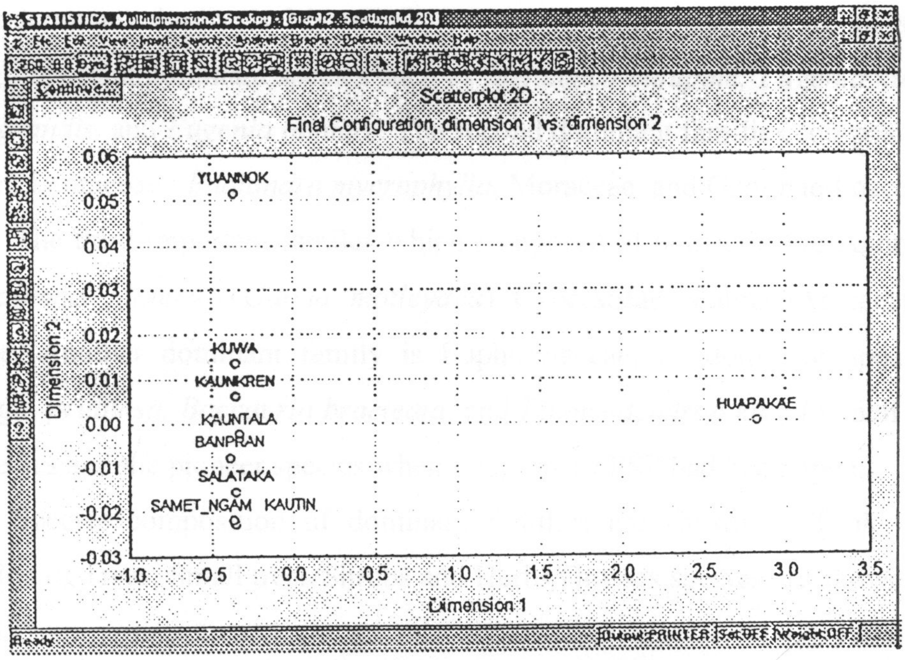
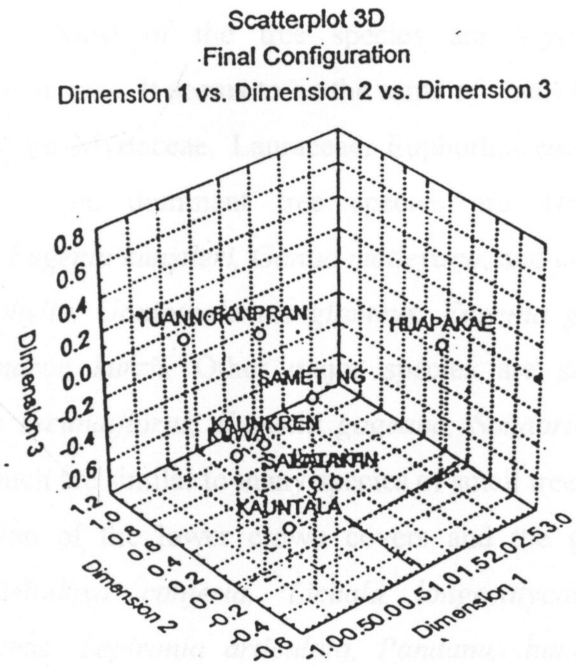


Figure 36 Classification of 9 stands of Kuankreng PSF(SLCA)



a)



b)

<u>Figure 37</u> Stand ordination of NMDS of Kuan Kreng PSF:
a) two dimension b) three dimension

show in Figure 38 and Table 7. The species lists with the family name and species present of TD PSF and KK PSF are shown in appendix I. It indicates that the principal dominant family is Myrtaceae, 11 species equal to 8 % of all species, including important/dominant species such as *Melaleuca cajupute, Eugenia kunstleri, Eugenia grandis,* and *Eugenia tumida,*. The second dominant families composing of 8 species are Lauraceae : *Endiandra mycrophylla*, Moraceae and Gaminae/Poaceae.

The third important familes which composed of 6 species are Annonaceae (*Goniothalamus gianteus, Ganua motleyana*) Cyperaceae, Palmae/Arecaceae and Rubiaceae. Another dominant family is Euphorbiaceae, its dominant species are *Macaranga pruinosa, Baccauria bracteata*, and *Blumeodendron kurzii* which are the native species and the pioneer species when the primary PSF had been open.

Species composition of dominant families are shown in Table 7. The composition of Trees, Small trees/Shrubs and Herbs/Grasses species are shown in and Figure 38.

Species composition of each stand and the abundance of trees, small trees / shrubs and herbs/grasses are shown in Figure 11-31 and 26-34 and in Appendix II. and III, respectively. Most of the tree species are Myrtaceae, Lauraceae, Euphorbiaceae and Annonaceae. It seems to be the same of small trees/shrubs, which the important families are Myrtaceae, Lauraceae, Euphorbiaceae, Annonaceae and Moraceae respectively. The dominant tree species are *Melaleuca cajupute*, *Macaranga pruinosa*, *Eugenia kunstleri, Ganua motleyana*, and co-dominant species are *Endiandra mycrophylla, Goniothalamus gianteus, Eugenia grandis, Polyalthia lateriflora, Blumeodendron kurzii.* Other major species are such as *Baccauria bracteata*, *Stemonurus secundiflorus, Eugenia gageana*, *Sandoricum beccarianum*, and *Eugenia tumida* which are similar to many species of small trees.

The vegetation of the lower crown covers and the ground covers are Palmae/Arecaceae, *Eleiodoxa conferia, Licuala longecalycata, Daemonorops angustifolia,* Cyperaceae, *Lepironia articulata, Pandanus humilis* of herbs and Gaminae of grasses, *Scleria sumatrensis, Leersia hexandra,* and *Hymenachne pseudinterrupta* etc.

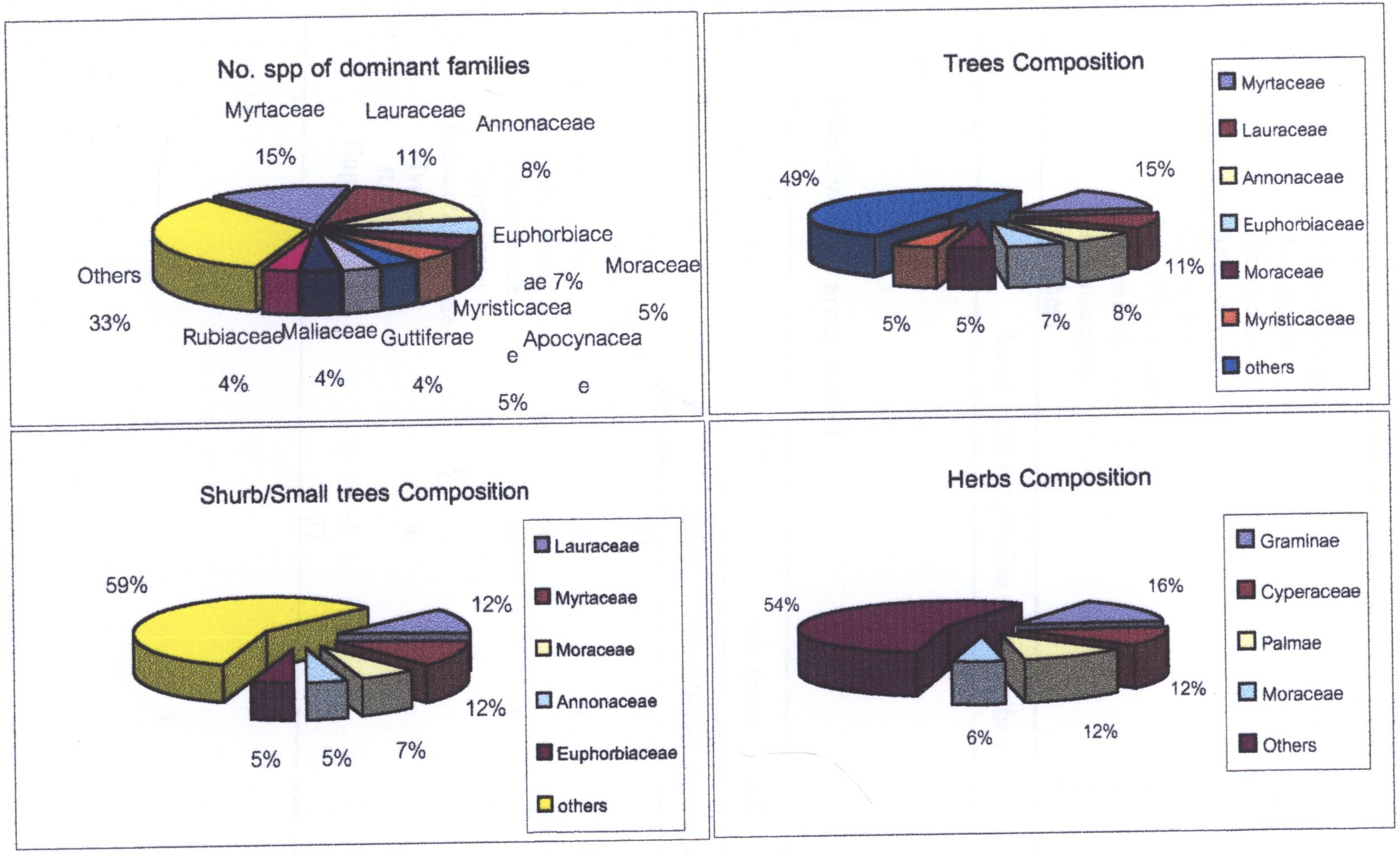


Figure 38 Total species of studied areas a) All life forms b) Trees composition c) Shurbs/small trees d) Herbs&grasses

Table 7. Species composition and dominant families of areas studied.

Family	no. species/ family
Mytaceae	11
Graminae/Poaceae	8
Lauraceae	8
Moraceae	8
Annonaceae	6
Cyperaceae	6
Palmae/Arecaceae	6
Rubiaceae	6
Euphorbiaceae	5
Others	66
Total : 130 species and 5 unidentified	

Total species of areas studied.

Family	no. species/ family		
	Trees	Shurb/Small trees	Herbs
Mytaceae	11	7	
Graminae/Poaceae			8
Lauraceae	8	7	
Moraceae	4		3
Annonaceae	6	3	
Cyperaceae			6
Palmae/Arecaceae			6
Myristicaceae	4		
Rubiaceae			
Euphorbiaceae	5	3	
Others	37	34	28

3.2 Structure and vegetation Distribution of PSF

3.2.1 Dbh-Class Distribution

Dbh-class distribution has been divided into 11 classes as shown in Table 8, it shows an inverse J-shaped distribution indicating its abundant recruitment throughout the topographical gradient (Figure 39).

The distribution of undergrowth, saplings or shrubs are 5206 stems from 65 species of 30 families that are dominated by Myrtaceae, Euphrobiaceae, Moraceae and Annonaceae.

There are a large number of small trees, 2435 stems of 64 species in dbh-class 1 (dbh = 4.5 –9.9 cm.), that is nearly two times of trees in other classes. There are 1676 trees within 65 species, dbh >= 10 cm., whereas only 57 big trees with dbh > 50 cm. are found. The comparative ratio of big trees and small trees is 43: 1 (2435: 57). This study shows only 4 big trees, dbh > 100 cm, and *Alstonia angustiloba* is the only biggest tree with the dbh 298 cm..

Vegetation, which present in many dbh-classes, demonstrate that they have distributed in many sizes and generations such as sapling, small tree, thorough tree and big tree. *Macraranga pruinosa* has present in many classes. That means it has widely distributed from top crown layer, lower layers to undergrowth and also dominated in many stands especially in the primary zone of TD PSF (stand 4, 6). *Melaleuca cajuputi* is also a dominant species distributing in many size classes but presenting in a large number of smaller sizes (dbh. = 4.5-39.9 cm), especially in sapling. It has dominated in many areas of secondary PSF both in TD and KK PSF because *Melaleuca cajuputi* grows better in the acidic condition. Consequently, it is the most distribution species in this study, 14 stands. Other species distributing in the lower layer are *Ganua motleyana* and *Baccauria bracteata* presenting in many classes including smaller trees to big trees. However, most of them are in middle dbh-class whereas *Baccauria bracteata* is smaller size and only a few big trees. *Eugenia kunstleri* is another species with a large number of small trees to middle classes and very a few numbers of big trees. *Eugenia kunstleri,* however is the dominant species in some stands of primary PSF of TD PSF which has high density in the lower layer (stand 1,5 and 3). *Xylopia fusca* is the co-dominate species with *Ganua motleyana* in stand 2 (KU) presents in many classes in a small number

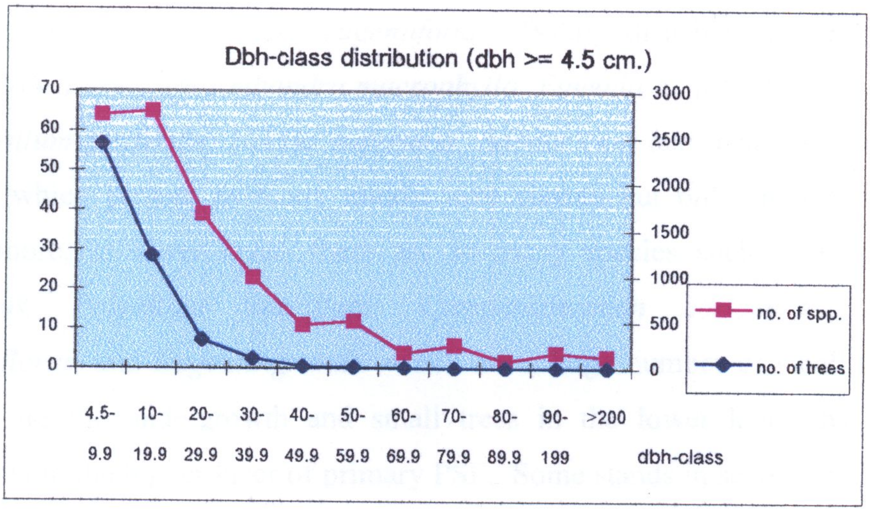
Table 8 **Species distribution/ Dbh-class Distribution of TDPSF and KK PSF.**

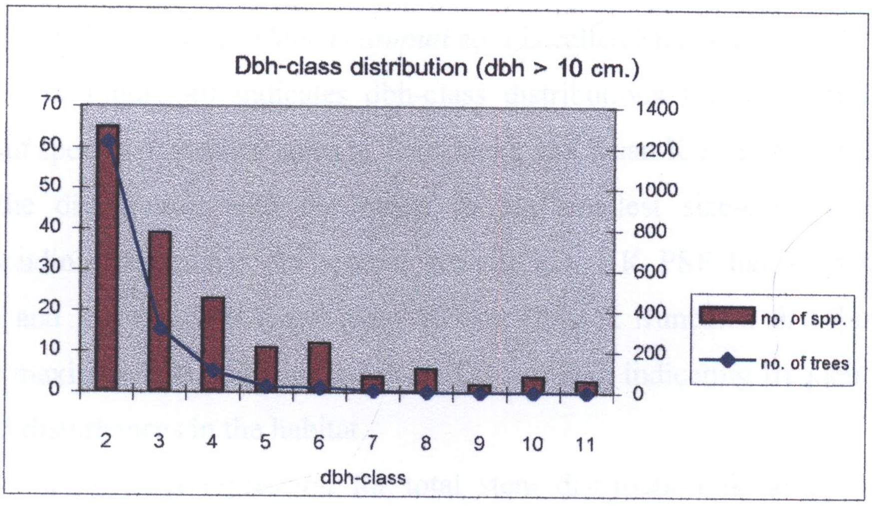
Species/dbh-class	1	2	3	4	5	6	7	8	9	10	11
Melaleuca cajuputi	1865	878	135	50	4			2		1	1
Macaranga pruinosa	61	57	47	15	10	4	5	1		1	1
Eugenia kunstleri	139	72	31	13	5	3					
Goniothalamus giganteus	47	19	2	1							
Eugenia grandis	40	21	3								
Endiandra macrophylla	20	14	14	2			1				
Eugenia longiflora	13	6	1	1		1	1				
Blumeodendron kurzii	6	11	10								
Ganua motleyana	9	6	9	4	4	5	7				
Baccauria bracteata	4	2	2	1	1	1			2	1	
Gymnacranthera eugeniifolia	3	1	1		1	2			2		
Xylopia fusca		3	1			1				1	1
Alstonia angustiloba	2										1

Note dbh - class/cm.

1 = 4.5-9.9, 2 = 10-19.9, 3= 20-29.9, 4 =30-39.9, 5 = 40-49.9, 6 = 50-59.9, 7 = 60-69.9,

8 = 70-79.9, 9 = 80-89.9, 10 = 90-199.9, 11 > 200 cm.





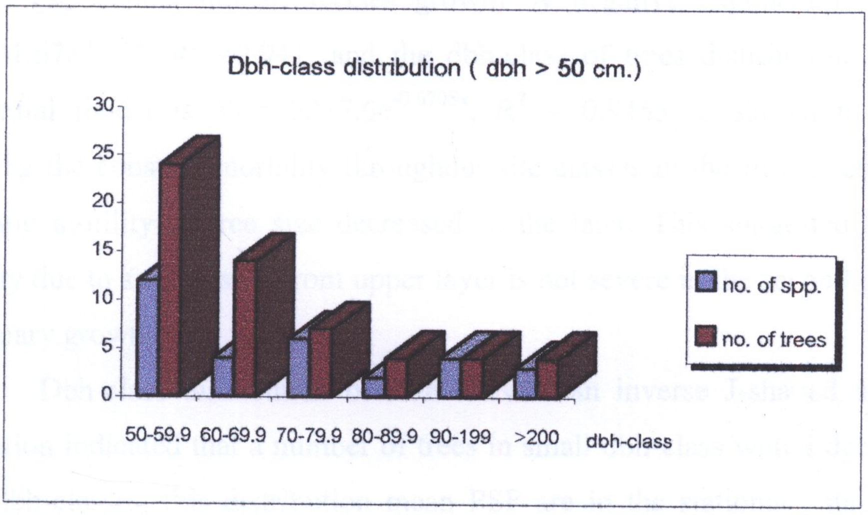


Figure 39 DBH - Classes Distribution of TD PSF and KK PSF

the same as *Gymnacranthera eugeniifolia.* Wildly distribution species in the second lower layer are *Endiandra macrophylla, Eugenia tumida, Eugenia longiflora, Carophyllum pisiferum, Neesia malayana, Sandoricum beccarianum,* and *Sterculia bicolor* which present in many middle size classes but only in a small number. Furthermore, in lower layer, there are so many species such as *Goniothalamus giganteus, Polyalthia lateriflora, Campnospermum coriaceum, Stemonurus secundiflorus,* and *Eugenia grandis* which are a large number of small trees. These species are the undergrowth and small trees in the lower layer that have been succeeded to the higher layer of primary PSF. Some stands in secondary PSF of Phru Toh Daeng are during succeed to be the primary PSF. whereas every layer in KK PSF are distributed of only *Melaleuca cajuputi* so it is called Melaleuca Forest.

In Figure 40 indicates dbh-class distributions for both total stems and dominant species of studied areas at Toh Daeng and Kuan Kreng PSF. All total stems show the distribution with the mode in the smallest size-class (dbh<4.5 cm.) corresponding to saplings. In second growth TD, KK PSF has higher density of sapling and has no stem larger than 50 cm. dbh. A truncated distribution with a smaller maximum stem size in two sites, TD and KK, indicating frequency of soil or physical disturbances in the habitat.

Curvilinear regression for total stem distribution is better fitted by the negative exponential model, species growth by negative exponential model with $Y = 101.67e^{-0.370x}$, $R^2 = 0.941$, and the dbh-class of trees distribution by negative exponential model is $Y = 2257.6e^{-0.6705x}$, $R^2 = 0.9463$ as shown in Figure 41, indicating the constant mortality throughout site classes in the former change to the increasing motility as tree size decreased in the later. This suggested that sapling mortality due to suppression from upper layer is not severe in the second growth as in the primary growth.

Dbh-class distribution of PSF showed an inverse J-shaped or L shaped distribution indicated that a number of trees in small dbh-class would decrease in the larger dbh-classes, this distribution mean PSF are in the stationary stage or in the constant condition that had a good succession. These are also the Dbh- class distribution of dominant species and second dominant species, which present inverse–J shape as shown in Figure 40, *Macraranga pruinosa* present the efficiently

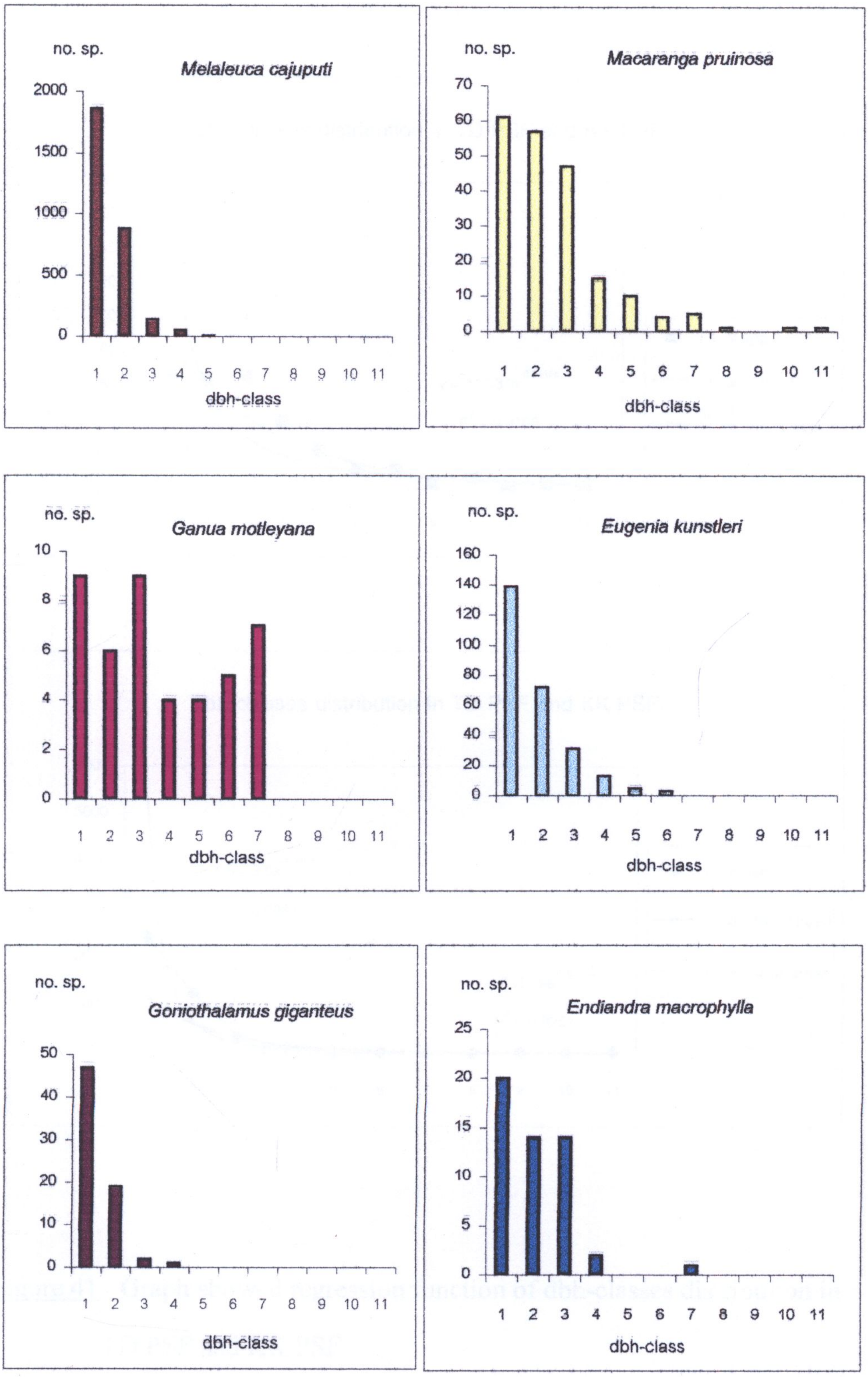
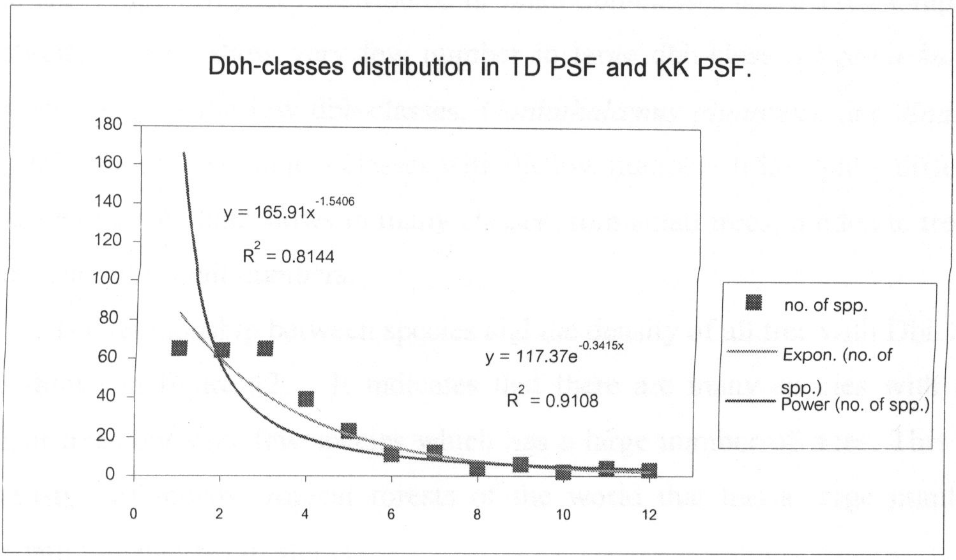


Figure 40 **Species distribution by dbh-class Distributions of study areas**



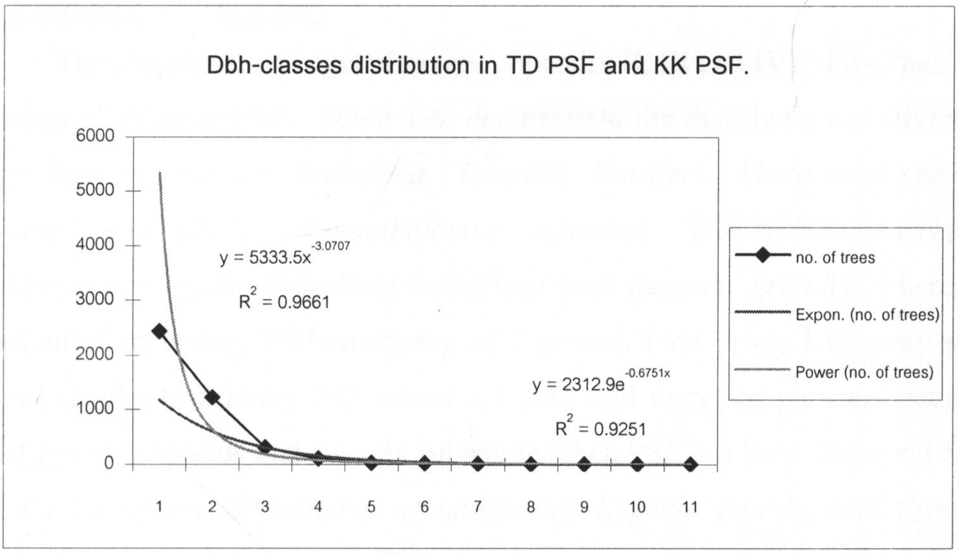


Figure 41 Graph showed regression function of dbh-classes distribution in TD PSF and KK PSF

distribution in almost every classes from sapling, small trees through big trees dbh-class, but mostly show high numbers of small trees. The distribution of *Melaleuca cajuputi* show high efficiency distributed in small dbh-classes and decrease rapidly in tree dbh-class which show very few number in large dbh-class. *Eugenia kunstleri,* also present only in the low dbh-classes, *Goniothalamus giganteus,* and *Endiandra macrophylla* also present in less classes with the low number. It is slightly different of *Ganua motleyana* that shows in many classes from small trees, moderate trees and big trees. but with small numbers.

The relationship between species and the density of all tree with Dbh >= 4.5 are shown in figure 42. It indicates that there are many species with a low number of trees but very few species which has a large number of trees. This is the characteristics of mostly tropical forests of the world that has a large number of species with low number of stems.

3.2.2 Abundance of vegetation

The abundance of vegetation (see appendix II, III and IV), show the distribution of Primary PSF. Stand 1-6, demonstrate the distribution of diversity of swampy species; *Ganua motleyana, Eugenia kunstleri, Macaranga pruinosa, Endiandra mycrophylla, Goniothalamus gianteus, Endiandra macrophylla, Endiandra macrophylla, Polyalthia lateriflora and Eugenia grandis,* whereas the distribution of secondary PSF consisting of 2 groups. First group has many species which are similar to Primary PSF (stand 7,10,11), and there are pioneer species and also fast growing species that became substitute when PSF has been disturbed such as *Polyalthia lateriflora, Stemonurus secundiflorus, Eugenia tumida, and Symplocos adenophylla.* Second group are PSF that have many tremendous change, while *Melaleuca cajupute* is dominant species in most of the study areas (14 stands). It has distributed with other few species or with some shrubs or herbs and grasses.

Plant community in Toh Daeng PSF (stand 1-11) shows more species than in Kuan Kreng PSF (stand 12-20). Stand in Toh Daeng PSF has a different structure especially, species composition, species diversity, density, frequency, dominant and IV whereas the stand of KK PSF has only one species but differing in the structure of density and frequency of species appearance (Figure 43).

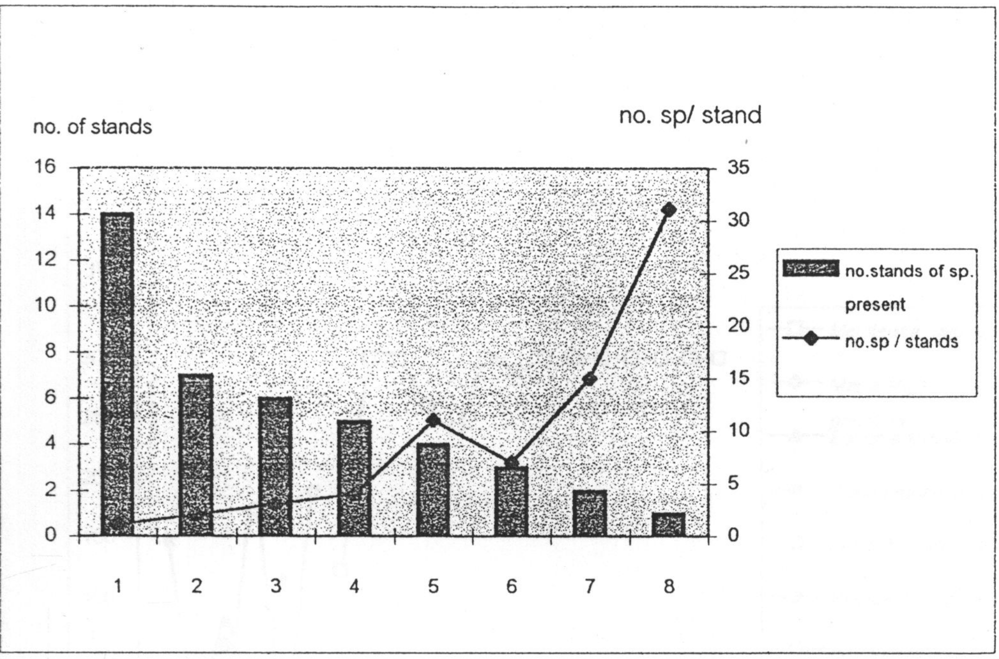


Figure 42 **No. of stand of species pesented in 20 stands of study areas.**

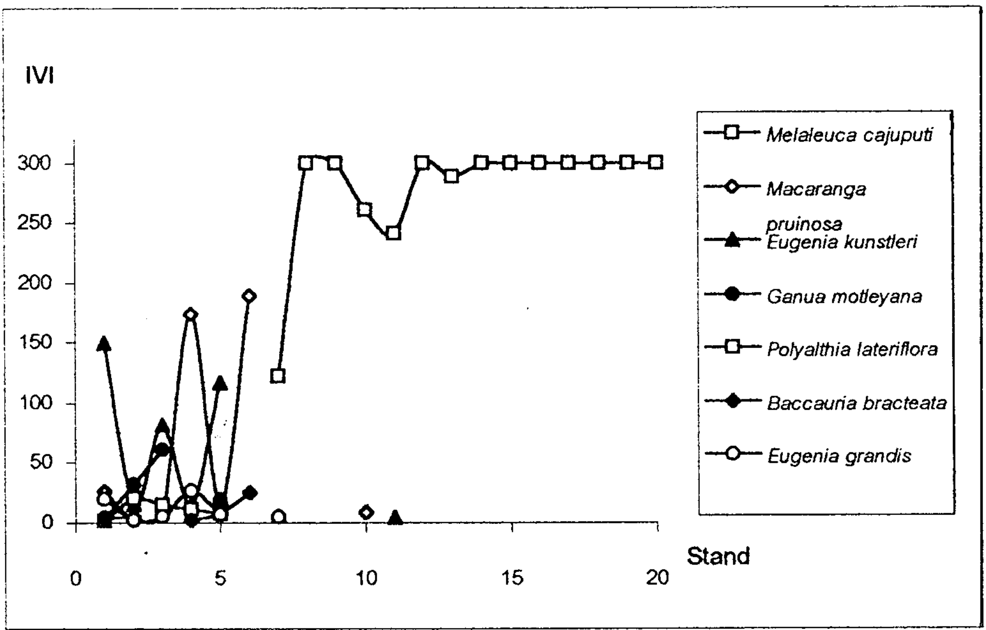


Figure 43 Abundance of the Dominant species in the study sites at Phru Toh Daeng and Phru Kuan Kreng base on Importance Value

The stand in the preservation zone (stand 1-6) is primary PSF with the abundance species diversity are highly (26-32 species). The dominant species are *Eugenia kunstleri*, *Macaranga pruinosa*, *Ganua motleyana*, *Goniothalamus giganteus*, *Eugenia grandis* and *Endiandra mycrophylla.*, The stand 2 (KU) has the highest H′ with dominant species, *Ganua motleyana* and co-dominant species are *Xylopia fusca* and *Neesia malayana.* The stand 3 (KL), is dominated by *Eugenia kunstleri* and *Ganua motleyana. Eugenia kunstleri* is the dominant species in stand 1 and stand 5, whereas *Goniothalamus giganteus* and *Eugenia tumida* are co-dominant species in stand 5 and *Goniothalamus giganteus* and *Macaranga pruinosa* are co-dominant species in stand 1. The stand 4 (PW) and stand 6 (LB), *Macaranga pruinosa* is the dominant species whereas other species are very low.

The three sample stands in the conservation zone of TD PSF (Stand 7-9), are highly different. Stand 7, (Kok Sataw = KS) has 22 species and the diversity is high. The dominant species is *Melaleuca cajuputi* and the second dominant are *Eugenia gageana, Ilex cymosa.* This structure is similar to the stands in conservation zone that higher than some stands within the preservation zone. Other 2 stands, stand 8 (KP) and stand 9 (TB) are the single species stand of *Melaleuca cajuputi.* The condition of this forest has been changed and it supports the divided of the conservation zone.

Two stands of plant community within the development zone, stand 10 (MN) and stand 11 (MR), *Melaleuca cajuputi* is the dominant species mixed with other 6 and 2 species with *Symplocos adenophylla* and *Macaranga purinosa* are the co-dominant species respectively.

The structure and distribution of TD PSF are higher and more stable than Kuan Kreng PSF that has single species stand of *Melaleuca cajuputi* in 8 stands except stand 13 (HP), has mixed with other 2 species.

All stands of Kuan Kreng PSF are secondary PSF. There are differences in density and frequency of *Melaleuca cajuputi* appearring among herbs such as *Lepironia articulata*, *Cyperus sp.*, *Scleria sumatrensis*, *Pandanus sp.*, and grasses such as *Leersia hexandra*, and *Phragmites karka*, There difference are based on the rate of disturbance.

As mentioned above, it indicates that vegetation in Phru Toh Daeng are more complexity than in Kuan Kreng PSF. There were crowding of continuous canopy and compose of 4-5 stratification both primary and secondary PSF in Phru Toh Daeng. Phru Kuan Kreng is secondary PSF compose of *Melaleuca cajuputi* in all areas just difference in the structure of lower plant mostly shurb and ground cover.

3.3. Community classification

3.3.1 Plant Community Type by species performance

Plant community type are classified according to structural, species composition and dominant species within each stand as mentioned above. Dominant species were classified by density, frequency, basal area and important value. As mentioned above the detail of characteristic and structural of all four community were categorized based on the first and second leading dominant tree species in each stand. Four community types of peat swamp forest could be recognized, two primary forest types and two secondary forest types.

The primary forest types were a *Eugenia kunstleri* community type, and a *Ganua motleyana* community type;. The *Eugenia kunstleri* community type could be further divided into 2 sub-types, (1) *Eugenia kunstleri* - *Goniothalamus giganteus*-*Macaranga pruinosa* sub-type; and (2) *Eugenia kunstleri* - *Ganua motleyana* sub-type.

The two secondary forest types were a *Macaranga pruinosa* community type, and a *Melaleuca cajuputi* community type. The *M. cajuputi* community type could be further divided into two sub-types: (1) a mixed community in which *M. cajuputi* was dominant, and (2) single species stands of *M. cajuputi*.

1). *Eugenia kunsteri* Community Type

This type was dominated by *Eugenia kunsteri,* generally it formed 2 sub-type by secondary dominant species :

First sub-type *Eugenia kunsteri* was dominant species with greater IV more than 100. This showed very strong dominated in stand 1 (PD) and stand 5 (TD) that present IV 149.55 and 116.85 respectively. Secondary dominant species were *Goniothalamus gianteus* and *Macaranga pruinosa* showed only a quarter IV of them, 25.79, 25.76 in stand 1 and showed IV 28.94, 16.04 in stand 5. *Eugenia kunstleri*

25.79, 25.76 in stand 1 and showed IV 28.94, 16.04 in stand 5. *Eugenia kunstleri* covered 78.71 and 72.87 % in stand 1,5 respectively while the %cover of other species were very low, only from 1 to 6 %.

Macaranga pruinosa, Eugenia tumida, Ganua motleyana, Endiandra mycrophylla were the third generations of plants in this type. Furthermore, *Eugenia kunstleri* and *Macaranga pruinosa* were also shrubs and small trees of lower layer.

pH of upper soil is about 3.8 while the lower soil pH is ~ 4.4. The organic matters were fairly high especially in stand 5, OM of upper soil = 83.30 %, whereas OM of upper soil and lower soil of stand 1 were 55.97 and 30.35 % respectively. Water pH was about 4.4 in both wet and dry seasons.

Second sub - type : *Eugenia kunstleri - Ganua motleyana* : Stand 3 (KL), *Eugenia kunstleri* was the dominant species with IV=81.40, and *Ganua metleyana* was the second dominant species with IV = 60.58. The %cover of *Eugenia kunstleri* was 41.07% which was close to the cover of *Ganua motleyana* 38.85%, *Stemonurus secundiflorus, Endiandra mycrophylla, Blumeodendron kurzii* and *Goniothalamus giganteus* were the third dominant species while other species had low percentage of cover (~0.65 - 5.69%).

Soil of this community type was fertility. The OM percentage of upper soil and upper lower soil were 66.28 and 69.5. While OM of lower soil was low ~22.04%, soil pH of upper soil was ~ 4.2. However, if pH of lower soil was >3.58, it indicated acidic soil.

2). *Ganua motleyana* Community Type

The dominant species of this community type is *Ganua motleyana* with IV = 32.07 while mostly smilar to the co-dominant species, *Xylopia fusca* and *Neesia malayana*, with IV = 25.01 and 23.90 respectivly. This type presented at stand 2 (KU) where *Blumeodendron kurzii, Sandoricum beccarianum, Endiandra mycrophylla* were the third growing trees. However, the cover of this stand could not be classified clearly. The cover of dominant species was close to co-dominant species, 20.57%, 14.39% and11.28 % respectively, which were very similar to other species of third dominant species.

This community type showed characteristics of climax community with high species diversity index 4.5743, while the important value of dominant species was not so high and close to others species.

pH was similar at upper and lower soil ~3.6 - 3.78 while OM is fairly high both upper soil and upper lower soil, 68.55% and 64.84%, but rather low at the lower soil, 24.54 %OM.

3). *Macaranga pruinosa* Community Type

This type presents in 2 stands (stand 4,6), *Macaranga pruinosa* has been the dominant species in both with the greater IV with the value of 174.20 and 195.35 respectively, whereas others are species present very low IV, from 10 to 28, that was about 10% of dominant species. *Eugenia grandis* is the second dominant species of stand 4 (PW), IV = 26.61 whereas *Eugenia kunstleri* is the third dominant species followed by *Polyalthia lateriflora*. The second dominant species of stand 6 (LB) is *Baccauria0 bracteata* (IV=26.11), and followed by *Euodia roxburghiana*. The percentage cover of dominant species is very high, 93.36% and 97.92% while the cover of other species is very low, 0.03-1.96 %.

Macaranga pruinosa is the dominant and pioneer species of primary PSF when the forest was opened. This event indicated that when the primary PSF had been once disturbed and later the forest can be again rehabilitated.

Compared with other stands in preservation zone, %OM of this type was slightly low. OM of stand 4 was similar to all intervals ~ 35.64 - 48.06 % while in the stand 6, OM of the upper soil and upper lower soil equal to 37.38 and 28.16% respectively. The lower soil had very low at 2.36%OM.

The range of soil pH was 4.3 where as the upper soil was more acidity than the lower soil, pH = 4.0.

The three community types as mentioned above represent the primary PSF of Toh Daeng , composed of swampy species growing in their next generations. These indicate the succession of *Macaranga pruinosa* community, when primary PSF had open and then community that under succesion by lower tree such as *Eugenia kunsteri* community. Finally they can be succeeded to be the climax community like *Ganua motleyana* community which composed of many swampy species with close IV that was not so high.

4). *Melaleuca cajuputi* Community Type

This type, is dominated by *Melaleuca cajuputi* that wildly distributed in many areas of secondary PSF. This community included 14 stands of both Toh Daeng and Kuan Kreng PSF. They can be divided into two sub-types according to the distribution of other species.

First sub-type, is represented by the stand that *Melaleuca cajuputi* was dominant species and widely distributed with other species, varying from few species to many species (3-22 species).

Stand 7 (ST), *Melaleuca cajuputi* is dominant species with IV=122.96, whereas secondary dominant species are *Eugenia gageana and Ilex cymosa* which IV =27.95 and 23.50 respectively. *Melaleuca cajuputi* covers 86.49 % and 75 % frequency. Other 21 species are only 1-3 % though they showed closely percent of frequency, (43.75-56.25%). Stand 9 (MN), 98.81 % cover of *Melaleuca cajuputi* with high IV (240.85) was found while other 6 species were only 1.09 percents. *Symplocos adenophylla* was second dominant species, IV=31.84 though it had low percent of covering. There were 2 interesting stands of this sub-type with other 2 species. Stand 10 (MR), was interesting of presenting of *Macaranga pruinosa* which was pioneer species of open primary PSF and *Melaleuca cajuputi* also showed strong dominated with IV=288.35. Stand 13 (HP) is the only stand in Kuan Kreng PSF that has other 2 species, *Mitragyna javanica* and *Bombax sp.* occurring with *Melaleuca cajuputi* which has greater IV=288.50.

Second sub-type, There are 10 stands that have only one species, *Melaleuca cajuputi* showing the highest IV=300 (stand 8, 9, 12 and stand 14 -20). These stands show differences in frequency and density of *Melaleuca cajuputi*. Furthermore there are differences in the lower plants, such as *Medinilla crassifolia, Melastoma decemfidum* while ground covers are *Stenochlaena palustris, Lygodium microphyllum, Nepenthes gracilis, Cyperus spp., Lepironia articulata* and grasses.

As mentioned above, communities were divided into two main groups, with and without *Melaleuca cajuputi.* The first three communities types are the stands in primary PSF that had no *Melaleuca cajuputi,* Another group that wide distributed with *Melaleuca cajuputi* that were all stands in secondary PSF.

3.3.2. Classification of Plant Community (SLCA).

For plant community, there is no stand which has the similarity characteristics and homogeneity. Sample stands in this group should have similarity and dissimilarity. Each group has ecological characteristics which is similar to others and it indicates the relationship between stands in those groups. Presence and absence of species in 20 stands of this study were shown in Table 9. Ranking order of importance value in Table 10 can be used to calculate the Euclidean distance, classification and grouping the stands of plant community by Single linkage cluster analysis (SLCA). Furthermore, the Multidimensional scaling (MDS) method was used to study community ordination.

SLCA is used to study the relationship of rearrangement stands both within the group in Toh Daeng PSF, Kuan Kreng PSF and between some stands that were close as illustrated in Figure 44.

The Euclidean distance matrix of 20 stands demonstrate three main interesting groups. The first group has the closest relation with 0% dissimilarity or its similarity is closest. There are 8 stands of KK PSF; stand 20 (YN), 19 (BP), 18 (KW), 17 (T M), 16 (SM), 15 (KR), 14 (KT), and 12 (SL) and 2 stands of conservation zone of TD PSF; stand 9 (BY) and 8 (KP). All stands of this group present of the only one species *Melaleuca cajuputi.* At present, this group is named BP group, which has close relation to stand 13 (HP). HP is the only stand left in KK PSF that has not only *Melaleuca cajuputi* but also two other species. This HP group is similar to 2 stands in development zone of TD PSF, stand 10 (MR) and stand 11 (MN) which has *Melaleuca cajuputi* and a few more species, 3 and 7 species respectively. Within this group showed very close distance, on the other hand it had high similarity and was called HP group.

The structure of HP group is closely related to stand 7 (ST), in conservation zone of TD PSF. It has the same represent of *Melaleuca cajuputi* and some more species, with high diversity of 22 species. At this stage, it shows the

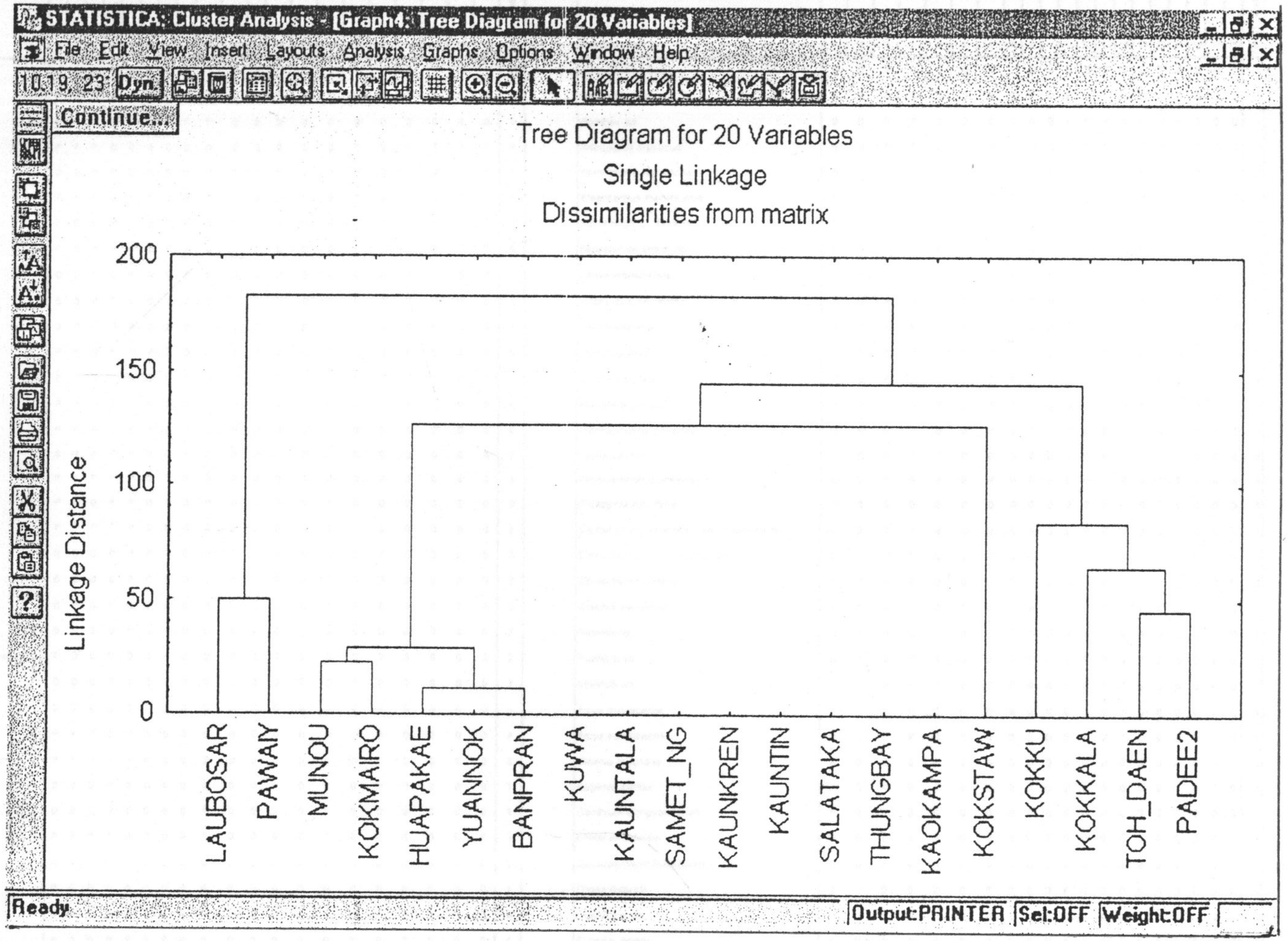


Figure 44 Classification of 20 stands of PSF(SLCA)

Table 9 Present and Absent of species in 20 stands of Toh Daeng and Kaun Kreng Peat Swamp Forest.

Species List	Stand No 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total/stands
Melaleuca cajuputi	0	0	0	0	0	0	P	P	P	P	P	P	P	P	P	P	P	P	P	P	14
Macaranga pruinosa	P	P	P	P	P	P	0	0	0	0	P	0	0	0	0	0	0	0	0	0	7
Eugenia kunstleri	P	P	P	P	P	0	P	0	P	0	0	0	0	0	0	0	0	0	0	0	7
Ganua motleyana	P	P	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Symplocos adenophylla	0	0	0	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	1
Goniothalamus giganteus	P	P	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Eugenia gageana	0	0	0	P	P	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Eugenia grandis	P	P	P	P	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Eugenia tumida	0	0	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Unknown	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Xylopia fusca	0	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Baccaurea bracteata	P	P	0	P	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Neesia malayana	0	P	0	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Stemonurus secundiflorus	P	P	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Endiandra macrophylla	P	P	P	P	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Blumeodendron kurzii	0	P	P	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Sandoricum beccarianum	P	P	P	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Ilex cymosa	P	0	0	P	P	0	P	0	P	0	0	0	0	0	0	0	0	0	0	0	5
Polyalthia lateriflora	P	P	P	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Eugenia longiflora	0	0	0	0	P	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Euodia roxburghiana	0	0	0	0	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Alstonia spathulata	0	P	0	P	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Elaeocarpus griffithii	0	0	0	0	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Gymnacranthera eugeniifolia	P	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Garcinia bancana	0	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Glochidion littorale	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Calophyllum pisiferum	P	P	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Campnosperma coriaceum	P	P	P	P	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Alstonia angustiloba	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Eugenia pseudosubtilis	0	0	0	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	1
Eugenia caudata	P	P	P	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	3
Dialium patens	0	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Alstonia pneumatophora	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Gynotroches axillaris	0	0	P	0	0	P	0	0	P	0	0	0	0	0	0	0	0	0	0	0	3
Horsfieldia crassifolia	P	P	0	0	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Polyalthia sclerophylla	P	P	P	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Sterculia bicolor	0	0	P	P	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Aglaia rubiginosa	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Mytragyna sp	0	0	0	0	0	0	0	0	0	0	0	0	P	0	0	0	0	0	0	0	1
Bombax sp	0	0	0	0	0	0	0	0	0	0	0	0	P	0	0	0	0	0	0	0	1
Artocarpus elasticus	0	0	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Barringtonia racemosa	0	0	0	0	0	0	P	0	0	P	0	0	0	0	0	0	0	0	0	0	2
Elaeocarpus macrocerus	0	P	0	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Macaranga [illegible] *Tithena*	P	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Parastemon urophyllus	0	0	P	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Litsea monopetala	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Artocarpus kemando	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Horsfieldia irya	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Myristica elliptica	0	P	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Crudia caudata	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Polyalthia glauca	0	P	0	0	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Nothaphoebe coriacea	0	P	P	P	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Litsea costata	0	0	0	P	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Archidendron clypearia	0	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Diospyros lanciifolia	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Calophyllum teysmannii var. inophylloide	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cinnamomum rhynchophyllum	0	P	P	P	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Chisocheton patens	0	P	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Brachia siamensis	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Naewsang	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pueng-prao	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Morinda sp	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Ficus microcarpa	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Ficus aurantiacea	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Dillenia pulchella	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Eugenia curtisii	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Canthium congestiflorum	P	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Litsea johorensis	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Decaspermum fruticosum	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Prese robusta	0	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Litsea grandis	0	0	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Eugenia oblata	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Dacryodes costata	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Dacryodes incurvata	0	0	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	24	29	30	26	28	11	22	1	1	7	7	1	3	1	1	1	1	1	1	1	

Table 10. Species abundance / 40x40 m^2 in 20 stands of Toh Daeng and Kaun Kreng Peat Swamp Forest.

No.	Species List \ Stand	PD	KU	KL	PW	TD	LB	KS	KP	BY	MR	MN	SL	HP	KT	KR	SM	TM	KW	BP	YN	
	Scienctific Name	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	Count
1	*Melaleuca cajuputi*							122.19	300	300	260.81	240.8	300	289	300	300	300	300	300	300	300	14
2	*Macaranga pruinosa*	25.763	2.153	7.762	174.202	16.037	189.6				8.5292											7
3	*Eugenia kunstleri*	149.55	15.26	81.4	14.7511	116.85		5.4469				4.292										7
4	*Endiandra macrophylla*	13.239	20.36	22.03	8.8624	14.683	3.603															6
5	*Eugenia grandis*	19.741	2.364	5.454	26.6051	6.7143		5.0337														6
6	*Campnospermum coria*	1.7667	9.2	1.503	2.071	11.008	3.62															6
7	*Polyalthia lateriflora*	1.7592	19.97	14.61	11.0349	7.6907																5
8	*Baccauria bracteata*	3.6356	4.531		2.0712	7.8795	24.7															5
9	*Sandoricum beccarianu*	2.2545	21.69	1.503	6.3133	5.2194																5
10	*Ilex cymosa*	1.7583			2.5941	2.0994		20.051				4.332										5
11	*Ganua motleyana*	4.5045	32.04	60.53		19.145																4
12	*Goniothalamus gianteus*	25.791	3.138	14.95		27.942																4
13	*Blumeodendron kurzii*		21.76	17.4	2.0918	6.8233																4
14	*temonurus secundiflorus*	7.3014	9.267	22.67		1.2327																4
15	*Eugenia gageana*				2.0732	1.2342	9.67	26.775														4
16	*Carophyllum pisiferum*	1.7726	12.05	3.789		2.4811																4

Table 10. (contd.).

No.	Species List \ Stand	PD	KU	KL	PW	TD	LB	KS	KP	BY	MR	MN	SL	HP	KT	KR	SM	TM	KW	BP	YN	
	Scienctific Name	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	Count
17	*Polyalthia sclorophylla*	3.5317	4.385	1.502				6.6817														4
18	*Sterculia bicolor*			2.41	2.6464	6.2313		2.0399														4
19	*Horsfieldia crassifolia*	1.8713	7.199			1.2433		1.5663														4
20	*Northaphoebe coriacea*		2.269	1.505	2.0736			3.0882														4
21	*namomum rhynchophyllum*		2.138	1.504	2.0738			1.5379														4
22	*Eugenia longiflora*					2.5042	7.273	18.187														3
23	*Neesia malayana*		23.81		2.0826	1.242																3
24	*Alstonia spathulata*		18.02		2.0723			2.0684														3
25	*Eugenia caudata*	4.7021	9.108	2.087																		3
26	*Gynotroches axillaris*			1.503			7.21					4.293										3
27	*Elaeocarpus macrocerus*		2.113		4.8908	1.2668																3
28	*Polyalthia glauca*		3.443			1.2435		1.9957														3
29	*Eugenia tumida*			7.05		25.727																2
30	*Xylopia fusca*		24.96	1.52																		2
31	*Elaeocarpus griffithii*					5.6099		17.101														2
32	*Euodia roxburghiana*					2.4759	18.06															2
33	*Gymnacranthera eugen*	14.695						5.1327														2

Table 10. (contd.).

No.	Species List \ Stand	PD	KU	KL	PW	TD	LB	KS	KP	BY	MR	MN	SL	HP	KT	KR	SM	TM	KW	BP	YN	
	Sciencific Name	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	Count
34	*Dialium patens*		7.732	2.471																		2
35	*Parastemon urophyllus*			4.842				3.645														2
36	*Barringtonia racemosa*							3.1185				5.039										2
37	*Macaranga griffithiana*	3.3026					4.846															2
38	*Artocarpus elasticus*			1.513	5.2488																	2
39	*Crudia caudata*	3.5256		2.429																		2
40	*Myristica elliptica*		3.626			1.7049																2
41	*Litsea costada*				2.6073	1.2431																2
42	*Chisocheton patens*		2.121	1.502																		2
43	*Canthium congestiflorum*	1.7736		1.556																		2
44	*Symplocos adenophylla*											31.84										1
45	Unknown							25.159														1
46	*Garcinia bancana*							14.458														1
47	*Glochidion littorale*						12.09															1
48	*Alstonia angustiloba*				9.5182																	1
49	*Eugenia pseudosubtillis*											9.361										1
50	*Alstonia pneumatophora*						7.24															1

Table 10. (contd.).

No.	Species List \ Stand	PD	KU	KL	PW	TD	LB	KS	KP	BY	MR	MN	SL	HP	KT	KR	SM	TM	KW	BP	YN	
	Scienctific Name	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	Count
51	*Aglaia rubiginosa*			6.082																		1
52	*Mitragyna javanica*													5.75								1
53	*Bombax sp.*													5.75								1
54	*Litsea monopetala*		4.286																			1
55	*Artocarpus kemendo*			3.768																		1
56	*Horsfieldia irya*				3.6342																	1
57	*Archidendron clypearia*							2.5459														1
58	*Diospyros lancifolia*	2.2164																				1
59	*ıllum teysmannii var.inophylloide*				2.1675																	1
60	*Brachia siamensis*		2.113																			1
61	*Uvaria cordada*		2.11																			1
62	*.ophopetalum javanicum*				2.0918																	1
63	*Morinda eliptica*				2.0755																	1
64	*Ficus microcarpa*				2.0736																	1
65	*Ficus aurantiacea*				2.0733																	1
66	*Dillenia pulchella*	2.0027																				1
67	*Eugenia curtisii*	1.7796																				1

Table 10. (contd.).

No.	Species List \ Stand	PD	KU	KL	PW	TD	LB	KS	KP	BY	MR	MN	SL	HP	KT	KR	SM	TM	KW	BP	YN	
	Scienctific Name	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	Count
68	*Litsea johorensis*	1.7704																				1
69	*)ecaspermum fruticosum*			1.602																		1
70	*Phesa robusta*							1.547														1
71	*Litsea grandis*							1.539														1
72	*Eugenia oblata*			1.507																		1
73	*Dacryodes costata*					1.2348																1
74	*Dacryodes incurvata*					1.2334																1
75	*Acacia mangium*										30.656											1
	Total	24 spp	29 spp	30 spp.	26 spp	28 spp.	11 spp	22 spp.	1 sp.	1 sp.	3 spp.	7 spp.	1 sp.	3 sp.	1 sp.	1 sp.	1 sp	1 sp	1 sp.	1 sp	1 sp.	

relation of plant community type dominated by *Melaleuca cajuputi,* called Melaleuca group. It is observable that all of these stands are in secondary PSF, occurring in both PSF studied sites. Furthermore, some of KK PSF are similar to some stands of conservation zone and development zone in Toh Daeng PSF. These show close relation to group of plant stands in preservation zone of the primary PSF in Toh Daeng PSF.

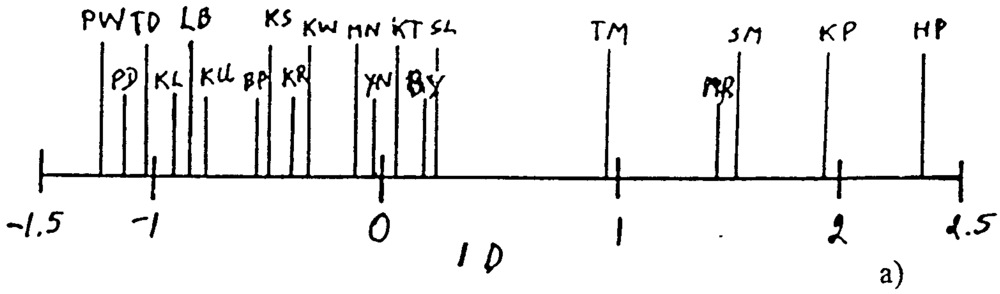
Moreover there are two other groups of SLCA dendrograme tree, including preservation zone of the primary PSF in Toh Daeng PSF. First, it is the group of high diversity species and stand 1 (PD) has the closest relation to stand 5 (TD) presented by *Eugenia kunsteri* this pair also has the similarity to stand 3 (KL) where *Eugenia kunsteri* is the dominant species with high diversity, so it is called *Eugenia kunsteri* group. This group also shows close relation to stand 2 (KU) and has 30 species which is the highest diversity in this study. It showed there are many similar species between *Eugenia kunsteri* group and KU, which had similar species of Melaleuca group. Consequently it is named KU group while other two stands of the primary PSF, stand 4 (PW) and stand 6 (LB), shows the close relation pair with *Macaranga pruinosa* which is the dominant species. So it is highly related to KU group and called *Macaranga pruinosa* group.

The demonstration of the relationship of plant community types were divided by the important value which represented the structure of each stand.

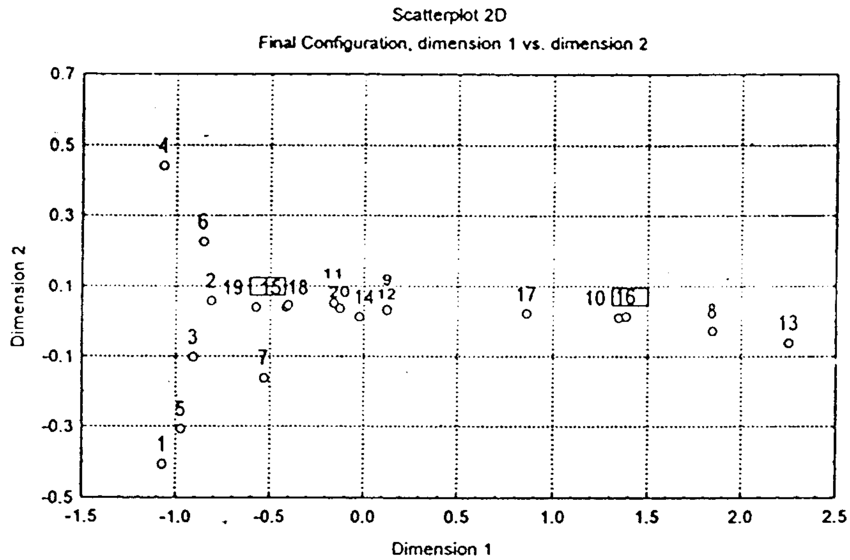
3.4. Ordination of Plant community.

3.4.1 Stand Ordination

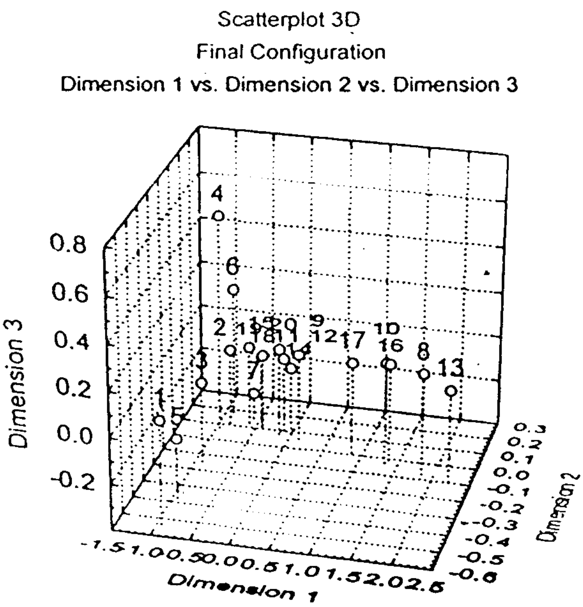
Stand Ordination was analyzed by floristic/vegetation data with NMDS Methods, indicating relation of stands in 1, 2 and 3 dimensions in Figure 45 a, b, c respectively. The correlation analysis showed that the calculated interstand distances and the corresponding data matrix values for the same stand pair were highly significant with correlation, of = 0.887, which proved to be acceptable for partial display of the data matrix. The positions of each stand on dimensions 1,2; 2,3, and 3,1 were displayed in Figure 46 a, b, c respectively.



a)

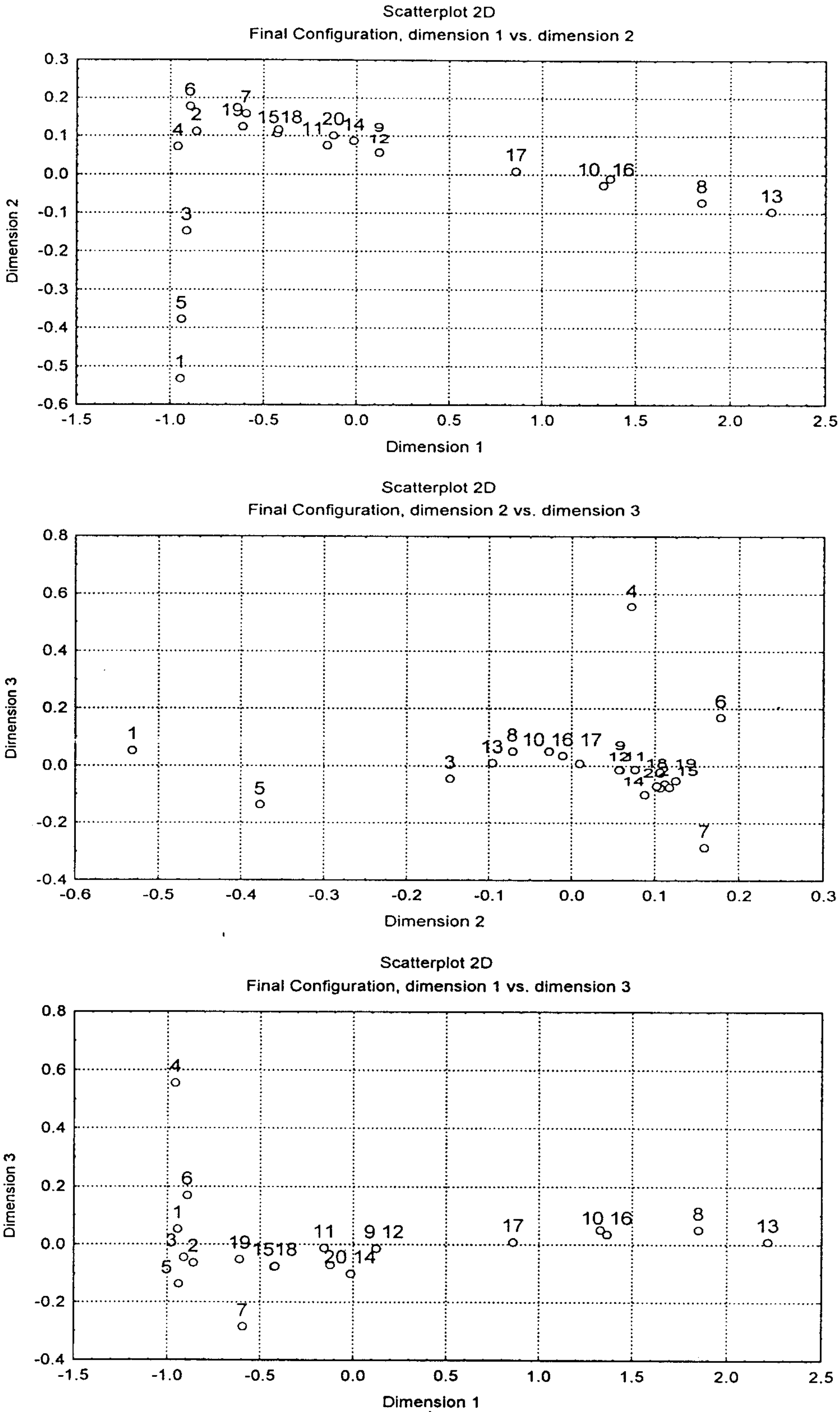


b)



c)

Figure 45 Stand Ordination of NMDS a) by one dimension
b) by two dimension c) by three dimension



a

b

c

<u>Figure 46</u> NMDS of 3 dimension of Stands ordination
a) ordinated by D1D2 b) by D2D3 and c) by D1D3

Community Ordination of sample stands were based on importance values with NMDS method, with the gradient ordinates values on one, two and three dimensions shown in Appendix 5. The stand ordination of all stands in PSF ordinated by 1, 2 and 3 dimensions were shown in Figure 45.

Stand ordination by one dimension showed very interesting of their relations gradient to axis as shown in Figure 45 a . It was started by the first group on the left hand side which was the community of *Macaranga pruinosa* (PW and LB) surrounded with *Eugenia kunstleri* community (PD, TD and KL) and connected to stand KU which had high species diversity with many swampy species. Second group was the group of *Melaleuca cajuputi* community from BP to HP, that showed the prominent of their connection to first group by BP that had low number of only one species of *Melaleuca cajuputi* distributed with grasses and then KS that had *Melaleuca cajuputi* and many other species with high H′. According to the stands of Melaleuca-Cyperaces, KT and then Melaleuca-Grass, KW, continue to MN which had *Melaleuca cajuputi* and other few species and then Melaleuca-Cyperaces, YN and KR, according to the distribution of only *Melaleuca cajuputi* stand, BY,SL,and TM. However there is the stand that has *Melaleuca cajuputi* and a few other species,

MR and HP, consequently with the Disturbed *Melaleuca cajuputi* stand of KK PSF and then reforestry stand of *Melaleuca cajuputi.* As note above, it had distinctively ordination of plant community group of with and without *Melaleuca cajuputi.*

There were classified to three groups when comparative to 2 D ordination (see Figure 45 b). First group, presenting at horizon gradient on the left of diagram were stand ordinate of plant community without *Melaleuca cajuputi,* which was the same as first group as one dimension ordination, but better demonstrated relation between stands. Stand PD and TD showed the closest relation of dominant species, *Eugenia kunstleri with* close relation to KL that dominated by *Eugenia kunstleri* Second dominant species was *Ganua motleyana* and other species which resulted in the closest relation to KU which had the highest species diversity. Whereas another close relation pairs were PW and LB which dominated by *Macaranga pruinosa* with other species same as some species of KU. Consequently, this group had high species diversity and composed of all stands in primary zone of TD PSF. At the top of the middle showed high relation of first group and second group in Stand 2, KU. Second group, was on above middle left gradient to middle composed of stand 19, BP Then companion pairs of KR and KW, after with pairs of MN, YN and KT, followed to the closest pairs of BY and SL. Whereas lower of this group was KS, which had rather high species diversity with mostly like species of first group, although it had *Melaleuca cajuputi.* Third group had present on the middle of diagram, composed of 5 stands, TM represent the closest relation to second group, continue to companion pairs of MR and SM, accordingly to KP and HP present far from others, at the end of these groups.

There were similarity in the case of comparative arrangement of 2D and 3D ordination (see Figure 45 c). The arrangement of 2D and between 1 and 3 of 3 D ordination (Figure 46) had supported the separately present of KS, in which very close to first group. It mean KS composed of old swampy species, pioneer species of PSF and also *Melaleuca cajuputi.*

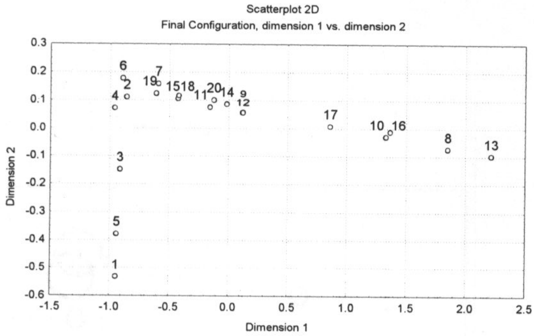
The results of stand ordination by MDS method were quite the same as the results of SLCA method. The relationship of interstand of each PSF area showed highly close relation between plant communities.

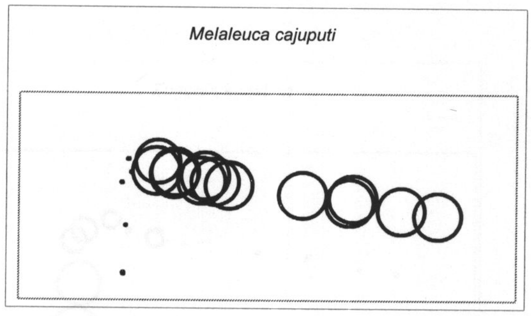
3.4.2 Species Ordination

The behavior of the tree species on the ordination was expressed by their importance values (Curtis and McIntoch 1950, 1951) and measurement of species performance (Swan and Dix 1966). For application, the importance values of each species were displayed on the three ordination diagrams using circles of the different sizes circles to represent selected levels of the importance values. Species performances can be compared.

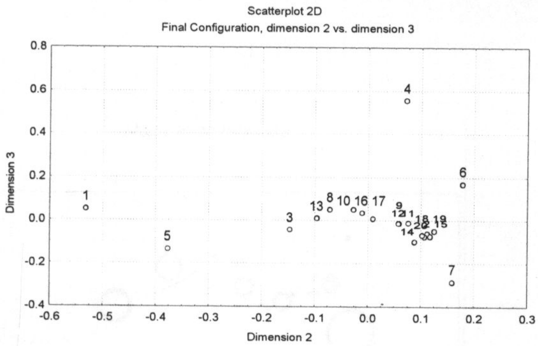
Four Tree species; *Melaleuca cajuputi, Macaranga pruinosa, Eugenia kunstleri* and *Ganua motleyana* are important dominances in the canopy layer. Consequently the structural analysis was made based on the performances of these species.

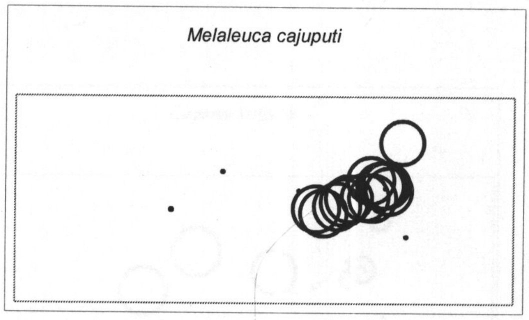
The ordination of dominance second dominant and important species were shown in Figure 47 to 50 respectively.



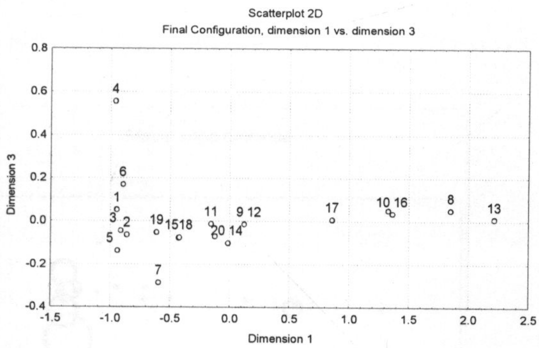


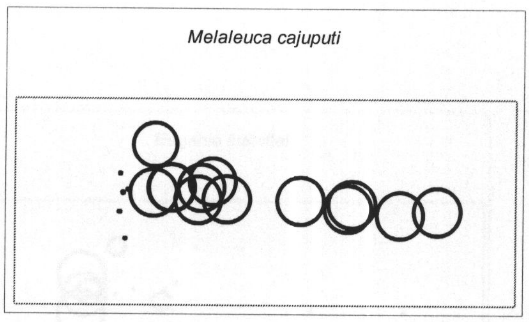
Melaleuca cajuputi (D1, D2)





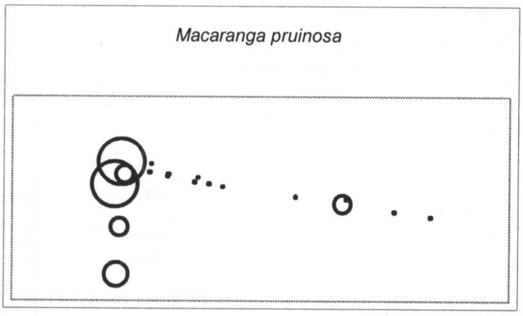
Melaleuca cajuputi (D2, D3)



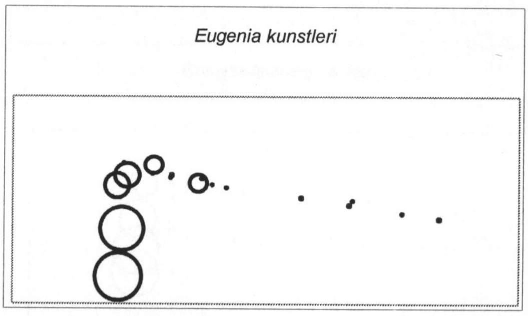


Melaleuca cajuputi (D1, D3)

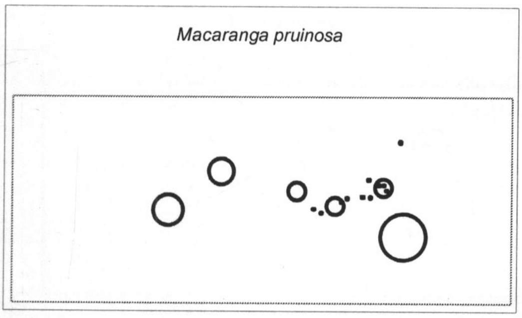
Figure 47 The ordination of dominant species, *Melaleuca cajuputi.*



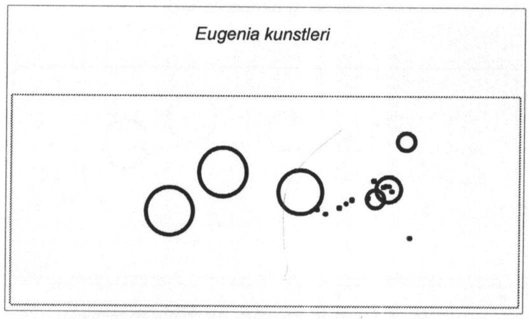
Macaranga pruinosa (D1, D2)



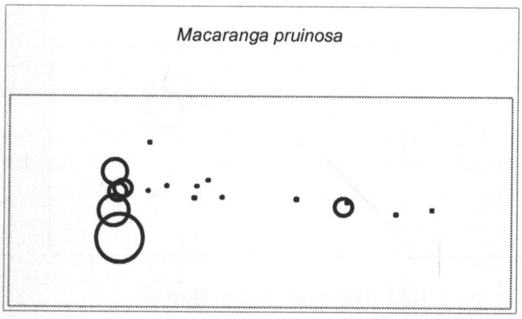
Eugenia kunstleri (D1, D2)



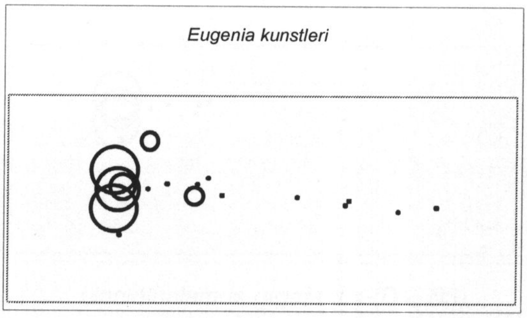
Macaranga pruinosa (D2, D3)



Eugenia kunstleri (D2, D3)



Macaranga pruinosa (D1, D3)



Eugenia kunstleri (D1, D3)

<u>Figure 48</u> The ordination of dominant species, *Macaranga pruinosa* and *Eugenia kunstleri*.

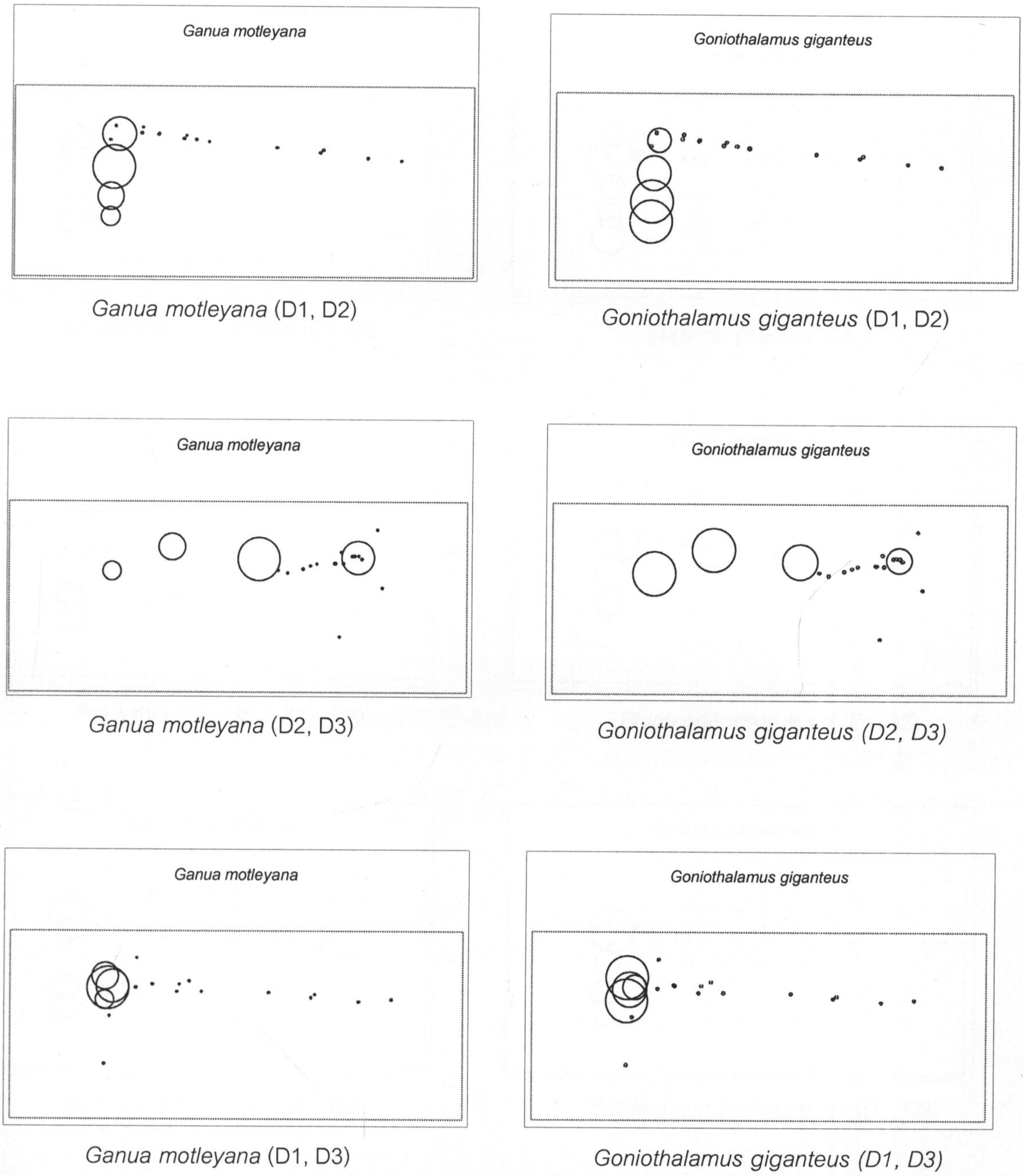
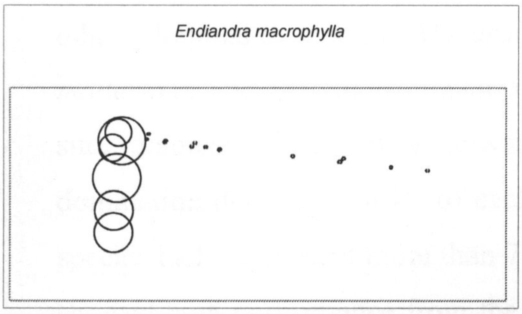
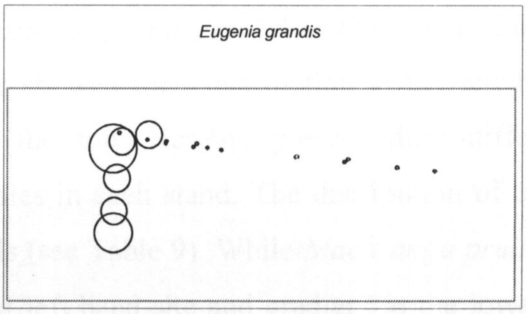


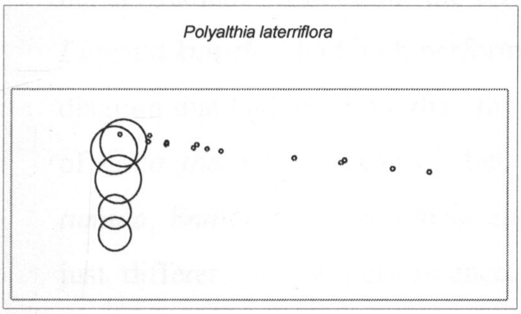
Figure 49 The ordination of dominant species, *Ganua motleyana* and *Goniothalamus giganteus*.



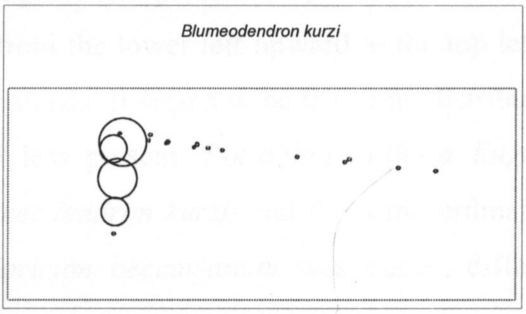
Endiandra macrophylla (D1, D2)



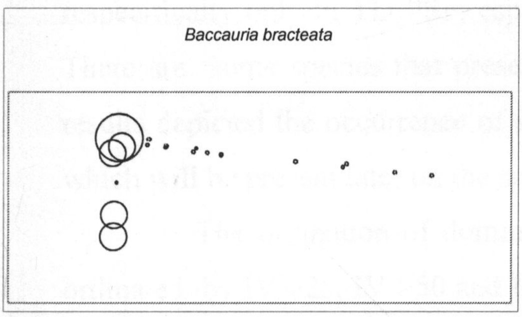
Eugenia grandis (D1, D2)



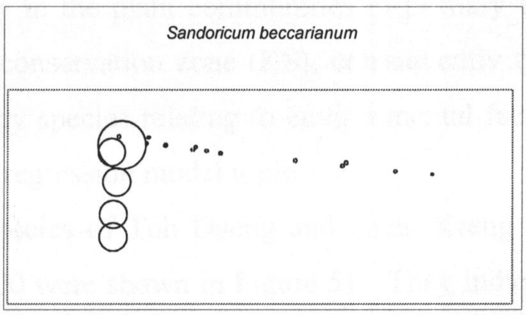
Polyalthia laterriflora (D1, D2)



Blumeodendron kurzi (D1,D2)



Baccauria bracteata (D1, D2)



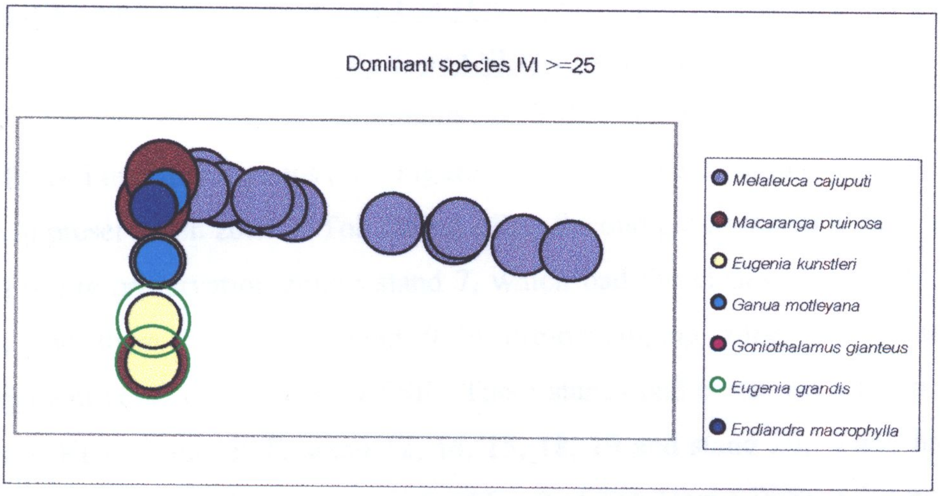
Sandoricum beccarianum (D1, D2)

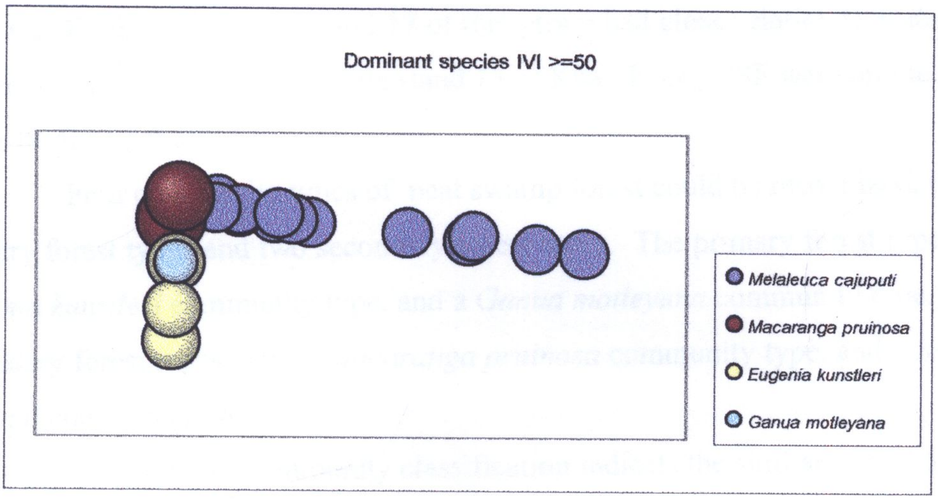
Figure 50 The ordination of secondary dominant species, *Endiandra macrophylla, Eugenia grandis, Polyalthia laterriflora, Blumeodendron kurzi, Baccauria bracteata* and *Sandoricum beccarianum.*

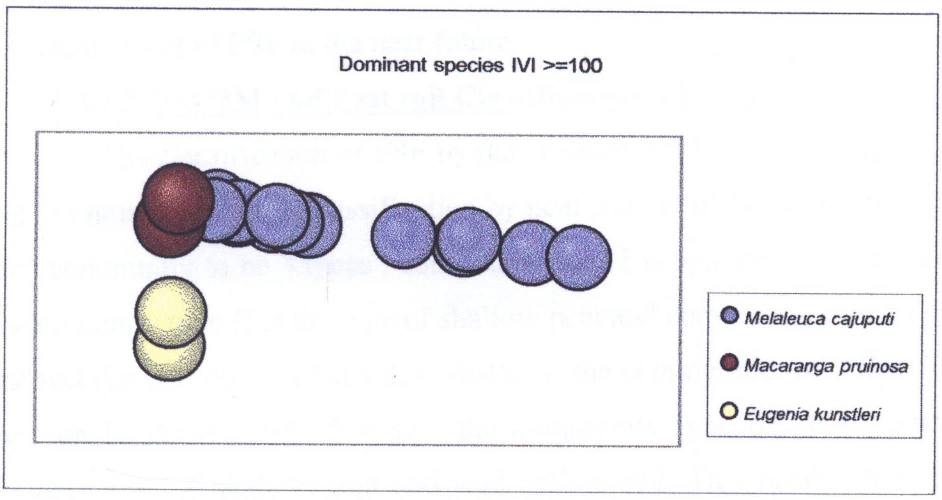
D1D2-ordination of *Melaleuca cajuputi* (Figure 47), has its highest performance at the top left of the diagram and forms gradients toward the right lower part of the diagram. It showed the most wildly distribution in this studied. In contrast, other dominant species *Macaranga pruinosa, Eugenia kunstleri* and *Ganua motleyana*, and second dominant species showed their distribution at the left hand site, gradients from lower upward to the top. Hereby, present their different domination depended on IV of each species in each stand. The distribution of other species had not present more than 7 stands (see Table 9). While *Macaranga pruinosa* showed high performance from the top of left hand site and gradient to the lower, it distributed to the lower right one stand. *Ganua motleyana*, had the same distribution but it gradient ordinate on the left of diagram and present only 4 stands. Whereas *Eugenia kunstleri* had high performance from the lower left upward to the top left of diagram that had lower IV than the lower stands. It seems to be the same distribution of *Goniothalamus gianteus,* but it had less present. *Poltalthia latiferla Eugenia tumida*, *Endiandra mycrophylla* and *Blumeodendron kurzii* had the same ordination, just different in IV performance. *Sandoricum beccarianum* was quite different fromothers as shown in Figure 47-50.

As mentioned above, the results indicate that other species occur respecifically only in TD PSF, especially in the plant communities in primary PSF. There are some species that present in conservation zone (KS), consequently these results depicted the occurrence of swampy species relating to environmental factors, which will be present later on the species regression model topic.

The ordination of dominant species of Toh Daeng and Kuan Kreng PSF ordinated by IV >25, IV >50 and IV >100 were shown in Figure 51. They indicated the species distribution along the stand and their composition in each stand that prominently divided the community type.







<u>Figure 51</u> Dominant species Ordination of Phru Toh Daeng and Phru Kuan Kreng. (with IV >=25, IV>= 50 and IVI >=100)

3.5 Peat Swamp Classification of Toh Daeng and Kuan Kreng PSF.

3.5.1. Plant Community type (SLCA, NMDS)

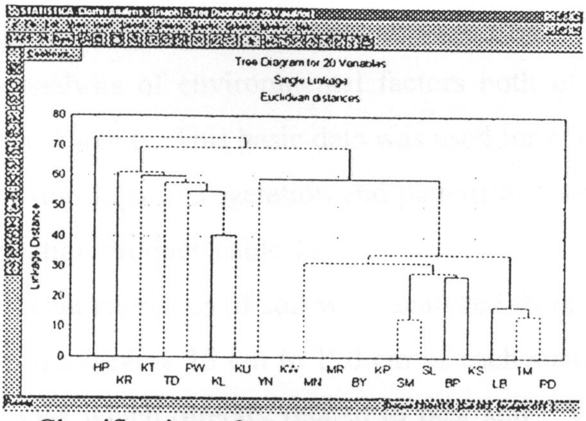
In this study, plant community, both data analysis of SLCA and NMDS were divided into three groups (see Figure 44-46). The first group is primary PSF which in preservation zone of Toh Daeng PSF. Second group included both stands (7 and 9) in pre-preservation zone : stand 7, which had the closest relation to the first group, and there were also stand 9 in pre-developing zone, and stand 11 in development zone, of Toh Daeng PSF. There stands had close relationship to many stands of Kuan Kreng PSF; stand 12, 14, 15, 18, 19 and stand 20, which have been highly disturbed. Third group, were stand 8, 10 of Toh Daeng PSF; and stand 16, 17, and 13 of Kuan Kreng PSF. Stand 17 of this group had close relation to stand 9,12 of the second group, It indicates while stand 13 of Kuan Kreng PSF were on the right top rather far from others.

Four community types of peat swamp forest could be recognized, two primary forest types and two secondary forest types. The primary forest types were a *Eugenia kunstleri* community type, and a *Ganua motleyana* community type. The two secondary forest types were a *Macaranga pruinosa* community type, and a *Melaleuca cajuputi* community type.

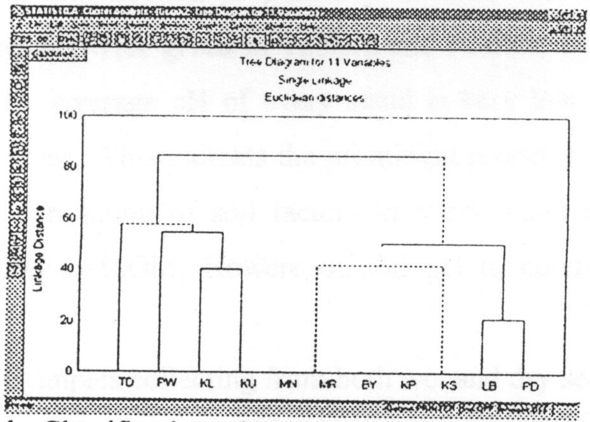
The group of community classification indicats the similarity and the resemblance of plant in some plant stands of KK PSF and TD PSF which benefiting to the management of PSF in the near future.

3.5.2 Soil OM and Peat soil Classification (SLCA)

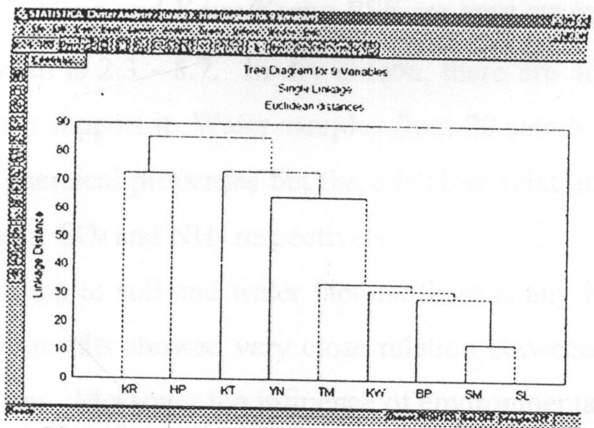
The classification of PSF by peat (%OM >= 2o % with depth >= 40 cm. shown in Figure 52. SLCA classification by peat soil at 30 % Euclidean distance can divided community to be 3 types : community type I is confined to moderate to thick peat, community type II is the type of shallow peat and community type III is the acid sulfate soil type. At 60 % of Euclidean distance, the communities of PSF at Toh Daeng can be divided into 2 type : the community type of thick peat and the community type of shallow peat and acid sulfate soil. This results depicts that the depth of peat is the important factor to classify PSF.



a. Classification of 20 stands of PSF (Peat)



b. Classification of 11stands of TohDaeng PSF (Peat)



c. Classification of 9stands of KuanKreng PSF (Peat)

<u>Figure 52</u> Classification of PSF by Peat a) of all 20 stands
b) of 11 stands of Toh Daeng PSF
c) of 9 stands of Kuan Kreng PSF

3.6. Vegetational and Environmental relationships of PSF.

The data analysis of environmental factors both of soil and water of 20 stands were shown in Table 6. This basic data was used for classification of soil type and studying the relationships of vegetation and pattern of species distribution given in the Pearson Correlation Product Table 11.

Chemical characteristics of soil were analyzed from soil samples collected from different depth from every 15 cm to 120 cm of each stand. The characteristics of soil pH and soil OM which directly related to peat soil (Vijarnsorn, 1989) were discussed. The important chemical properties of the soils were analyzed at 8 depths.

The results were given in Table 6 and Pearson Correlation Product was shown in Table 11. Average pH of every stand is very low indicating strong acid condition in these areas. This indicats the prominent property of PSF characteristics. Other soil factors correlation of soil factors in every stand showed no significant difference only CEC to %OM, Howere of soil pH to conductivity showed close relations.

Water samples collecting from both wet and dry seasons inside and outside the study standied were analyzed. In term of chemical properties, water samples from Toh Daeng and Kaun Kreng PSF are very strong acidity (pH 3.0-4.5), and dissolved oxygen is 2.3 - 8.7. In dry season, there are no water in many stand and very dry climate support it Water samples from 20 stands showed no significant difference among chemical properties but there is close relation between Mg Ca and EC, EC and hardness, SO_4 and NH_4 respectively.

Regarding to soil and water factors, there is any interesting relationship between them The results showed very close relation between soil Na and Mg, EC, and hardness of water. Moreover the influence of environmental factor to the patterns of species distribution of plant community appeared cleaely.

Soils with 125 cm. depth of 20 studied stands are categorized into 3 groups, thick peat, moderate or shallow peat and acid sulfate soil (as mentioned above).

Table 11 Pearson Product of environmental variables of 20 study stands of Toh Daeng andKuanKreng PSF.

	Stand	DIM. 1	DIM. 2	DIM. 3	OM1	OM2	OM3	OM4	OM5	OM6	OM7	OM8	pH
Stand	1.00												
DIM. 1	0.37	1.00											
DIM. 2	0.45	0.00	1.00										
DIM. 3	0.26	0.00	0.00	1.00									
OM1	-0.42	-0.32	-0.46	0.02	1.00								
OM2	-0.39	-0.23	-0.40	-0.16	0.89	1.00							
OM3	-0.44	-0.59	-0.31	-0.20	0.74	0.83	1.00						
OM4	-0.27	-0.23	-0.17	-0.03	0.70	0.85	0.74	1.00					
OM5	-0.21	-0.17	-0.20	-0.06	0.71	0.78	0.68	0.82	1.00				
OM6	-0.01	-0.04	-0.18	-0.08	0.63	0.68	0.48	0.66	0.82	1.00			
OM7	-0.01	0.04	-0.11	-0.10	0.67	0.51	0.30	0.48	0.78	0.86	1.00		
OM8	0.12	0.23	0.01	-0.07	0.40	0.38	0.12	0.41	0.70	0.69	0.91	1.00	
pH	-0.31	-0.34	-0.24	-0.13	0.40	0.53	0.60	0.46	0.49	0.39	0.13	0.14	1.00
Conductivi	0.66	0.13	0.23	0.22	-0.26	-0.40	-0.41	-0.33	-0.33	-0.22	-0.01	-0.02	-0.82
Ca	0.61	-0.10	0.09	0.27	0.08	0.11	0.20	0.21	0.41	0.33	0.36	0.64	0.33
Mg	0.41	-0.14	-0.02	0.22	-0.13	-0.26	-0.26	-0.29	-0.32	-0.30	-0.11	-0.08	-0.36
K	-0.12	-0.06	-0.04	0.02	0.26	0.31	0.06	0.23	0.20	0.16	0.18	0.21	0.15
Na	0.16	0.01	0.09	0.18	-0.06	0.03	0.12	0.06	0.31	-0.06	0.01	0.28	0.40
EA	0.12	-0.13	-0.06	0.00	0.67	0.76	0.66	0.66	0.73	0.70	0.69	0.69	0.24
CEC Soil(	-0.15	-0.16	-0.21	-0.05	0.72	0.84	0.66	0.79	0.86	0.76	0.72	0.86	0.38
%(B/C)	0.60	-0.01	0.07	0.36	-0.32	-0.37	-0.29	-0.34	-0.33	-0.34	-0.28	-0.16	-0.22
W-pH	0.30	-0.30	-0.11	-0.04	0.28	0.24	0.27	0.32	0.32	0.34	0.26	0.28	0.27
W-EC	0.16	0.06	0.14	0.12	-0.25	-0.18	-0.06	-0.15	0.09	-0.24	-0.16	0.12	0.17
W-Alkalinit	-0.07	-0.47	0.10	-0.33	0.12	0.21	0.30	0.07	-0.11	-0.01	-0.12	-0.14	0.30
W-Ca	0.06	0.11	-0.26	0.10	-0.14	-0.13	-0.06	-0.26	-0.09	-0.30	-0.17	0.06	0.12
W-Mg	0.26	0.13	0.13	0.14	-0.22	-0.14	-0.06	-0.16	0.09	-0.25	-0.14	0.13	0.19
W-Fe	0.03	0.00	0.17	-0.09	-0.41	-0.37	-0.36	-0.29	-0.29	-0.31	-0.27	-0.28	-0.24
W-Mn	0.05	-0.22	-0.16	0.29	0.20	0.00	0.01	-0.07	0.06	0.32	0.30	0.23	0.31
W-Cu	0.33	0.23	0.11	0.19	-0.02	0.03	-0.08	-0.01	0.09	0.09	0.07	0.06	-0.25
W-Zn	-0.46	0.07	-0.09	-0.29	-0.40	-0.44	-0.30	-0.33	-0.36	-0.41	-0.30	-0.28	-0.12
W-Al	-0.07	0.16	0.24	-0.06	-0.24	-0.21	-0.29	-0.33	-0.33	-0.30	-0.17	-0.20	-0.43
W-SO*4	0.24	0.34	0.16	-0.22	-0.36	-0.26	-0.28	-0.35	-0.12	-0.26	-0.06	0.12	-0.23
W-NH4	-0.10	-0.21	0.31	-0.29	-0.08	-0.02	0.09	-0.08	-0.16	-0.19	-0.17	-0.13	0.24
W-NO3	0.08	-0.17	0.16	0.41	0.09	-0.09	-0.13	-0.13	0.00	0.05	0.09	-0.04	-0.14
W-DO	0.00	0.34	-0.16	-0.06	-0.38	-0.42	-0.36	-0.28	-0.07	-0.23	-0.09	-0.08	-0.33
W-Hardnes	0.20	0.13	0.01	0.12	-0.21	-0.14	-0.06	-0.20	0.04	-0.27	-0.18	0.12	0.18
W-Turbidit	0.63	-0.06	0.33	0.02	-0.31	-0.15	0.06	0.10	-0.18	-0.12	-0.28	-0.24	-0.03

	onductivi	Ca	Mg	K	Na	EA	EC Soil(	%(B/C)	W-pH	W-EC	W-Alkalinity	W-Ca	W-Mg	W-Fe	W-Mn	W-Cu	W-Zn	W-Al	W-SO*4	W-NH4	W-NO3	W-DO	V-Hardness	V-Turbidity
Conductivi	1.00																							
Ca	0.08	1.00																						
Mg	0.66	0.24	1.00																					
K	-0.29	-0.02	-0.05	1.00																				
Na	-0.23	0.63	-0.07	0.05	1.00																			
EA	0.06	0.42	0.08	0.23	0.07	1.00																		
CEC Soil(	-0.22	0.39	-0.13	0.60	0.19	0.82	1.00																	
%(B/C)	0.57	0.42	0.84	-0.16	0.22	-0.05	-0.18	1.00																
W-pH	0.12	0.53	0.40	0.15	0.18	0.26	0.35	0.39	1.00															
W-EC	-0.09	0.44	-0.16	-0.03	0.89	-0.16	-0.07	0.11	0.01	1.00														
W-Alkalinit	-0.20	0.06	0.17	0.26	-0.10	0.16	0.11	-0.06	0.33	-0.19	1.00													
W-Ca	0.02	0.42	0.11	-0.08	0.67	-0.17	-0.06	0.28	-0.03	0.76	-0.10	1.00												
W-Mg	-0.06	0.51	-0.03	-0.03	0.94	-0.06	0.00	0.26	0.05	0.96	-0.13	0.77	1.00											
W-Fe	0.20	-0.27	0.01	-0.08	-0.17	-0.24	-0.40	0.03	-0.28	0.11	-0.36	-0.06	-0.06	1.00										
W-Mn	-0.11	0.37	0.13	0.13	-0.10	0.07	0.12	0.14	0.27	-0.25	0.14	0.02	-0.23	-0.29	1.00									
W-Cu	0.32	0.02	0.12	-0.28	0.10	0.24	-0.02	0.17	-0.10	0.15	-0.25	-0.06	0.14	0.18	-0.55	1.00								
W-Zn	-0.14	-0.46	-0.16	-0.24	-0.23	-0.63	-0.46	-0.16	-0.38	-0.11	-0.33	-0.01	-0.21	0.44	-0.04	-0.41	1.00							
W-Al	0.09	-0.42	-0.24	0.34	-0.22	-0.11	-0.10	-0.34	-0.69	0.06	-0.04	0.04	-0.01	0.35	-0.24	-0.02	0.06	1.00						
W-SO*4	0.24	0.16	0.03	-0.03	0.48	-0.09	-0.08	0.14	-0.22	0.66	-0.18	0.70	0.69	0.12	-0.32	0.09	0.02	0.38	1.00					
W-NH4	-0.26	-0.07	-0.07	-0.28	0.03	-0.01	-0.30	-0.26	-0.18	0.08	0.55	-0.04	0.08	-0.02	-0.19	0.13	-0.12	0.08	-0.01	1.00				
W-NO3	0.09	-0.08	0.23	0.19	-0.06	0.08	0.01	0.10	0.08	-0.21	0.17	-0.38	-0.10	-0.38	0.20	0.07	-0.34	0.00	-0.26	0.06	1.00			
W-DO	0.09	-0.18	-0.09	-0.04	0.16	-0.47	-0.26	0.03	-0.10	0.29	-0.61	0.14	0.24	0.21	-0.29	-0.03	0.42	0.10	0.36	-0.46	0.03	1.00		
W-Hardnes	-0.04	0.61	0.01	-0.06	0.90	-0.09	-0.02	0.27	0.03	0.93	-0.12	0.88	0.88	-0.06	-0.16	0.08	-0.15	0.01	0.74	0.06	-0.20	0.22	1.00	
W-Turbidit	0.22	0.32	0.27	-0.28	-0.10	0.06	-0.13	0.41	0.31	-0.21	0.22	-0.28	-0.13	0.00	-0.06	0.06	-0.15	-0.31	-0.32	0.09	-0.18	-0.23	-0.19	1.00

3.7. Species regression model of PSF.

3.7.1 Species regression model of PSF. (Stepwise Multiple Regression)

Regression analysis is one of the most efficiency method for displaying relationships between the distribution of species and environmental gradients. Since species is not controlled by only one environmental factor, therefore, multiple regression analysis is the most efficiency productive method. The importance values of each selected species were treated as the dependent variables and the environmental factors were treated as the independent variables in the multiple regression models following this general equation;

$$\mathbf{Y = b_0 + b_i x_i + \ldots\ldots\ldots\ldots\ldots\ldots + b_n x_n \pm SE}$$

Where: **Y** = dependent variable (the importance values of each selected species)

b_0 = Y intercept

b_i = partial regression coefficient where I =1 ….n

(number of independent variables used in the general equation)

x_i = independent variables

SE = standard error of estimation

The stepwise elimination multiple regression was run with **STATISTICA** program on some environmental data (soil and water characteristics).

Results regression model of all stands was :

Y = 1.0387 +0.151 **% BC** –0.4027 **Zn-w** +0.8894 **OM1** +0.5471 **OM6**

– 0.2056**Conductivity** +0.8894 **Turbidity-w** –0.7127 **OM3**

+ 0.6481 **SO_4-w** –0.7467 **OM2** –0.1729 **OM8** +0.1144 **Fe-w** ± 0.6514

(**R** = 0.9974, $\mathbf{R^2}$ = 0.9949 , **p** = 0.00)

Species Regression Model of Dominance species and Co-dominance species

The selected multiple regression model for dominance species and co-dominance species each species based on the multiple correlation coefficient from independent variables were given in Table 12. The multiple correlation coefficient (**R**) of the selected range from 0.996 – 0.999 and the coefficient of determinations ($\mathbf{R^2}$) of 0.992-0.999 indicated high correlation. Thus, it can be said that the species performance is highly correlated with the environmental factors appearing in each model.

Table 13 Predictive multiple regression equations based on species performance (importance value) of the important species along environmental parameters.

Selected Species	Selected Regression Model
Melaleuca cajuputi	Y = 385.691 –0.60OM3 +1.25Mn-w –0.11NH_4-w +0.66Zn-w +0.31OM1 +1.31OM6 –1.8OM5 –0.16 pH–w –0.50Cu +0.331NO_3-w - 0.38Alkalinity +0.153pH-s +0.94EA –0.86K +0.030 SO_4-w +0.17OM4 -0.01EC-w ± 0.0707 (R = 9999, R^2 = 9999, p = 0.0003)
Macaranga pruinosa	Y = – 68.352 +1.07NH_4-w + 0.822OM3 – 0.01Zn-w + 0.732 pH-w – 0.92Ca-s + 0.375OM7 –0.85 OM4 – 0.29NO_3-w –0.54OM1+0.36OM8 –0.33Cu-w –0.56Alkalinity –0.20DO-w +0.533CEC – 0.34Ca-w +0.309Hardinity –0.06Fe-w –0.02OM2 ± 0.3117 (R = 0.9999, R^2 = 0.9999, p = 0.0043)
Eugenia kunstleri	Y = – 22.192 +0.182 OM1 –0.49 OM8 +1.40 Ca-w –0.76 SO_4-w +0.395OM7 +0.579 DO-w – 0.43 EC-w +0.547 OM2+0.351Alkalinity +0.338 Fe-w +0.298 NO_3-w –0.09K +0.204 Mn-w +0.099 Cu-w +0.059OM4 +0.037 OM6 –0.12Mg-w +0.034pH-w ± 0.1941 (R = 0.9999, R^2 = 0.9999, p = 0.0034)
Ganua motleyana	Y = 2.1279 +1.66 OM4 – 0.88 OM6 +0.169 Mg-w –0.81OM5 –0.87OM8 +1.46OM7 –0.14NH_4-w – 0.02Conductivity –0.24 SO_4-w –0.22pH-w +0.227Ca-w +0.194OM3+0.221DO-w+0.177 NO_3-w + 0.044 Mn-w + 0.096 Fe-w + 0.057 Na (R = 0.9999, R^2 = 0.9999, p = 0.0021)
Goniothalamus giganteus	Y = – 21.9586 +0.364OM1 –1.6OM8 +0.346DO-w – 0.25 Mn-w +1.39Ca-w –0.94 SO_4-w +1.28OM7 –0.73EC-w +0.058 pH-s –0.52 OM3 +0.324Alkalinity +0.813OM5 +0.158Fe-w + 0.388Hardinity –0.11CEC –0.15 Ca-s ± 0.1402 (R = 0.9999, R^2 = 0.9999, p = 0.0000)

Table 13 (contd.)

Selected Species	Selected Regression Model
Eugenia grandis	Y = – 34.1766 –0.21Cu-w +1.27OM3 +0.176Zn-w +0.585 pH-w +0.003 Turbidity-w –0.82 OM4 + 0.404OM2 –1.4Ca-s –0.72OM1 +0.743OM8 + 0.390 %BC + 0.348 Mn-w + 0.186 EC-w – 0.12 NO_3-w +0.005 DO-w –0.12 SO_4-w +0.161 Ca-w +0.248 OM5 ± 0.0193 (R = 0.9999, R^2 = 0.9999, p = 0.0020)
Endiandra macrophylla	Y = 21.7672 +0.905OM3 +0.571Ca-s –0.09 NH_4-w –0.62OM6 +0.307OM4 –0.10Mn-w – 0.23OM7 –0.02Cu-w –0.72OM1 –0.83 Turbidity-w –0.35Mg-w +0.681 OM2 –0.37 SO_4-w – 0.27 pH-s +0.117DO-w –0.25EC-w –0.05Mg-s –0.01 NO_3-w ± 0.0084 (R = 0.9999, R^2 = 0.9999, p = 0.0009)
Polyalthia lateriflora	Y = 11.7412 +0.894 OM3 –0.74 CA +0.906 CEC –1.0 OM2 +0.481 OM4 –0.16 OM6 –0.17 pH-w –0.09 SO_4-w –0.09 NH_4-w –0.11 DO-w +0.142 EC-w +0.98 %BC ± 1.2039 (R = 0.9921, R^2 = 0.9843, p = 0.0004)
Baccauria bracteata	Y = 13.159 +0.687 NH_4-w +0.452 OM1 –0.45 OM8 +0.436OM7 –0.37 pH-w –0.19 Al-w –0.29EA + 0.187 Cu-w +0.316Alkalinity +0.145 Fe-w +0.19 Ca-s –0.06 %BC ± 0.8401 (R = 0.996, R^2 = 0.992, p = 0.0004)
Blumeodendron kurzii	Y = 12.1315 +0.332 OM4 –0.25 pH-w –0.72 OM8 +2.22 CEC –0.09pH-s –0.49OM6 –0.36SO_4-w +0.002 OM5 –0.74 EA + 0.133 DO-w + 0.210 Mn-w + 0.779 NH_4-w – .41Alkalinity – 0.26Mg + 0.591 Conductivity + 0.40 Fe-w – 0.02 Ca-w + 0.007 Turbidity-w ± 0.0493 (R = 0.9999, R^2 = 0.9999, p = 0.0062)

The influences of each environmental factor on each species are extremely complicated and they cannot be entirely expressed in the regression models. However, the set of variables occurring in the model tend to have more influence on the species than any other set of variables. Each of the environmental variables is retained in the regression, but some occur more frequently than others. The environmental factors with greater frequency in the species models should have more importance for the community structure than those of lower frequency. However, the lower frequency have more importance for consideration of the species behavior than the higher frequency. There are occurrence of 33 independent variables retained in the species regression models of this study.

The overall pattern based on the total number of the independent variables that occur in the species models showed that eighteen parameters occurred six or more times in the species regression models. These included four soil chemical characteristics OM, pH Ca and %BC and ten water qualities: SO_4, NO_3, DO, NH_4, pH, EC, Zn, Mn, Fe and Ca. It had very influence of five depths of peat provides that had been importance for community structure, OM1-15 cm. depth of upper soil, OM3 and OM4 of 31-60 cm depth of upper lower soil, and OM7-OM8 of 91-125 cm depth of lower soil. Figure 53-54 demonstrat the influence of the distribution of the stands along the environmental gradeints.

As mentioned in the Table 11, when considering only soil and water characteristics separately, the correlation of soil chemical property showed only the relation of stand and OM, CEC and %BC, but not showing the relation between stand and depth. And also the relation among others. The relation between the water qualities had not showed the significant relation. When considering both of soil and water property in the stepwise multiple regression, it showed very interesting highly relation among environmental factors especially the relation of many water qualities which may be the effect of **polycoliniarity** that had the very close value of multiple correlation coefficient of soil OM which may be dominated or forbidden the importance efficiency of other environmental factors. This event demonstrated that every environmental factor had influence efficiency to community structure and species distribution and confirmed that species is not controlled by just only one environmental factor.

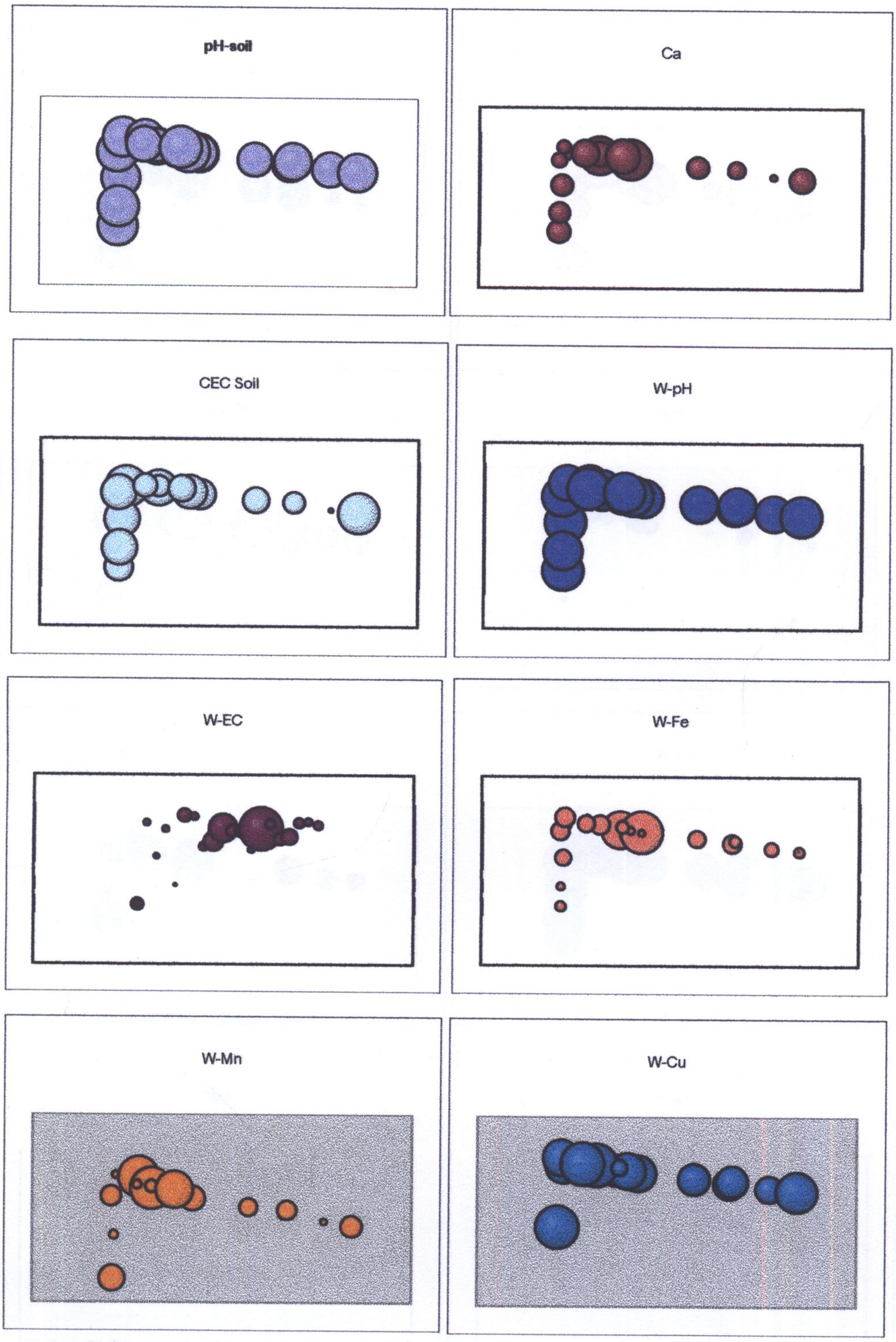


Figure 53 **Stand ordination along the environmental gradient.**
(pH-soil, Ca, CEC soil, W-pH, W-EC, W-Fe, W-Mn and W-Cu)

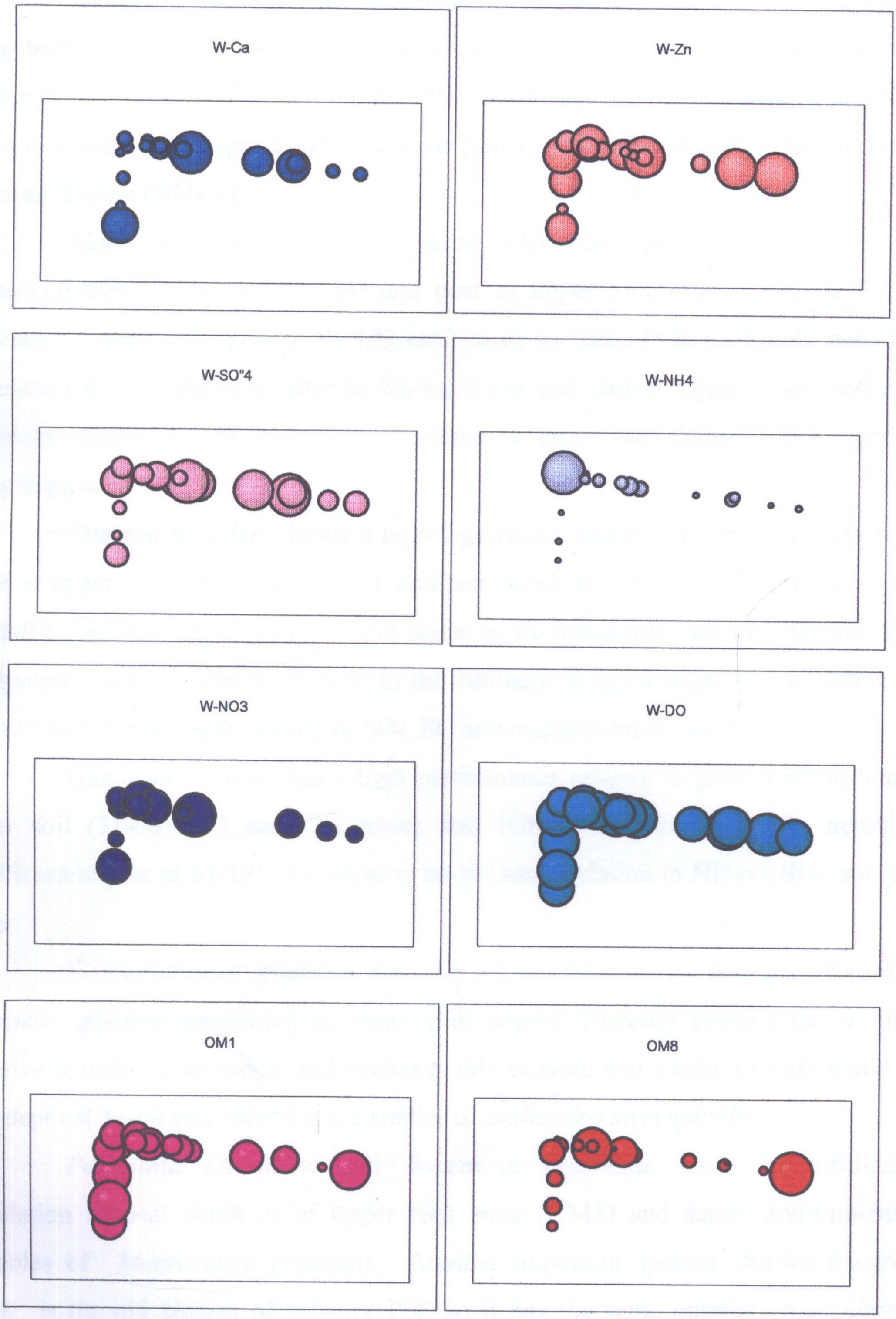


Figure 54 **Stand ordination along the environmental gradient.**

(W-Ca, W-Zn, W-SO4, W-NH4, W-NO3, W-DO, OM1 and OM8)

3.7.2 Species distribution along environmental gradients

Melaleuca cajuputi shows a high significant positive correlation with OM1 (peat depth of upper root zone) and at peat depth of 76-90 cm. or peat of lower soil similar to Mn, Zn NO_3 of water. On the other hand, this species shows high negative correlation with peat depth at 61-75 cm. or peat of upper lower soil, potassium and water-aluminum (NH_4-w).

Macraranga pruinosa has a highly significant positive correlation to water-aluminum (NH_4-w), water-pH and peat of upper root zone (OM3) and also correlate to lower soil (peat at 91-125 cm.) same as CEC. It has a highly negative correlation to exchangeable calcium Zn-w,, Ca-w and peat of upper lower soil and upper soil (OM4, OM1) respectively. In addition it shows the relation to peat layer of many depths.

Eugenia kunstleri shows a high significant positive correlation with peat depth at upper root zone (OM2,OM1) and peat depth at 46-60 and 76-90 cm. (OM 4, OM6), this correlation is to be the same as exchangeable calcium, ferrous and manganese and also water-calcium. In the contrary, it has a negative correlation to peat at106-125 cm. depth slightly to SO_4, EC and magnesium of water.

Ganuo moltylyana has a high performance relative to peat depth at upper lower soil (31-60 cm.) same as lower soil (OM7) and shows highly negative significant to peat at 61-125 cm. seem to ba the same relation to NH_4-w, SO_4, and pH water.

Goniothalamus gianteus has the close relation to *Eugenia kunstleri* especially positive correlation to many peat depths. *Eugenia grandis* has a high negative correlation to copper and exchangeable calcium and calcium solution and to peat depth at 31-60 cm, which is the similar to *Endiandra mycrophylla.*

Polyalthia lateriflora and *Baccauria bracteata*, have the similarity correlation to peat depth at of upper root zone (OM3) and same environmental variables of *Macraranga pruinosa.* Another important species, *Blumeodendron kurzii* is the old species of primary PSF so it has the same correlation as *Ganuo moltylyana. Ganuo moltylyana.*

3.7.3 Species ordination and environmental gradients relationship

Relationship of the environmental gradients on the D1 dimension from the arrangement of the dominant species as shown in Figure 47-50 on the D1 dimension range from *Eugenia kunstleri community* at the lower left of diagram and upward connected to *Ganuo moltyana* type toward to *Macraranga pruinosa* showing on the top upper left hand side. Base on the ecological optima and amplitudes of the species performance on the environmental gradients, peat depth of upper lower soil and of the lower soil or peat of lower root zone, pH of both soil and water seem to be directly connected with the D1 dimension.

Relationship of the environmental gradients on the D2 dimension (Figure 45 b) The best performance for *Macraranga pruinosa* is at the lower left and upward to *Ganuo moltlyana* and to *Macraranga pruinosa. Melaleuca cajuputi* reach its best function performance at the upper middle gradually range to the middle right of the dimension. *Melaleuca cajuputi* best fit distribution though out the range, OM1 peat depth at 1-15 cm. or peat of upper root zone is the best fit and depthof lower soil (91-105 cm.) to this dimension and also of upper lower soil seem to fit this dimension too. *Macraranga pruinosa* and *Ganuo moltlyana* reach its best performance the lower end of this environmental range.

Relationship of the environmental gradients on the D3 dimension. *Macraranga pruinosa* show high performance at the top left of the diagram.

3.8. Community type analysis of PSF.

In previous section, the values of tree were ordinated based on species performance (IV) and the relationships of the species performance to the environmental gradient was analyzed by multiple regression analysis. Stand ordination and environmental gradient relationships can be related by using species performance or species behavior as the parameters. The vegetative structure and patterns of species distribution may be synthesized into a single unit. This analysis was based on the distribution patterns of the selected species of each stand on the D1D2 diagram.

The distribution of the three community types on the ordination diagram was shown in Figure 55. Community type I, *Eugenia kunstleri* community confined

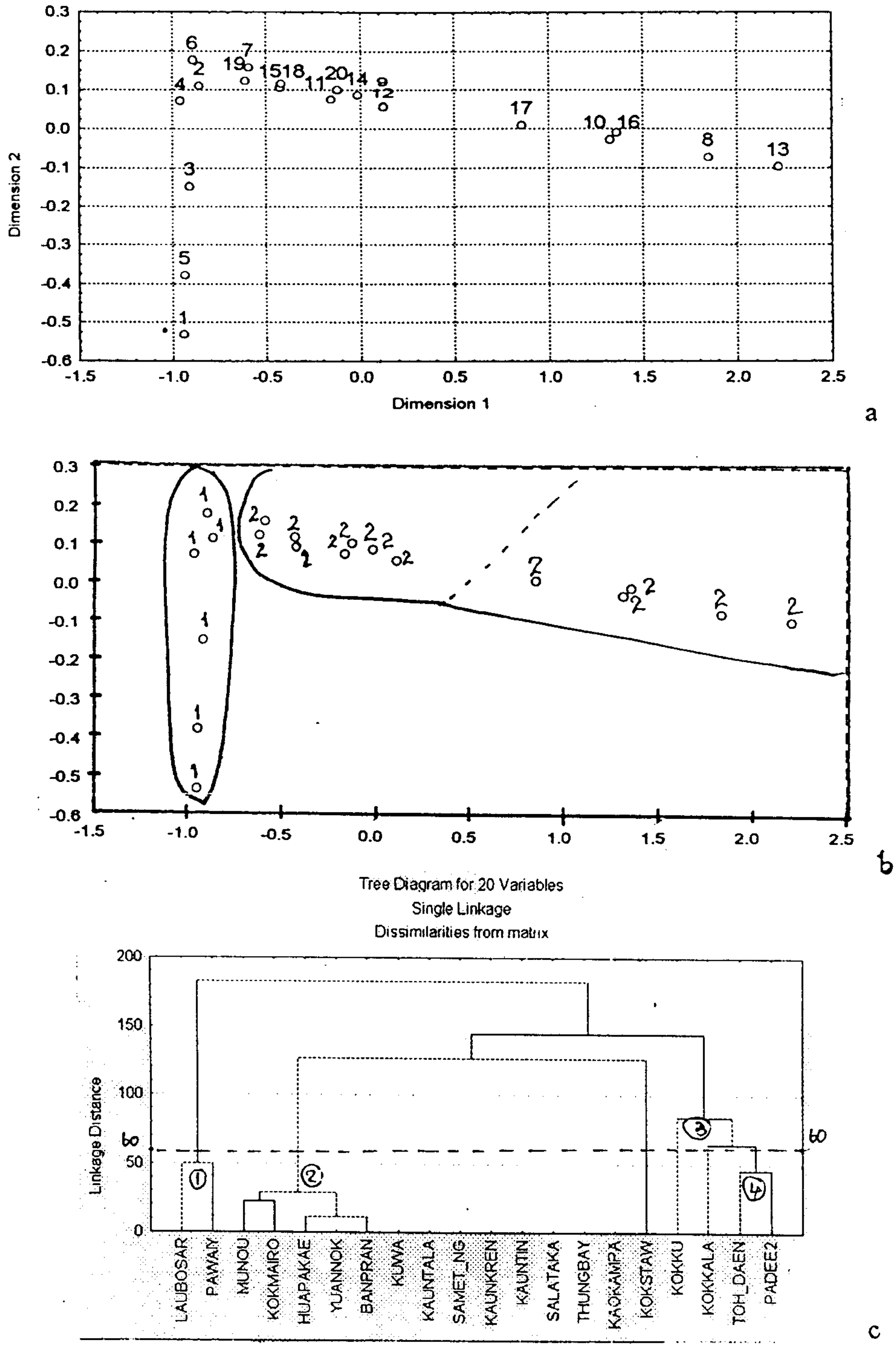


Figure 55 **Community Types of TD and KK PSF.**

a) stand ordination of 20 stands of TD and KK PSF.

b) Community Type I, with *Melaleuca cajuputi* and Community Type II, with out *Melaleuca cajuputi* by NMDS

b) Four Community Types at 60 % of SLCA (1. *Macaranga pruinosa* 2. *Melaleuca cajuputi* 3. *Ganua motleyana* and *Eugenia kunstleri* Community type).

to the lower left of diagram and upward connected to *Ganuo moltyana* community showing on the top upper left hand side. The *Macraranga pruinosa* community had its range on the top left of diagram close to *Ganuo moltylyana* community. Community tupe II, distributed on the upper center and right downward to the lower right was the *Melaleuca cajuputi* type, were the various kinds of vegetation especially shurb, herbs and grasses. Interesting occurrence in this distribution on the top of *Melaleuca cajuputi* type close to the community has variety of other species that are similar to the primary PSF on the left of diagram (see Figure 51).

Regarding to using ordination method to analyse the community type into two types: Community type I and type II : with and without *Melaleuca cajuputi,* it is not discriminate to classified or explained in the detail of species composition in the Community type I in the primary PSF.

According to classified by SLCA method, can explain the dividing the community type in primary PSF into three groups as follow. At 30 % of Euclidean distance, it can divide plant communities of primary PSF into 2 groups or community types : community type with and without *Melaleuca cajuputi,* when considerate classify at 60% of Euclidean distance it dipict the dividing community type to be 4 types : *Macraranga pruinosa* community type, *Eugenia kunstleri* community type, *Ganuo moltyana* community type and *Melaleuca cajuputi* type. These communities types are classified by using the species perfomance of each stand.

SLCA classification by peat soil (Figure 52) at 30 % Euclidean distance can divided community to be 3 types : community type I is confined to moderate to thick peat, community type II is the type of shallow peat and community type III is the acid sulfate soil type. At 60 % of Euclidean distance, the communities of PSF at Toh Daeng can be divided into 2 type : the community type of thick peat and the community type of shallow peat and acid sulfate soil. This results depicts that the depth of peat is the important factor to classify PSF.

3.9. Succession trend of TD and KK PSF

Successional Process

The term succession can be used in two ways. It can refer to the sequence of plant, animal, and microbial communities that successively occupy an area over a period of time, such as the changes that can be observed over hundred years following by the abandonment of plowed field. It can also refer to the process of change Biotic communities alternately replace each other and the physical environment becomes altered over a period of time. Succession occurs for a variety of reasons that by the importance from place to place and form time to time. (Kimmins, 1996).

The replacement of one community by the next results from changes in the physical environment that have been produced by the resident organisms. These changes often render the less optimal for the organism producing the change and more optimal for those organisms that replace them. Such a process is called autogenic succession, in contrast to allogenic succession, which occurred when geological processes cause changes in the physical environment, which in turn lead to changes in the biota. The filling in of a lake with sediment and the resulting change in the biota is an example of allogenic succession, whereas the subsequent biotically-controlled conversion from bog community to forest is an example of autogenic succession.

The development of successional process in TD and KK PSF include both autogenic and allogenic succession which present by species composition of plant communities as shown in Figure 56 and by the environmental variables within those stands that shown in diagram of Figure 57. The diagram was presented by comparing to the ordinated of stands in this areas.

The succession of PSF can be explained by community type. In primary PSF they had changed among the stands (stand 1-6), and showed the relation to community of transition zone between primary to secondary zone, it was *Macrarnga pruinosa* Community for stand 4, 6 (PW,LB) and *Melaleuca cajuputi* Community for stand 7 (KS). This can be explained the relation to the stand ordination and species ordination. The trend of succession in this area as shown in Figure 58 and 59.

The succession in peat swamp forest can be explained in the following manner. In Toh Daeng peat swamp forest, the present diversity of plant species in the surroundings is sufficiently high to enable succession in the most species-poor areas

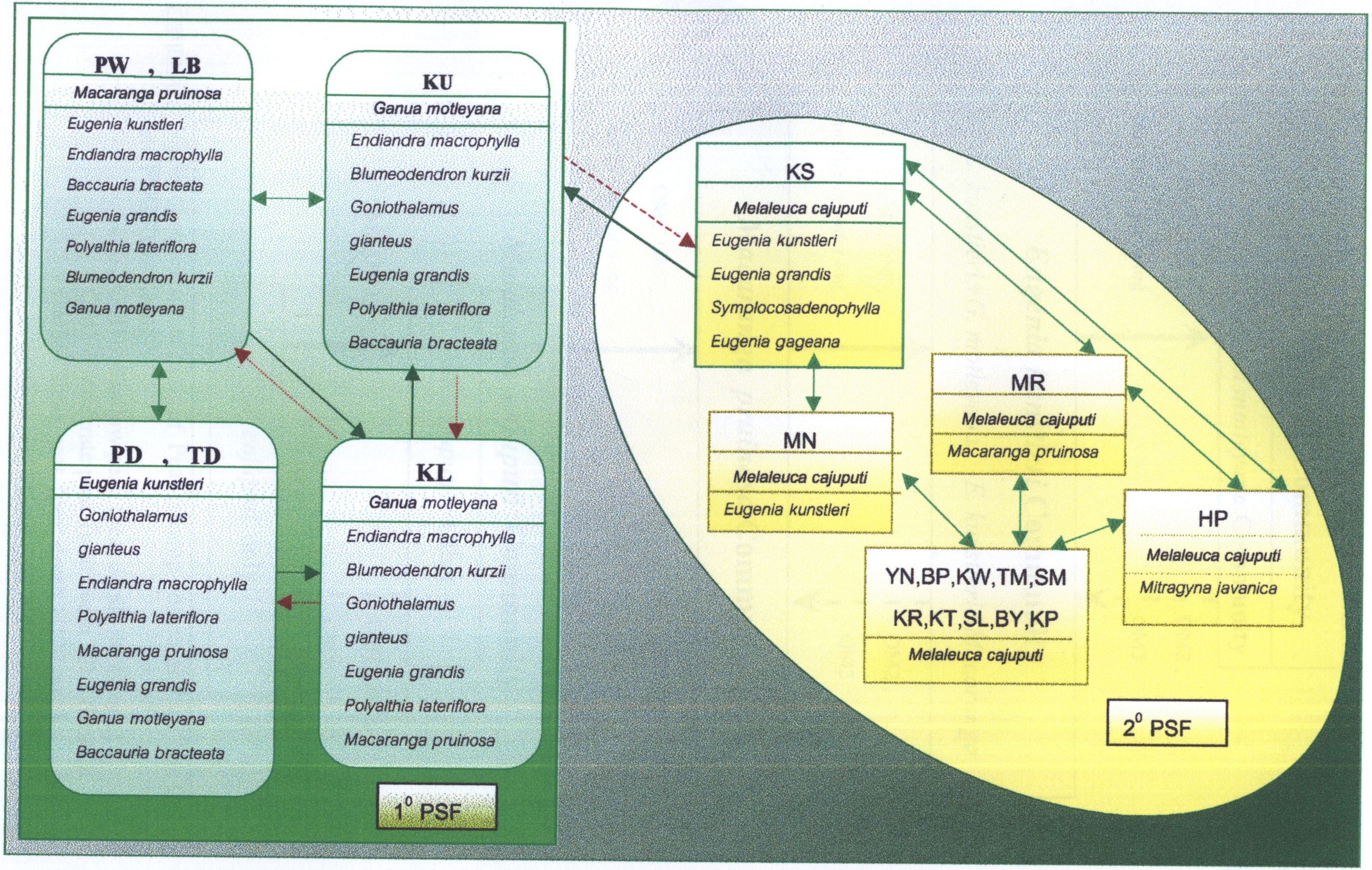


Figure 56 Diagram of Plant Communities related to stands ordination of Toh Daeng and Kuan Kreng Peat Swamp Forest.

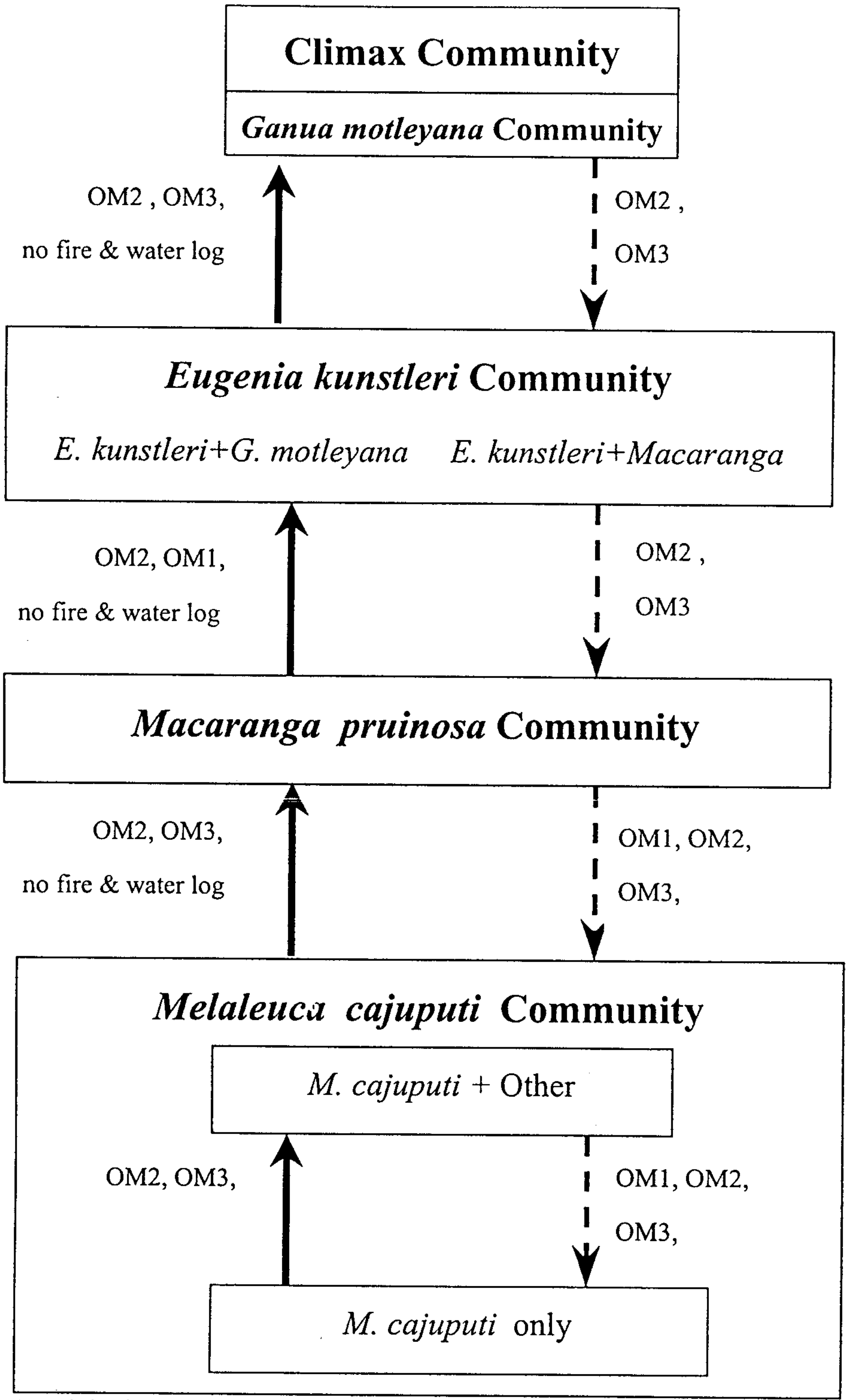


Figure 57. Model of successional trend of Peat Swamp Forests at Phru Toh Daeng and Phru Kuan Kreng

ASS, OM1 = Shallow peat (peat depth 40-60 cm.)
OM2 = Moderate peat (peat depth 60-120 cm.)
OM3 = Thick peat (peat depth > 120 cm.)

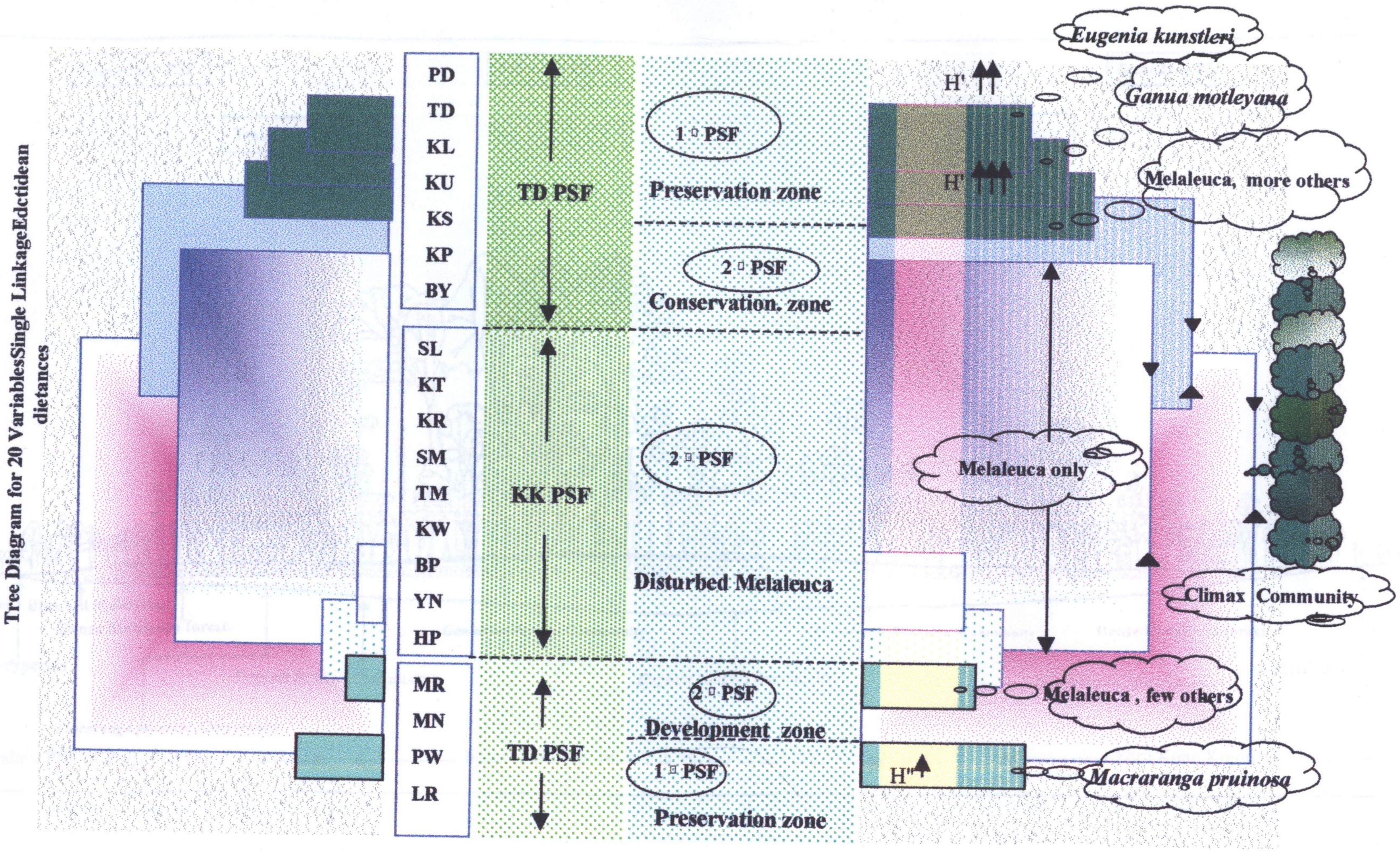


Figure 58 Model of Successional trend showed Tree diagram (SLCA) related to zoning and plant community of TD and KK PSF.

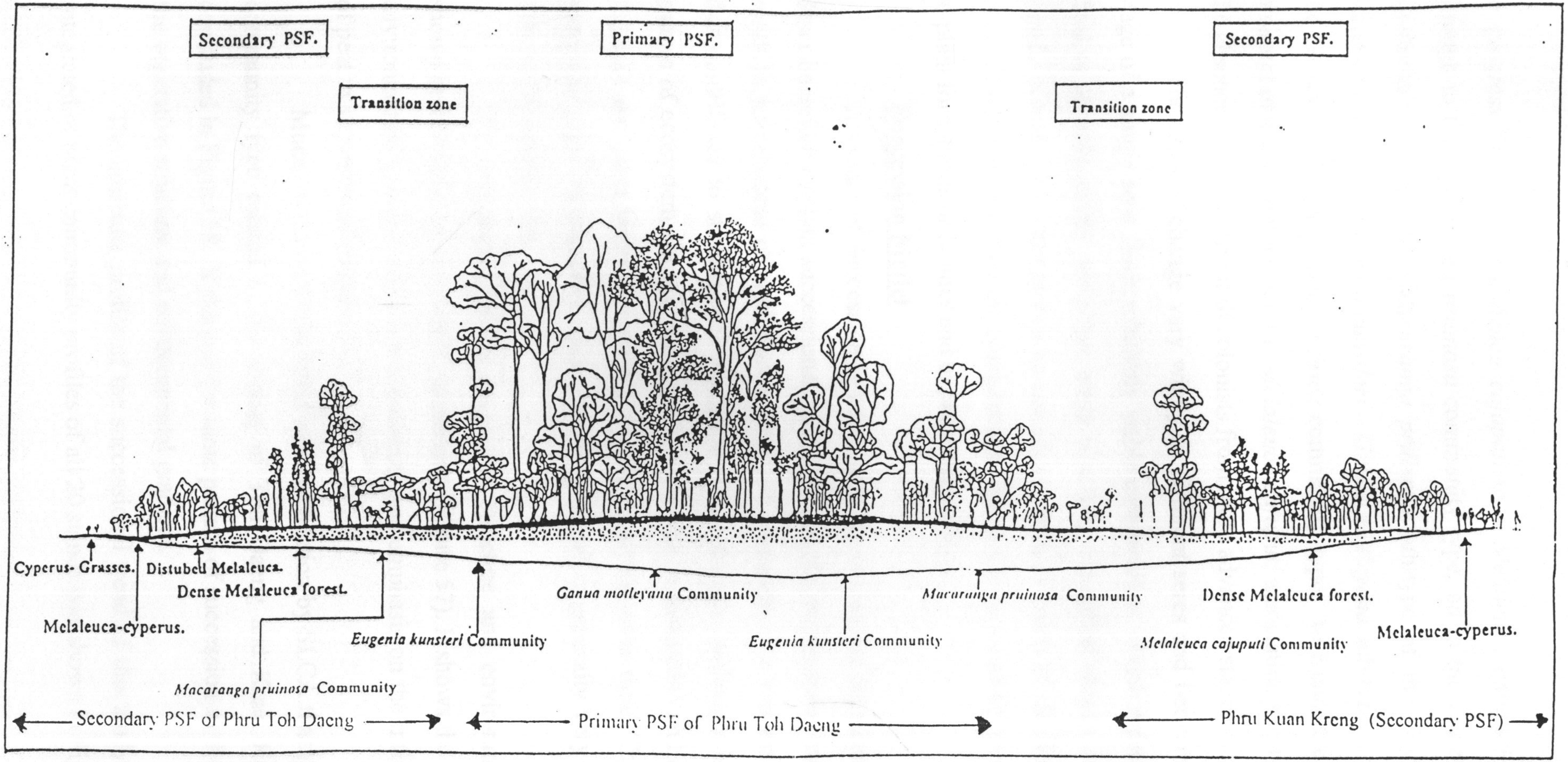


Figure 59 Profile of succesional trend of Peat Swamp Forests at Phru Toh Daeng and Phru Kuan Kreng, however, KK PSF consists a mainly of *Melaleuca cajuputi*, similar to the margin of TD PSF where disturbed by human activities.

to progress from pure *Melaleuca cajuputi* to a *Melaleuca cajuputi* association through to the *Macaranga pruinosa* community type, on to the *Eugenia kunstleri - Goniothalamus giganteus-Macaranga pruinosa* sub-type of the *Eugenia kunstleri* community type the *Eugenia kunstleri – Ganua motleyana* sub-type and eventally to the *Ganua motleyana - Xylopia fusca* community type. In Kuan Kreng there is no prospect of succession beyond the *Melaleuca cajuputi* association sub-type because of the absence of any reservoir of colonists from more advanced stages in the succession.

The rates of change vary wildly in different seres and between the different stage of a single sere. Such relatively stable communities, which represent either the final or an indefinitely prolonged stage of a sere, are called climax communities-or simple climax. The climax can be considered both in terms of physiognomy and in terms of structure and floristic composition. Thus, the term can be used to refer both to plant formations or biomes and to plant associations.

Succession Model

A model of succession is some abstract conceptual representation used to describe and/or explain successional pathways and the successional mechanisms that result in successional change. Successional mechanisms is a process or interaction that contributes to successional change and successional pathways is the temporal pattern of ecosystem change: the sequence of plant communities and changes in the physical and other biotic components of the ecosystem over time. The successional pattern of plant communities on an oligotrophic soil is generally very different from that on a eutrophic soil.

The integration of the vegetative structure and environmental gradient shown in the model of community succession (Figure 57). It shows the relationship of environmental gradient and plant community and emphasis on the influence of depth of peat to successional trends.

Model of successional trend of classification by SLCA that grouping of the community type related to the zoning of Toh Daeng and Kuan Kreng PSF was concluded in Figure 58. It showed the same pattern of succession as the integration of the vegetative structure and environmental gradient.

The structure profile of the successional trend of this study presenting by integrated of plant community profiles of all 20 stands was shown in Figure 59.

3.10. Biological resources in Phru Toh Daeng and Phru Kuan Kreng

The study on species and abundance of other natural resources was based on birds and fishes which were recorded through both primary and secondary data. Interviewing villagers around the study area and observation in the field were also made. At the same time, the study of plant community was done as well, Table 15 showed the data on the member of birds and fishes in study areas.

The results showed that Toh Daeng PSF had more biological resource than Kuan Kreng PSF. There were in total 128 and 94 species of birds and fishes respectively. Especially in Toh Daeng PSF had a high diversity of 93 birds and 88 fish species compared with only 64 bird and 50 fish species in Kuan Kreng PSF. The species list of birds and fishes are shown in appendix IV.

There were 32 species of fishes that were confined to peat swamp area (black-water species) in Toh Daeng PSF and 12 species of them were not found after the occurrence of burning in March-May 1998 (checked 2 months after burning). (see appendix Figure 62).

Table 13. Fish and Bird in TD and KK PSF.

Species of	TD PSF	KK PSF	Total of this study
BIRDS	93	88	128
FISHES	64	50	101

Conclusions and Recommendations

Conclusions

The successional trend of peat swamp forest was studied at two locations : Toh Daeng, Narathiwat and Kuan Kreng, Nakorn Si Thammarat provinces. Plant communities from 20 sample stands; 11 stands from Toh Daeng and 9 stands from Kuan Kreng, were intrusively studied. The study included structural characteristics and plant communities as related to some environmental conditions, particularly soil and water properties. Species and number of birds and fishes in both peat swamp forests were also investigated in order to explain the total biodiversity of peat swamp forests. Plant community analysis included importance value index, species diversity indices, vegetation and environmental relationship, classification and ordination analysis. Finally, the successional trends of peat swamp forests was demonstrated. The results of studies can be summarized as follows :

1. In total there were 135 species in 29 families . There were 75 tree species (dbh > 4.5 cm) in 26 families, including 5 species which were not identified either to family or species. 56 species, and two unidentified species, of shrubs and small trees, and 54 herbs and grasses, including 3 unidentified species. The dominant species were Family Myrtaceae : *Melaleuea cajuputi* ; *Eugenia kunstleri* ; Family Euphorbiaceae: *Macaranga pruinosa*; Family Lauraceae: *Endiandra mycrophylla;* Family Annonaceae: *Goniothalamus giganteus;* Family Sapotaceae: *Ganua motleyana.*

2. Four community types of peat swamp forest could be recognized, two primary forest types and two secondary forest types.
   The primary forest types were a *Eugenia kunstleri* community type, and a *Ganua motleyana - Xylopia fusca* community type;. The *Eugenia kunstleri* community type could be further divided into 2 sub-types, (1) *Eugenia kunstleri - Goniothalamus giganteus-*

Macaranga pruinosa sub-type; and (2) *Eugenia kunstleri* - *Ganua motleyana* sub-type.

The two secondary forest types were a *Macaranga pruinosa* community type, and a *Melaleuca cajuputi* community type. The *M. cajuputi* community type could be further divided into two sub-types: (1) a mixed community in which *M. cajuputi* was dominant, and (2) single species stands of *M. cajuputi*.

3. All four community types, *Eugenia kunstleri* community type, *Ganua motleyana - Xylopia fusca* community type, *Macaranga pruinosa* community type and *Melaleuca cajuputi* community type, as mentioned above can be found at Toh Daeng, while Kuan Kreng only has one type, the *Melaleuca cajuputi* community type.

4. Toh Daeng peat swamp forest indicated a high biodiversity as compared with Kuan Kreng in terms of both plant and animal species and communities.

5. With regard to environmental factors, particularly soil and water properties, results showed that pH of both soil and water was very low (2.7–4.3) in all stands at both study sites. The depth of peat was the most important factor in influencing the pattern and distribution of dominant species and community types. Thick peat indicated a primary forest type with higher diversity than either shallow peat, which in turn had a higher diversity than acid sulfate soil. Acid sulfate soils mostly support *Melaleuca cajuputi*. While Kuan Kreng had some areas of thick peat, these only supported *Melaleuca cajuputi* owing to previous fires which had destroyed the primary peat swamp vegetation.

6. The succession in peat swamp forest can be explained in the following manner. In Toh Daeng peat swamp forest, the present diversity of plant species in the surroundings is sufficiently high to enable succession in the most species-poor areas to progress from pure *Melaleuca cajuputi* to a *Melaleuca cajuputi* association through to the *Macaranga pruinosa* community type, on to the *Eugenia kunstleri - Goniothalamus giganteus-Macaranga pruinosa* sub-type of the *Eugenia kunstleri* community type the *Eugenia kunstleri – Ganua motleyana* sub-type and eventally to the *Ganua motleyana - Xylopia fusca* community type. In Kuan Kreng there is no prospect of succession beyond the *Melaleuca cajuputi* association sub-type because of the absence of any reservoir of colonists from more advanced stages in the succession.

The balance of ecology system in natural swamp forest is very important. When one community of plant has been disturbed, it will be substituted by another. However, nature will help it adjust itself in some degree. The development of plant community will take place and the changeable cycle is vary to the appropriateness of the degree of the ecology. Finally, when the balance of nature is stable, that area will become fertility forest as it used to be. On the contrary, if the balance of nature is disturbed again and again until its ecology has been changed completely , plant community will be changed and unable to return to be the forest.

Recommendations

Results from this study can be used for zoning area and management plan, conservation, development and seeking ways to maximize the consistent benefit from natural resource of peat swamp forest so as to follow a process of sustainable development.

1. Review of land use zoning for management and conservation.

TD PSF is the last fertile PSF in Thailand, situated in Chalerm Prakiat Wildlife Sanctuary, and KK PSF is included in the Thalae Noi Non Hunting Area, and part of KK, Kuan Kisian, was established as the first Ramsar site of Thailand. It is therefore important a management plan is drawn up for both areas so as to ensure appropriate conservation measures are implemented.

Although the TD PSF has been zoned, under the Pikun Thong Development Study Center, with the primary PSF in the Preservation zone, and the secondary PSF being shared between a conservation zone and development zone, the present zoning arrangements need further modification and rezoning regarding to this knowledge investigation about the current existing structural plant communities.

2. Rehabilitation.

The Successional trend observed from this study showed the close relation among some stand of KK and TD PSF. It is therefore possible to maintain or rehabilitate the plant community of disturbed areas towards greater complexity and higher diversity through appropriate management. For areas which have been subject to long disturbance, should be control the suitable projects and development. The suitable species can be used for successfully planting are *Macaranga pruinosa, Eugenia kunstleri, Endiandra mycrophylla, Goniothalamus giganteus and Ganua motleyana.*

3. Disturbed areas – intensively studied.

The vegetation of Kuan Kreng PSF mostly dominated by *Melaleuca cajuputi* with a few other species. In the past it was found that some stands had the plant community structure and composition similar to TD PSF. Due to severe fires in 1942, followed by monsoonal wind damage with changing soil type in this KK PSF, the area then covered by a Melaleuca forest. In terms of TD PSF, fire protection should be strictly controlled in order to maintain the forest to be fertile with high biodiversity otherwise it may be changed to only Melaleuca community as happened KK PSF.

4. Frequent severely burning caused Melaleuca forest to be waste land.

In case of Melaleuca forest in both locations, fire is also strictly controlled if not the forest will be replaced by *Cyperus* – grasses association and it is difficult to rehabilitate to Melaleuca forest again.

5. The basic information knowledge of this study are basically for further studies:

1). Environmental variables related to plant community ordination indicating the successional trend needs further study to understand clearly their relations.

2). The functioning of peat swamp ecosystem should be intensively studied particularly the relationships among organisms components like plants, terrestrial animals and aquatic fauna.

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APPENDICES

Appendix I **Total species of the studied areas in Toh Daeng and Kuan Kreng Peat Swamp Forest.**

no. sp.	Family	Scienctific Name	Life form	Present Area	
				TD	KK
1	**Myrtaceae**	*Decaspermum fruticosum* Forst.	T	/	
2		*Eugenia caudata* King	ST,T	/	
3		*Eugenia ciaviflora* Roxb.	T	/	
4		*Eugenia gageana*	ST,T	/	
5		*Eugenia grandis* Wight	ST,T	/	
6		*Eugenia kunstleri* King+C9	ST,T	/	
7		*Eugenia longiflora* (Presl) F. Vill.	ST,T	/	
8		*Eugenia oblata* Roxb.	T	/	
9		*Eugenia pseudosubtillis* King	T	/	
10		*Eugenia tumida* Duth.	ST,T	/	
11		*Melaleuca cajuputi* Powell	ST,T	/	/
12	**Graminae/ Poaceae**	*Fimbristylis dichotoma* (linn.) Vahl	G	/	
13		*Hymenachne pseudinterrupta*	G		/
14		*Isachne globosa* (Thunb.) Ktze.	G	/	
15		*Ischaemum barbatum* Retz.	G	/	
16		*Leersia hexandra* Swartz	G		/
17		*Oryza rufipogon* Griff.	G	/	
18		*Paspalum longifolium* Roxb.	G		/
19		*Phragmites karta*	G		/
20	**Lauraceae**	*Cinnamomum rhynchophyllum* Miq	ST,T	/	
21		*Dialium patens* Bak.	ST,T	/	
22		*Endiandra macrophylla (*Bl.) Borel.	ST,T	/	
23		*Litsea costada* (Bl.) Boerl.	T	/	
24		*Litsea grandis (*Wall. Ex Nees) Hool	ST,T	/	
25		*Litsea johorensis* Gamble	ST,T	/	
26		*Litsea monopetala*	ST,T	/	
27		*Northaphoebe coriacea* Kosterm.	ST,T	/	

Appendix I. Continued

no. sp.	Family	Scienctific Name	Life form	Present Area TD	KK
28	**Moraceae**	*Artocarpus elasticus* Reinw. Ex Bl.	T	/	
29		*Artocarpus kemendo* Miq.	T	/	
30		*Ficus aurantiacea* Griff	ST	/	
31		*Ficus microcarpa*	ST	/	
32		*Ficus obscura* Bl. Var. *borneensis* (	Hb/L	/	
33		*Ficus retusa* Linn.	ST,Hb	/	
34		*Ficus sp*	T	/	
35		*Ficus sp.*	ST,Hb	/	
36	**Annonaceae**	*Polyalthia sclorophylla* Hook.f.et T	T	/	
37		*Goniothalamus giganteus* Hook.f.et.	ST,T	/	
38		*Polyalthia glauca* (Hassk.) Boerl.	ST,T	/	
39		*Polyalthia lateriflora* (Bl.) King	ST,T	/	
40		*Uvaria cordada* (Dunal) Alston	T	/	
41		*Xylopia fusca* Maing.ex Hook.f.et.Tl	T	/	
42	**Cyperaceae**	*Eleocharia ochrostachys*	G	/	/
43		*Lepironia articulata* (Retz.) Domin	G	/	/
44		Schoenpletus grossus (Linn.f.) Palla	G	/	/
45		*Scirpus mucronatus*	G		/
46		*Scleria poaeformis* Retz.	G	/	/
47		*Scleria sumatrensis* Retz.	G	/	/
48	**Palmae/Arecaceae**	*Calamus sp.*	P	/	
49		*Caryota urens*	P	/	
50		*Daemonorops angustifolia* (Griff.) M	P	/	
51		*Eleiodoxa conferta* (Griff.) Burr.	P	/	
52		*Licuala longecalycata* Furt.	P	/	
53		*Nenga pumila* (Bl.) Wendl.	P	/	
54	**Rubiaceae**	*Canthium congestiflorum*	T	/	
55		*Gynochthodes sublanceolata* Miq.	Hb	/	
56		*Mitragyna javanica*	T		/

Appendix I. Continued

no. sp.	Family	Scienctific Name	Life form	Present Area TD	KK
57	**Rubiaceae**	*Morinda eliptica*	ST,T	/	
58		*Timonius flavescens* (Jack) Bak.	ST	/	
59		*Uncaria sclerophylla*	Hb/G	/	
60	**Euphorbiaceae**	*Baccauria bracteata* Muelll. Arg.	ST,T	/	
61		*Blumeodendron kurzii* (Hook.f.) Sm	ST,T	/	
62		*Glochidion littorale* Bl.	ST,T	/	
63		*Macaranga griffithiana* Muell. Arg.	T	/	
64		*Macaranga pruinosa* (Miq.)Muell. A	ST,T	/	
65	**Myristicaceae**	*Gymnacranthera eugeniifolia* (A. D	T	/	
66		*Horsfieldia crassifolia (*Hook.f. et.T	T	/	
67		*Horsfieldia irya* (Gaertn.) Warb.	T	/	
68		*Myristica elliptica* Wall.ex Hook.f.e	ST,T	/	
69	**Apocynaceae**	*Alstonia angustiloba* Miq.	T	/	
70		*Alstonia pneumatophora* Back. Ex d	T	/	
71		*Alstonia spathulata* Bl.	ST,T	/	
72	**Guttiferae**	*Carophyllum pisiferum* Planch.	T	/	
73		*Carophyllum teysmannii* Miq. var. *i*	ST,T	/	
74		*Garcinia bancana* Miq.	ST,T	/	
75	**Araceae**	*Aglaonema marantifolium* Bl.	Hb	/	
76		*Homalomena griffithii* Hook.f.	Hb	/	
77	**Bombacaceae**	*Bombax sp.*	T		/
78		*Neesia malayana* Bakh.	ST,T	/	
79	**Burseraceae**	*Dacryodes costata*	ST,T	/	
80		*Dacryodes incurvata* (Eanl.) Lamk.	T	/	
81	**Celastraceae**	*Bhesa robusta* (Roxb.) Ding Hou	T	/	
82		*Lophopetalum javanicum*	T	/	
83	**Elaeocarpaceae**	*Elaeocarpus griffithii* (Wight) A.Gr	ST,T	/	
84		*Elaeocarpus macrocerus* (Turez.) M	T	/	
85	**Leguminosae-Caes**	*Archidendron clypearia* (Jack) Niel	ST,T	/	

Appendix I. Continued

no. sp.	Family	Scienctific Name	Life form	Present Area TD	KK
86		*Melastoma decemfidum* Roxb.	ST,Hb	/	
87	**Meliaceae**	*Aglaia rubiginosa* (Hiern) Pannell	ST,T	/	
88		*Chisocheton patens* Bl.	ST,T	/	
89	**Pandanaceae**	*Pandanus humilis* Lour.	Hb	/	/
90		*Pandanus immersus* Ridl.	Hb	/	
91	**Pteridaceae**	*Pteridium aquilinum* (Linn.) Kuhn	Hb/G	/	
92		*Stenochlaena palustris* (Burm.f.) Be	Hb	/	/
93	**Schizaeaceae**	*Lygodium microphllylum* (Cav.) R. l	Hb	/	/
94		*Lygodium salicifolium* Presl	Hb	/	/
95	**Thelypteridaceae**	*Thelypteris dentata* (Forssk.) St. Joh	Hb	/	
96		*Thelypteris interrupta* (Willd.) K. Iw	Hb	/	
97	**Anacardiaceae**	*Campnospermum coriaceum* (Jack)	ST,T	/	
98	**Aquifoliaceae**	*Ilex cymosa* Bl.	ST,T	/	
99	**Aspleniaceae**	*Asplenium nidus* Linn.	Hb/Ep	/	
100	**Compositae**	*Mikania micrantha* H.B.K.	ST,Hb	/	
101	**Dilleniaceae**	*Dillenia pulchella* (Jack) Gilg	T	/	
102	**Dipterocarpaceae**	*Vatica pauciflora* (Koeth.) Bl.	ST,T	/	
103	**Ebenaceae**	*Diospyros lancifolia* Roxb.	T	/	
104	**Flagellariaceae**	*Flagellaria indica* Linn.	Hb	/	
105	**Hanguanaceae**	*Hanguana malayana* (Jack) Merr.	Hb		/
106	**Icacinaceae**	*Stemonurus secundiflorus* Bl.	ST,T	/	
107	**Lecythidaceae**	*Barringtonia racemosa* (Linn.) Gaer	T	/	
108	**/Barringtoniac**	- *Subsp.spicata (Bl.) Payens*			
109	**Lentibulariaceae**	*Utricularia aurea* Lour	Hb/Aq	/	/
110	**Maliaceae**	*Sandoricum beccarianum* Baill.	ST,T	/	
111	**Mimosaceae**	*Acacia mangium*	ST,T	/	
112	**Myricaceae**	*Myrica rubra* Sieb. Et Zucc.	ST	/	
113	**Myrsinaceae**	*Ardisia lanceolata* Roxb.	ST,Hb	/	
114	**Nepenthaceae**	*Nepenthes gracilis* Korth.	Hb	/	

Appendix I. Continued

no. sp.	Family	Scienctific Name	Life form	Present Area TD	KK
115	**Oleaceac**	*Olea brachiata* (Lour.) Merr.	T	/	
116	**Oleandraceae**	*Nephrolepis radicans* (Burm.f.) Kuh	Hb	/	
117	**Parkeriaceae**	*Pityrogramma calomelanos* (Linn.)]	Hb	/	
118	**Piperaceae**	*Piper miniatum* Bl	ST,Hb	/	
119	**Loganiaceae**	*Fagraea fragrans* Roxb.	ST,Hb	/	
120	**Rhizophoraceae**	*Gynotroches axillaris* Bl.	ST,T	/	
121	**Rosaceae**	*Parastemon urophyllus* A. DC.	T	/	
122	**Rutaceae**	*Euodia roxburghiana* (champ.) Bent	ST,T	/	
123	**Sapotaceae**	*Ganua motleyana* Pierre ex Dubard	ST,T	/	
124	**Sterculiaceae**	*Sterculia bicolor* Mast.	ST,T	/	
125	**Stilaginaceae**	*Antidesma gnaesembilla* Gaertn.	Hb	/	
126	**Symplocaceae**	*Symplocos adenophylla* Wall. Ex.Dc	T	/	
127	**Urticaceae**	*Poikilospermum suaveolens* Merr.	Hb	/	
128	**Unidentified**	Unidentified	T	/	
129	**Unidentified**	Unidentified	T	/	
130	**Unidentified**	Unidentified	ST,T	/	
131	**Unidentified**	Unidentified	ST,T,Hb	/	
132	**Unidentified**	Unidentified	Hb	/	
133	**Unidentified**	Unidentified	Hb	/	
	Total 56 Families 127 species+6Unidentified		135	**127**	**20**

<u>Appendix 2</u> **Tree Species abundance / 40x40 m^2 in 20 stands of Toh Daeng and Kaun Kreng Peat Swamp Forest.**

No.	Species List \ Stand Scienctific Name	PD S1	KU S2	KL S3	PW S4	TD S5	LB S6	KS S7	KP S8	BY S9	MR S10	MN S11	SL S12	HP S13	KT S14	KR S15	SM S16	TM S17	KW S18	BP S19	YN S20
1	Unknown							25.16													
2	*Olea brachiata*		2.113																		
3	*Polyalthia lateriflora*	1.759	19.97	14.61	11.03	7.691															
4	*Polyalthia sclorophylla*	3.532	4.385	1.502				6.682													
5	*Litsea costada*				2.607	1.243															
6	*Northaphoebe coriacea*		2.269	1.505	2.074			3.088													
7	*Dialium patens*		7.732	2.471																	
8	*Alstonia spathulata*		18.02		2.072			2.068													
9	*Sterculia bicolor*			2.41	2.646	6.231		2.04													
10	*Dacryodes incurvata*					1.233															
11	*Artocarpus kemendo*			3.768																	
12	*Diospyros lancifolia*	2.216																			
13	*Eugenia curtisii*	1.78																			
14	*Decaspermum fruticosum*			1.602																	
15	*ampnospermum coriaceu*	1.767	9.2	1.503	2.071	11.01	3.62														
16	*Baccauria bracteata*	3.636	4.531		2.071	7.88	24.7														
17	*Myristica elliptica*		3.626			1.705															
18	*Barringtonia racemosa*							3.119				5.04									
19	*Aglaia rubiginosa*			6.082																	
20	*Garcinia bancana*							14.46													
21	*Eugenia grandis*	19.74	2.364	5.454	26.61	6.714		5.034													
22	*Neesia malayana*		23.81		2.083	1.242															
23	*Dillenia pulchella*	2.003																			
24	*Xylopia fusca*		24.96	1.52																	
25	*Parastemon urophyllus*			4.842				3.645													
26	*Carophyllum pisiferum*	1.773	12.05	3.789		2.481															
27	*llum teysmannii var.inophylloide*				2.168																

Appendix 2 Continued.

No.	Species List \ Stand Scienctific Name	PD S1	KU S2	KL S3	PW S4	TD S5	LB S6	KS S7	KP S8	BY S9	MR S10	MN S11	SL S12	HP S13	KT S14	KR S15	SM S16	TM S17	KW S18	BP S19	YN S20
28	*Elaeocarpus macrocerus*		2.113		4.891	1.267															
29	*Polyalthia glauca*		3.443			1.244		1.996													
30	*Alstonia angustiloba*				9.518																
31	*Alstonia pneumatophora*						7.24														
32	*ınamomum rhynchophyllum*		2.138	1.504	2.074			1.538													
33	*Litsea monopetala*		4.286																		
34	*Ficus microcarpa*				2.074																
35	*Uvaria cordada*		2.11																		
36	*Goniothalamus gianteus*	25.79	3.138	14.95		27.94															
37	*Canthium congestiflorum*	1.774		1.556																	
38	*Litsea johorensis*	1.77																			
39	*Horsfieldia irya*				3.634																
40	*Eugenia longiflora*					2.504	7.273	18.19													
41	*Eugenia tumida*			7.05		25.73															
42	*Lophopetalum javanicum*				2.092																
43	*Phesa robusta*							1.547													
44	*Elaeocarpus griffithii*					5.61		17.1													
45	*Archidendron clypearia*							2.546													
46	*Ficus aurantiacea*				2.073																
47	*Macaranga pruinosa*	25.76	2.153	7.762	174.2	16.04	189.6				8.53										
48	*Macaranga griffithiana*	3.303					4.846														
49	*Glochidion littorale*						12.09														
50	*Litsea grandis*							1.539													
51	*Morinda eliptica*				2.076																
52	*Blumeodendron kurzii*		21.76	17.4	2.092	6.823															
53	*Dacryodes costata*					1.235															
54	*vmnacranthera eugeniifol*	14.69						5.133													
55	*Horsfieldia crassifolia*	1.871	7.199			1.243		1.566													

Appendix 2 Continued.

No.	Species List \ Stand Scienctific Name	PD S1	KU S2	KL S3	PW S4	TD S5	LB S6	KS S7	KP S8	BY S9	MR S10	MN S11	SL S12	HP S13	KT S14	KR S15	SM S16	TM S17	KW S18	BP S19	YN S20
56	*Symplocos adenophylla*											31.8									
57	*Ilex cymosa*	1.758			2.594	2.099		20.05				4.33									
58	*Ganua motleyana*	4.505	32.04	60.53		19.15															
59	*Sandoricum beccarianum*	2.255	21.69	1.503	6.313	5.219															
60	*Chisocheton patens*		2.121	1.502																	
61	*Euodia roxburghiana*					2.476	18.06														
62	*Melaleuca cajuputi*							122.2	300	300	261	241	300	289	300	300	300	300	300	300	300
63	*Eugenia caudata*	4.702	9.108	2.087																	
64	*Crudia caudata*	3.526		2.429																	
65	*Eugenia pseudosubtillis*											9.36									
66	*Eugenia oblata*			1.507																	
67	*Eugenia tumida*	149.5	15.26	81.4	14.75	116.9		5.447				4.29									
68	*Eugenia gageana*				2.073	1.234	9.67	26.78													
69	*Endiandra macrophylla*	13.24	20.36	22.03	8.862	14.68	3.603														
70	*Stemonurus secundiflorus*	7.301	9.267	22.67		1.233															
71	*Artocarpus elasticus*			1.513	5.249																
72	*Gynotroches axillaris*			1.503			7.21					4.29									
73	*Mitragyna javanica*													5.75							
74	*Bombax sp*													5.75							
75	*Acacia mangium*										30.7										
	Total	**24 spp**	**29 spp.**	**30 spp**	**26 spp**	**28 spp.**	**11 spp**	**22 spp.**	**1 sp.**	**1 sp.**	**3 spp.**	**7 spp**	**1 sp.**	**3 sp.**	**1 sp.**	**1 sp.**	**1 sp.**	**1 sp.**	**1 sp.**	**1 sp.**	**1 sp.**

<u>Appendix 3</u> **Shurb/Small trees species abundance / 40x40 m^2 in 20 stands of Toh Daeng and Kaun Kreng Peat Swamp Forest.**

	Species List \ Stand	Padee	Kokku	KokKa	Pawaih	Daeb	oSak	Sat	Kamung	Bak	Mai	Munot	Salat	Hua	Kaun	Ka	Sam	Kaun	Kuwa	Ban	Yunok
No.	Sciencific Name	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
1	_				2			2													
2	_				2																
3	*Polyalthia lateriflora*		4		1	2															
4	*Polyalthia sclorophylla*		1																		
5	*Northaphoebe coriacea*		1	22		2															
6	*Dialium patens*		1																		
7	*Alstonia spathulata*							1													
8	*Sterculia bicolor*				1	1															
9	*Acacia sp*										9	1									
10	*Artocarpus kemendo*			1																	
11	*Mikania micrantha*										2										
12	*Campnospermum coriaceum*				1	1	1				3										
13	*Timonius flavescens*			1							2										
14	*Melastoma candidum*							1			8	365 /1 3*5									
15	*Melastoma decemfidum*										19										
16	*Baccauria bracteata*			5	2	1	8														
17	*Myristica elliptica*						1														
18	*Aglaia rubiginosa*			2																	
19	*Garcinia bancana*							2													
20	*Eugenia oblata/grar.*	3+16		3	11	3+10		2													

Appendix 3 Continued.

	Species List \ Stand	Padee	Kokku	KokKa	Pawaih	Dae	boSa	kSat	Kam	ungB	kMai	Muno	Salat	Hual	Kaun	Kai	Sam	Kaun	Kuwa	Ban	Yunok
No.	Scienctific Name	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
21	*Neesia malayana*		3																		
22	*Carophyllum teysmannii var.inophylloid*				1																
23	*Elaeocarpus macrocerus*																				
24	*Cinnamomum rhynchophyllum*						3														
25	*Fagraea fragrans*			1							4										
26	*Litsea monopetala*		3																		
27	*Ficus microcarpa*					1															
28	*Ficus retusa*				1																
29	*Ficus sp.*				1																
30	*Piper miniatum*		2	1																	
31	*Goniothalamus giga*	23		4																	
32	*Litsea johorensis*																				
33	*Eugenia longiflora*		1																		
34	*Eugenia tumida*			5		3+20															
35	*Elaeocarpus griffithii*							11													
36	*Archidendron clypearia*					2															
37	*Macaranga pruinosa*				8		11					1									
38	*Glochidion littorale*						1														
39	*Litsea grandis*										1										
40	*Morinda eliptica*																				
41	*Blumeodendron kurzii*		5			1															

Appendix 3 Continued.

	Species List \ Stand	**Padee**	**Kokku**	**okKa**	**Pawai**	**h Da**	**boSa**	**kSat**	**Kam**	**ungB**	**kMai**	**Muno**	**Salat**	**Hua**	**Kaun**	**Ka**	**Sam**	**Kaun**	**Kuwa**	**Ban**	**Yunok**
No.	**Scienctific Name**	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**	**S16**	**S17**	**S18**	**S19**	**S20**
42	*Ardisia lanceolata*					16															
43	*Dacryodes costata*		1			2					2			*							
44	*Symplocos adenophylla*																				
45	*Ilex cymosa*							11			2										
46	*Ganua motleyana*		4	3	1																
47	*Sandoricum beccarianum*		1																		
48	*Vvtica pauciflora*		1					1													
49	*Chisocheton patens*		1	2				2													
50	*Euodia roxburghiana*						3														
51	*Melaleuca cajuputi*								36	34		12	99	947	59	19	)4**:	1022	19	41	748
52	*Myrica rubra*										1										
53	*Eugenia caudata*						4				1										
54	*Eugenia kunstleri*	6+24	15	3	3	27		13													
55	*Eugenia gageana*		2	4		3+20		24													
56	*Endiandra macrophylla*		1	4	1																
57	*Stemonurus secundi*	1	9	1		9	1	2													
58	*Gynotroches axillaris*						1				1										
	58 spp.	**4**	**17**	**15**	**14**	**15**	**10**	**11**	**1**	**1**	**14**	**4**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Appendix 4 **Herbs abundance / 40x40 m² in 20 stands of Toh Daeng and Kaun Kreng Peat Swamp Forest.**

No.	Species List Scienctific Name	Family	PD S1	KU S2	KL S3	PW S4	TD S5	LB S6	KS S7	KP S8	BY S9	MR S10	MN S11	SL S12	HP S13	KT S14	KR S15	SM S16	TM S17	KW S18	BP S19	YN S20
1	*Scirpus mucronatus*	Cyperaceae																				
2	*Schoenpletus grossus*	Cyperaceae												1		6	1					
3	*Pandanus humilis*	Pandanaceae	5*39	4*8	9	6*28	9*		5	leafs	leafs											9****
4	*Lepironia articulata*	Cyperaceae								16**				9*		14	2	3	2	4****'	7**	
5	*Licuala longecalycata*	Palmae/Arecaceae	7*90	3*15	1		2*20															
6	*Thelypteris dentata*	Thelypteridaceae				1*2		5*	4				1									
7	*Nephrolepis radicans*	Oleandraceae				1																
8	*Thelypteris interrupta*	Thelypteridaceae						1														
9	*Taeniophyllum obtusum*	Orchidaceae																				
10	*Mikania micrantha*	Compositae				1							1									
11	*Asplenium nidus*	Aspleniaceae		3,1,1,1	3																	
12	*Antidesma gnaesembilla*	Stilaginaceae										1										
13	*Melastoma candidum*	Melastomataceae							1				16***	3*5								
14	*Melastoma decemfidum*	Melastomataceae																				
15	*Scleria sumatrensis*	Cyperaceae						2*	13			3	15	12**		8				2		
16	*Eleocharia ochrostachys*	Cyperaceae										1		1		1		2	3	16**		
17	*Caryota urens*	Palmae/Arecaceae		1	2		1	4*32														

Appendix 4 Continued.

No.	Scienctific Name	Family	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
18	*Pandanus immersus*	Pandanaceae			1																	
19	*Poikilospermum suaveole*	Urticaceae						3														
20	*Ficus retusa*	Moraceae																				
21	*Ficus sp.*	Moraceae																				
23	*Piper miniatum*	Piperaceae		2	1																	
24	*Homalomena griffithii*	Araceae+C39		7	4																	
25	*Hanguana malayana*	Hanguanaceae														1						
26	*Sceria poaeformis*	Cyperaceae							1					1		1	7				4	7
27	*Oryza rafipogon*	Graminae/ Poaceae				1																
28	*Pityrogramma calomelan*	Parkeriaceae					1															
29	*Fagraea fragrans*	Potaliaceae																				
30	*Gynochthodes sublancec*	Rubiaceae										4*										
31	*Ficus obscura*	Moraceae				4																
32	*Lygodium salicifolium*	Schizaeaceae							10			14*	1	12*					2	1		
33	*Lygodium microphllylum*	Schizaeaceae											1	1		2						
34	*Isochne globosa*	Graminae/ Poaceae										4*										
35	*Aglaonema marantifolium*	Araceae		4	1																	
36	*Ardisia lanceolata*	Myrsinaceae																				
37	*Phragmites karta*	Graminae/ Poaceae												7		3*					8**	

Appendix 4 Continued.

No.	Scienctific Name	Family	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
38	*Stenochlaena palustris*	Pteridaceae	1	4	1	4	1	6*				14*	12	11*		6			5	1		
39	*Utricularia aurea*	Lentibulariaceae												1						2		
40	*Eleiodoxa conferia*	Plamae		f8/40	5*150	5	1*105		1													
41	*Nenga pumila*	Plamae				1																
42	*Daemonorops angustifoli*	Plamae			1	5		11*33														
43	*Flagellaria indica*	Flagellariaceae						4*	6*6			3										
44	*Calamus sp.*	Plamae																				
45	*Nepenthes gracilis*	Nepenthaceae							5													
46	*Uncaria sclerophylla*	Rubiaceae	1*10	1		1																
47	*Pteridium aquilinum*	Pteridaceae				2	1					11*										
48	*Leersia hexandra*	Graminae/ Poaceae											1	3		3		2	2	2	2	2
49	*Hymenachne pseudinterr*	Graminae/ Poaceae																		16***		
50	*Fimbristylis dichotoma*	Graminae/ Poaceae						2														
51	*Ischaemum rugosum*	Graminae/ Poaceae										1										
52	*Paspalum longifolium*	Graminae/ Poaceae												2								
53	Unknown2	_			1																	
54	Unknown3	_			1																	
55	Unknown5	_			1																	
	52+3U		4	10	14	15	7	10	9	1	******	11	10	13	*****	11	3	3	5	8	4	3

Appendix 5 Species list of Birds of Toh Daeng and Kuan Kreng PSF.

Sp.No.	Common name	*Scientific name*	TD PSF	KK PSF
1	Little Grebe	*Tachybaptus ruficollis*		/
2	Little Cormorant	*Phalacrocorax niger*		/
3	Grey Heron	*Ardea cinerea*		/
4	Purple Heron	*Ardea purpurea*	/	/
5	Chinese Pond-Heron	*Ardeola bacchus*	/	/
6	Javan Pond-Heron	*Ardeola speciosa*		/
7	Cattle Egret	*Bubulcus ibis*	/	/
8	Great Egret	*Egretta alba*		/
9	Intermediate Egret	*Egretta intermedia*		/
10	Little Egret	*Egretta garzetta*		/
11	Black-crowned Night-Heron	*Nycticorax nycticorax*		/
12	Cinnamon Bittern	*Ixobrychus cinnamomeus*	/	
13	Painted Stork	*Mycteria leucocephala*		/
14	Cotton Pygmy Goose	*Nettapus coromandelianus*		/
15	Lesser Whistling-Duck	*Dendrocygna javanica*	/	/
16	Black-shouldered Kite	*Elanus caeruleus*	/	/
17	Black Kite	*Milvus migrans*		/
18	Brahminy Kite	*Haliastur indus*	/	/
19	Crested Honey-Buzzard	*Pernis ptilorhyncus*	/	
20	Grey-headed Fish-Eagle	*Ichthyophaga ichthyaetus*	/	
21	Crested Serpent-Eagle	*Spilornis cheela*	/	/
22	Changeable Hawk-Eagle	*Spizaetus cirrhatus*	/	
23	White-browed Crake	*Porzana cinerea*		/
24	White-breasted Waterhen	*Amaurornis phoenicurus*	/	/
25	Watercock	*Gallicrex cinerea*		/
26	Common Moorhen	*Gallinula chloropus*		/
27	Purple Swamphen	*Porphyrio porphyrio*		/
28	Pheasant-tailed Jacana	*Hydophasianus chirurgus*		/
29	Bronze-winged Jacana	*Metopidius indicus*		/
30	Red-wattled Lapwing	*Vanellus indicus*	/	/
31	Black-winged Stilt	*Himantopus himantopus*		/
32	Common Tern	*Sterna hirundo*		/
33	Whiskered Tern	*Chlidonias hybridus*		/
34	Thick-billed Pigeon	*Treron curvirostra*	/	
35	Pink-necked Pigeon	*Treron vernans*		/
36	Spotted Dove	*Streptopelia chinensis*	/	/

<u>Appendix 5</u> **(continued)**

Sp.No.	Common name	*Scientific name*	TD PSF	KK PSF
37	Zebra Dove	*Geopelia striata*	/	/
38	Large Hawk-Cuckoo	*Cuculus sparverioides*	/	
39	Plaintive Cuckoo	*Cacomantis merulinus*	/	
40	Common Koel	*Eudynamys scolopacea*		/
41	Green-billed Malkoha	*Phaenicophaeus tristis*	/	
42	Raffles's Malkoha	*Phaenicophaeus chlorophaeu*	/	
43	Greater Coucal	*Centropus sinensis*	/	/
44	Lesser Coucal	*Centropus bengalensis*	/	
45	Barn Owl	*Tyto alba*		/
46	Brown Hawk Owl	*Ninox scutulata*	/	
47	Collared Scops-Owl	*Otus bakkamoena*	/	
48	Large-tailed Nightjar	*Caprimulgus macrurus*	/	/
49	Common Kingfisher	*Alcedo atthis*	/	
50	Banded Kingfisher	*Lacedo pulchella*	/	
51	Stork-billed Kingfisher	*Pelargopsis capensis*	/	
52	White-throated Kingfisher	*Halcyon smyrnensis*	/	/
53	Black-capped Kingfisher	*Halcyon pileata*	/	
54	Collared Kingfisher	*Halcyon chloris*	/	/
55	Chestnut-headed Bee-eater	*Merops leschenaulti*		/
56	Green Bee-eater	*Merops orientalis*		/
57	Blue-throated Bee-eater	*Merops viridis*	/	
58	Red-bearded Bee-eater	*Nyctyornis amictus*		/
59	Indian Roller	*Coracias benghalensis*	/	/
60	Dollarbird	*Eurystomus orientalis*	/	
61	Bushy-crested Hornbill	*Anorrhinus galeritus*	/	
62	Great Hornbill	*Buceros bicornis*	/	
63	Lineated Barbet	*Megalaima lineata*	/	
64	Blue-eared Barbet	*Megalaima australis*	/	
65	Coppersmith Barbet	*Megalaima haemacephala*	/	/
66	Brown Barbet	*Calorhamphus fuliginosus*		/
67	Common Flameback	*Dinopium javanense*	/	/
68	Crimson-winged Woodpecker	*Picus puniceus*	/	
69	Rufous Woodpecker	*Celeus brachyurus*	/	
70	Grey-and-buff Woodpecker	*Hemicircus concretus*	/	
71	Black-and-Red Broadbill	*Cymbirhynchus macrorhynch*	/	
72	Banded Broadbill	*Eurylaimus javanicus*	/	

Appendix 5 (continued)

Sp.No.	Common name	*Scientific name*	TD PSF	KK PSF
73	Asian Palm Swift	*Cypsiurus balasiensis*	/	
74	Pacific Swift	*Apus pacificus*	/	
75	Grey-rumped Treeswift	*Hemiprocne longipennis*	/	
76	Barn Swallow	*Hirundo rustica*	/	/
77	Pacific Swallow	*Hirundo tahitica*	/	
78	Richard's Pipit	*Anthus novaeseelandiae*	/	
79	Yellow Wagtail	*Motacilla flava*	/	
80	Large Wood-shrike	*Tephrodornis virgatus*	/	
81	Lesser Cuckoo-shrike	*Coracina fimbriata*	/	
82	Fiery Minivet	*Pericrocotus igneus*	/	
83	Scarlet Minivet	*Pericrocotus flamimeus*	/	
84	Green Iora	*Aegithina viridissima*	/	
85	Striated Bulbul	*Pycnonotus striatus*		/
86	Stripe-throated Bulbul	*Pycnonotus finlaysoni*	/	
87	Yellow-vented Bulbul	*Pycnonotus goiavier*	/	/
88	Olive-winged Bulbul	*Pycnonotus plumosus*	/	
89	Streak-eared Bulbul	*Pycnonotus blanfordi*	/	/
90	Cream-vented Bulbul	*Pycnonotus simplex*	/	
91	Black Drongo	*Dicrurus macrocercus*		/
92	Bronzed Drongo	*Dicrurus aeneus*	/	
93	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	/	
94	Large-billed Crow	*Corvus macrorhynchos*	/	/
95	Puff-throated Babbler	*Pellorneum ruficeps*	/	
96	Abbott's Babbler	*Tricastoma abbotti*	/	
97	Sooty-capped Babbler	*Malacopteron affine*		/
98	Chestnut-winged Babbler	*Stachyris erythroptera*	/	
99	Striped Tit-Babbler	*Macronous gularis*	/	
100	Blyth's Leaf-Warbler	*Phylloscopus reguloides*		/
101	Yellow-bellied Prinia	*Prinia flaviventris*	/	
102	Common Tailorbird	*Orthotomus sutorius*	/	
103	Dark-necked Tailorbird	*Orthotomus atrogularis*	/	/
104	Ashy Tailorbird	*Orthotomus sepium*	/	
105	Oriental Magpie Robin	*Copsychus saularis*	/	/
106	White-rumped Shama	*Copsychus malabaricus*		/
107	Blue-and-White Flycatcher	*Cyanoptila cyanomelana*	/	
108	Pied Fantail	*Rhipidura javanica*	/	

Appendix 5 (continued)

Sp.No.	Common name	*Scientific name*	TD PSF	KK PSF
109	Black-naped Monarch	*Hypothymis azurea*	/	
110	Asian Paradise flycatcher	*Terpsiphone paradisi*	/	/
111	Mangrove Whistler	*Pachycephala grisola*	/	
112	Brown Shrike	*Lanius cristatus*	/	
113	Black-collared Starling	*Sturnus nigricollis*		/
114	Common Myna	*Acridotheres tristis*	/	/
115	Jungle Myna	*Acridotheres fuscus*	/	/
116	Plain Sunbird	*Anthreptes simplex*	/	/
117	Ruby-cheeked Sunbird	*Antreptes singalensis*	/	
118	Purple-throated Sunbird	*Nectarinia sperata*	/	
119	Olive-backed Sunbird	*Nectarinia jugularis*	/	
120	Crimson Sunbird	*Aethopyga siparaja*	/	/
121	Little Spiderhunter	*Arachnothera longirostra*	/	
122	Spectacled Spiderhunter	*Arachnothera flavigaster*	/	/
123	Yellow-breasted Flowerpecker	*Prionochilus maculatus*	/	
124	Crimson-breasted Flowerpecke	*Prionochilus percussus*	/	
125	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	/	
126	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	/	
127	Buff-bellied Flowerpecker	*Dicaeum ignipectus*		/
	TD 93 species	**KK 64 species**		

Appendix 6 **Fishes of Peat Swamp habitats.**

no.	Families	Scientific name	TD PSF	KK PSF
1	Clupeidae	*Clupeichthys goniognathus*	/	
		Corica lacinata		/
2	Osteoglossidae	*Scleropages formosus*	/	
3	Notopteridae	*Notopterus notopterus*	/	/
4	Cyprinidae	*Borarus maculata* *	/	
		Borarus urophthalmoides *	/	
		Brachydanio albolineata	/	/
		Rasbora heteromorpha *	/	
		R. agilis *	/	
		R. sumatrama	/	/
		R. trilineata	/	/
		R. retrodorsalis	/	
		R. caudimaculata	/	
		R. einthovenii *	/	
		R. borapetensis	/	/
		R. bankanensis *	/	
		R. pauciperforata *	/	
		R. paucisqualis *	/	/
		Esomus metalicus	/	
		Parachela caudimaculata	/	
		Oxygaster anomalura	/	
		Oxygaster sp.	/	
		O. siamensis	/	/
		Puntius brevis	/	/
		Systomus hexazona *	/	
		S. orphoides		/
		S. partipentazona	/	
		S. binotatus	/	
		Puntius johorensis *	/	
		Barbodes gonionotus		/
		Hampula macrolepidota	/	/
		Osteochilus spilurus *	/	
		O. hasselti	/	/
		O. microcephalus	/	
		Cyclocheilichthys apogon	/	
		C. enopplos Bleeker, 1850		/
		Henicorhychus siamensis		/
5	Cubitidae	*epidocephalichthys berdmore*	/	
		Pangio pangia	/	
		P. euniovirgata *	/	
		P. kuhlii	/	

__Appendix 6__ **(continued)**

no.	Families	Scientific name	TD PSF	KK PSF
6	Bagridae	*Leiocassis poccilopterus* *	/	
		L. siamensis		/
		Mystus singarigan	/	/
		M. micracanthus	/	
		Hemibagrus filamentus	/	/
		Hemicrychioides filamentus		/
		Pelteobagrus ornatus *	/	
7	Siluridae	*Ompok bimaculatus*	/	
		O. hypophthalmus	/	/
		O. fumidus *	/	
		Krypttopterus macrocephalus	/	
		K. bicimhis	/	
		Silurichthysphaiosoma *	/	
8	Parakysidae	*Parakysis verucosus* *	/	
9	Chacidae	*Chacabankanensis* *	/	
10	Clariidae	*Clarias nicuhofii* *	/	
		C. meladerma	/	/
		C. batrachus	/	/
		C. macrocephalus	/	/
		Encheloclarais keliliodes *	/	
12	Belonidae	*Xenantodon cancilla*	/	/
13	Hemiramphidae	*Dermogenys pusillus*	/	/
		Hemirhamphus pogonognathus	/	
14	Oryziidze	*Oryzius minutilus*	/	/
15	Aploacheilidae	*Aploacheilus panchax*	/	/
16	Indostomidae	*Indostomus paradoxus*	/	/
17	Synbranchidae	*Monopterus albus*	/	/
18	Mastacembelidae	*Macrognathus circumcintus*	/	/
		M. siamensis		/
		Mastacembelus armatus	/	
19	Chaudhurlidae	*Chaudhuria sp.*	/	/
20	Eleotrididae	*Oxycleotris marmoratus*	/	/
		Ophiocara porocephala		/
21	Nandidae	*Nandus nebulosus*	/	
		Pristolepis fasciatus	/	/
		P. grootii *	/	
22	Anabantidae	*Anabas testudineus*	/	/
23	Helostomaidae	*Helostoma temmincki*	/	/
24	Belontidae	*Belontia hasselti* *	/	
		Betta imbellis	/	/
		B. prima ?	/	/

Appendix 6 (continued)

no.	Families	Scientific name	TD PSF	KK PSF
		B. pi *	/	
		Parosphonemus paludicola *	/	
25	Taxotidar	*Toxots catarus*		/
26	Chaudhurlidae	*ohacrichthys osphonemoides*	/	/
27	Ambassidar	*Parambassis siamensis*		/
		Trichopsis vittatus	/	/
		Trichogaster lecri *	/	
		T. trichopterus	/	/
		T. pectoralis	/	/
28	Luciocephalidae	*Luciocephalus pulcher* *	/	
		C. striata	/	/
		C. micropeltes	/	/
		C. striata		/
		C. melasoma *	/	
		C. limbata	/	
30	Tetraodontidae	*Tetraodon palembangensis* *	/	
		T. leiurus		/
***peat specialist, 32 species, 16 fam.**			**88 sp. 27 Fam.**	**50 sp 23 Fam.**

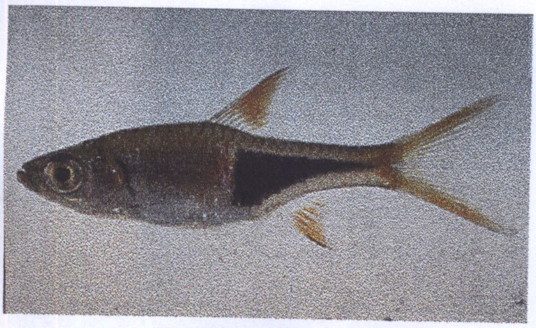
Note **12 species disappeared (27 June-7 July 1998)**
2 months after severely fire

Figure 60 Collecting Data in the fields.

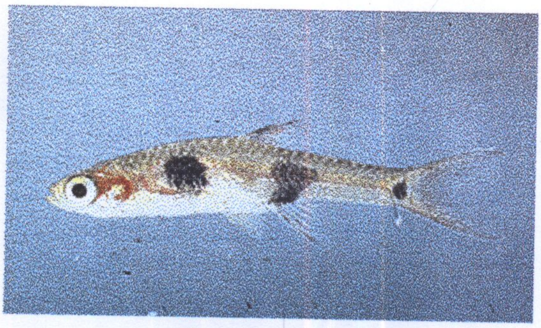
Figure 61 Biodiversity of Peat Swamp Forest at Phru Toh Daeng and Phru Kuan Kreng
a) Breeding area of Waterbird at Phru Kuan Kreng
b) Cyperus havesting c) The biggest tree (dbh 298 cm.) of this study (at Phru Toh Daeng).

Clarias nicuhofii

Chaca bankanensis

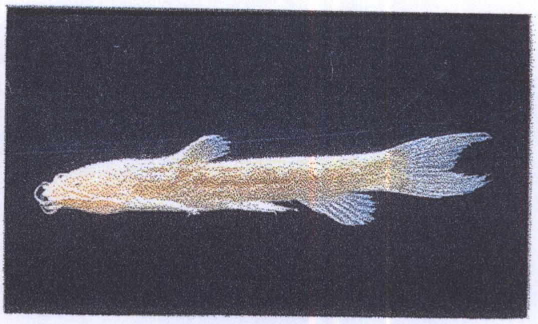


Rasbora heteromorpha



Borarus maculata

Scleropages formosus



Parakysis verucosus

Figure 62 **Six of thirty two species of fishes in swamp areas (black-water species) of this study.**