UNIVERSITI PUTRA MALAYSIA

INVASIVE WOODY PLANTS IN DIFFERENT AGED STANDS OF A REHABILITATED FOREST

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A Project Report Submitted in Partial Fulfillment of the Requirement for the Degree of Bachelor of Science Bioindustry in the Faculty of Agriculture and Food Sciences Universiti Putra Malaysia Bintulu Sarawak Campus

2009

ABSTRACT

A study was conducted in Rehabilitated Forest at the Universiti Putra Malaysia Bintulu Sarawak Campus with the objectives of identifying the invasive species that invaded in the rehabilitation forest and showing its composition, distribution and abundance. Three plots was establish in different ages stand of Rehabilitated Forest which every plot represent for 5, 10 and 15 years old of planted trees. A 1 hectare plot consisted of 3 subplots with 33 x 33 m plots was established. From the study, 37 individual tree consist of 30 genera from 24 families were enumerated in 1 hectare plot. The total number of individuals enumerated was 1497 invasive tree per hectare. The 3 most abundant species was *Dillenia indica* (596 individuals), *Melastoma malabathricum* (398 individuals) and *Vitex pubescens* (174 individuals). The most diverse family was Euphorbiaceae with 6 species followed by Lauraceae and Moraceae 3 species for each family. However, the most diverse genera were Macaranga; *Macaranga javanica, Macaranga gigantae and Macaranga triloba.*

ABSTRAK

Satu kajian telah dijalankan di Hutan Pemuliharaan Universiti Putra Malaysia Kampus Bintulu, Sarawak yang bertujuan untuk mengenalpasti spesies pokok yang menceroboh masuk di kawasan Hutan Pemuliharaan dan menunjukkan komposisi, taburan dan limpahannya. Tiga plot telah didirikan di dalam kawasan Hutan Pemuliharaan yang mempunyai peringkat umur yang berbeza yang diwakili setiap plot 5, 10 dan 15 tahun umur pokok yang ditanam. 1 hektar saiz plot mengandungi 3 plot dengan 33 x 33 m saiz plot didirikan. Daripada hasil kajian, 37 spesies didalam 30 genera dan 24 famili didapati di dalam 1 hektar plot. Jumlah individu yang didapati adalah 1497 pokok penceroboh per hektar. 3 spesies yang paling banyak adalah *Dillenia indica* (596 individu), *Melastoma malabathricum* (398 individu) dan *Vitex pubescens* (174 individu). Euphorbiaceae adalah famili pokok yang paling banyak ditemui iaitu 6 spesies dan diikuti oleh famili Lauraceae dan Moraceae dengan hanya 3 spesies bagi setiap famili. Walaubagaimanapun, genera pokok yang paling banyak ditemui adalah Macaranga, *Macaranga javanica, Macaranga gigantae* dan *Macaranga triloba.*

ACKNOWLEDGEMENTS

Praise to God for His help and guidance that finally I am able to complete this thesis.

I wish to express my gratitude to my supervisor Prof. Dato' Dr Nik Muhamad Nik Ab. Majid and my co-supervisor Mrs. Donna Jackson for their tireless efforts and on-going support, advice as well as guidance. Without their help, my thesis would not have been completed successfully.

Further gratitude goes to Tuan Haji Abdul Kadir, Mr. Awang Marzuki, Mr. Fahizal and Mr. Muaish Sait, whose importance helped me a lot in my field work at the rehabilitated forest.

To all my friends and course mates on believing and helping me for the experiences and knowledge we gained throughout the process of completing this undergraduate project would prove the invaluable to better equip us for the challenges which lie ahead. Last but, definitely not least to my family, I can never thank you enough for your love and for supporting me throughout my studies in Universiti Putra Malaysia Bintulu Sarawak Campus.

Finally, to the readers and users of this thesis, may this piece of effort assist, inspire and further advance the understanding of invasive woody plants in Malaysia.

APPROVAL

I certify that this research project report entitled **"Invasive woody plants in different age stands of a rehabilitated forest"** has been examined and approved as a partial fulfilment of the requirements for the degree of Bachelor of Bioindustry Science in the Faculty of Agriculture and Food Sciences, Universiti Putra Malaysia Bintulu Campus.

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LIST OF ABBREVIATION

FAO	Food and Agriculture Organization
WRI	World Resource Institute
UPMKB	Universiti Putra Malaysia Bintulu Campus

CHAPTER 1

INTRODUCTION

1.1 General background

In recent years, scientists have repeatedly called for more research on the dynamics of tropical forests. They want to study these complex ecosystems before the extensive clearing in all tropical region of the world reduce these forests to small, isolated fragments. Because of their unusually high level of biological diversity, tropical forests challenge the understanding of ecosystem structure and function, community organization, population dynamics, speciation, and the fundamental physiological, demographic and behavioral attributes. Furthermore, tropical forests still have a potential important source of timber, food and medicine for human population.

There are 4.5 billion hectares of forests of which 3% are in the tropics. Tropical forests have been affected severely by human activities resulting in their rapid reduction in size and quality. Apart from the estimated 16.9 million hectares lost annually mainly through conversion for agriculture and shifting cultivation, more than 5 million hectares have become secondary forests after harvesting. In Malaysia, there are 20 million hectares of forests managed for production, conservation and protection. The Selective Management System, which allows for minimal site disturbance through limited number of trees harvested per hectare, is considered as management strategy. However, some of the forest ecosystems have been degraded by improper harvesting by loggers and shifting cultivation.

Malaysia covers an area of approximately 32.86 million hectares, consisting of 11 states in Peninsular Malaysia and 2 states in Borneo Island which are in Sabah and Sarawak. The largest state in Malaysia is Sarawak approximately equal in area to the whole of Peninsular Malaysia, while Sabah is the second largest state. Approximately 80% of the population of 23.8 million is located in Peninsular Malaysia and 20% in Sabah and Sarawak.

More than 4 million hectares of the forests have been denuded by shifting cultivation, tin mining and other practices in recent years. There have been intensive efforts by various forestry related agencies to rehabilitate the denuded areas with fast-growing exotic tropical species and indigenous tree species. Some of the trials have given positives results, while others have performed poorly, which may attribute to inappropriate planting strategies. The potential loss of biological diversity, which could be as high as one quarter of all species of plants, animal, fungi and microorganism on the earth over the next 25 years.

Thus, the concern over depletion of the tropical rainforests has resulted in an increasing emphasis on forest rehabilitation to maintain the ecological balance within the ecosystem. Forest clear lodging in Sarawak is mainly by shifting cultivation practices. The figures based on the satellite imageries of 1990 to 1991, show the total area of land affected by shifting cultivation is about 3 million hectares. Of this 116,121 hectares are located within the permanent forest estate while 11,404 hectares are in totally protected areas. In view of this loss, an extensive reforestation program is necessary both to sustain the forest resources and to rehabilitate the deteriorating ecosystem. Malaysian research in this area has included planting the native species

on barren land and in secondary vegetation and much experience is available from research dating back to the 1920s (Azani *et al.*, 1995).

Rehabilitated of forest involves re-establishment of a more intact canopy that is found in undisturbed forest (Lim, 1992). This forest ecosystem has an enormous interest to science, with great potential for development; their ecology and biology can be understood although the available data are sketchy and often inadequate for planning and policy development. From the information of FAO (2003), the taxonomy of many trees and shrubs remain week, and many species are unnamed. Therefore, rehabilitation and conservation of these forests are important for educational purposes because of the high natural resources and biodiversity richness (Azani *et al.*, 1995).

One of the forest rehabilitation projects in Universiti Putra Malaysia Bintulu Campus. The area has been planted with various indigenous trees. Some of the species are *Calophyllum ferrugenium, Cotylelobium burckii, Eugnia sp, Eusideroxylon zwagerii, Hopea kerangsensis, Pentaspodon motley, Shorea gibbosa, Shorea leprosula, Shorea macrophylla, Shorea materialis, Vatica nitens* and *Whiteodendron moultianum*. Alongside the planted indigenous species, invasive species began to encroach the planted area.

Most of the invasive plants have colonized areas of high levels of human disturbance, but a number of them have also been capable of invading apparently undisturbed ecosystem and accordingly threatens many of the endangered indigenous species and habitats with extinction. Invasive plant species can be grouped into two

categories; woody plants and non-woody plants. The research project aims to identify the invasive species that naturally grew in the experimental planted forest. Invasive plants are introduced plants that invade an area and replace the native vegetation. Most of the invasive plants have colonized areas of high levels of human disturbance, but a number of them have also been capable of invading apparently undisturbed ecosystem and accordingly threatens many of the endangered indigenous species and habitats with extinction. Those exotics have invaded forests through gaps formed through lodging from ornamentals grown in gardens in forested areas. Invasive plants are major problem for our forest ecosystem.

Invasive plant species can affect all components of an environment, from ecosystem process (Vitousek and Walker, 1989 and Rice, 1999; Bart and Hartman, 2000; Mack *et al.*,; Ehrenfeld, 2003) to biodiversity pattern (Brown and Gurevitch, 2004) to community structure (García-Robeldo and Murcia, 2005; Gratton and Denno, 2005). Generally, non-native invasive trees colonize open and degraded habitats that are recovering from some sort of perturbation. However, invasive species that are shade-tolerant can also establish viable population in mature tropical forest (Rejmanek, 1996; Fine, 2002). Nevertheless, the extent and degree to which invasive tree species influence vegetation structure and composition in mature tropical forests remains a point of considerable debate (Fine, 2002; Lugo, 2004). Thus, determination of tree species composition, distribution and abundance in this rehabilitate forest for the invasive plants that emigrate in the planted area is the aim of this study for evaluates the plant diversity.

1.1 Objectives of Study

The objectives of this study are to identify the invasive species that invaded in the rehabilitated forest and to determine the composition, distribution and abundance of invasive species.

CHAPTER 2

LITERATURE REVIEW

2.1 Tropical rain forest

Tropical rain forests located in Central and South America, Africa, Asia and Australia. Tropical rain forest is ancient and complex environments, needing a climate that provides constant daily rain with at least 59 inches (150cm) a year and a uniform temperature of about 28°C.

According to Neil (2006), all tropical rain forests show a great diversity of life. Between 50 and 200 different types of trees may be found in the most diverse temperate forest. Biome classification scheme, tropical rain forest are considered a type of tropical wet forest or tropical moist broadleaf forest and may also be referred to as low land equatorial evergreen rain forest (WRI, 1985).

Neil (2006) mentioned that tropical rain forests produce half of the world's living wood and are also home to about half of the world's species of plants and scientists are still finding the new species hidden away in the depths of these dense green environments.

2.2 Trees of tropical rain forests

Among the tropical rain forests in the world, the Indo-Malayan (Southeast Asia) is the second most extensive rain forest after the American rain forest centred on the Amazon basin (Whitemore, 1984). The tropical rainforests in Southeast Asia are the most species rich in the world in terms of both plant and animal life. The extreme

floristic richness is largely due to co-occurrence of a great number of species within the same community (Whitemore, 1990).

Thus, there have two sorts of tree species, those with shade-bearing (or shade-tolerant) seedlings and those with light-demanding (or shade-intolerant) seedlings (Swaine and Whitemore, 1988). The latter cannot regenerate under any shade, including their own. These two species classes are often known as climax and pioneer species respectively, referring to their abilities to perpetuate ***in situ*** or not (Whitemore, 1991).

2.3 Forest rehabilitation

Many tropical countries have achieved economic growth at the expense of converting their forest. Some of those countries have prospered and now have the resources and the will to restore some of the lost forest cover. Others remain impoverished despite converting forests. Forest rehabilitation is not a new phenomenon. But as tropical forest conversion continues seemingly unabated, rehabilitating degraded landscapes is likely to become more and more important (Will *et al.*, 2006).

Will *et al.*, (2006) also stated that as tropical countries across the globe have grown increasingly concerned about the consequences of forest conversion, they are attempting to reverse the trend. Worldwide efforts to rehabilitate tropical forest have accelerated. Although largely a recent phenomenon, many tropical countries had already started forest rehabilitation during the first half of the 20th century.

Forest rehabilitation has been discussed at the conceptual level (Lamb and Gilmour 2003; Poulsen *et al.*, 2002), and has been associated with various other terms (i.e restoration, reclamation, reforestation, afforestation). For instance, Lamb and Gilmour (2003) suggested three groups of actions aimed at reversing forest degradation such as reclamation, rehabilitation and restoration. By their definition, these activities have different expectations of improvements in biological diversity, structure and/or productivity. But in this project rehabilitation is an intermittent activity to restore productivity and biological diversity, but is less interested in achieving the level of biodiversity of the original forest.

Will et al. (2006) stated that the true era of forest rehabilitation began in the late of 20th century. This era of forest rehabilitation is still only the beginning. Previous forest rehabilitation experience can provide important and valuable lessons for the future.

2.3.1 Deforestation

Conserving biological diversity in the tropics has become an issue of increasing priority and urgency in recent years. However, the option available to address this issue and to slow or arrest the decline in tropical ecosystems and biological diversity, are limited and discoursing. More than 11 million hectares of mature tropical forests are converted into agricultural, pasture lands or other uses every year (Lanly 1982, WRI, 1985). Less than 10% of the land being deforested is replanted each year. Although the amount of tropical forest land coming under protection or conservation management is growing, the future many of these areas is in doubt due to rapidly increasing pressure of development and exploitation (Gomez *et al.*, 1991).

A large potential area for forest management in the tropics is the land area that increases daily through logging without any subsequent measures for regeneration (Gomez *et al.*, 1991). This area, during the next five years, could be well over 60 million hectares (WRI, 1985). Even assuming that 10% of this area could be rehabilitated into a managed forest, the impact on the biological resources (ecosystems and species) will be enormous. Only about 600,000 hectares of industrial plantations are being established in developing countries each year world-wide, less than 10% of natural forest being converted (Gomez *et al.*, 1991).

2.3.2 Forest restoration

According to Amo (1985), forest restoration also known as "assisted natural regeneration system", include a great variety of techniques for planting desirable species in the logged forest and in the lights gaps produced by falling trees, logging tracts, etc. One interesting variation is now being tested in Mexico (Amo, 1985) by introducing the seedlings of the desirable species in the secondary stages of succession. There are examples of restoration management in different parts of the world tropics.

2.4 Invasive species

Invasive plants are defined as those exotic species, which are not native to a region, that persist without human intervention, and potentially have serious impacts on their new environment (Simberloff *et al.*, 1997; Davis and Thompson, 2000). The mounting issue of climate variability and invasive plants as follows: "Some native species are unlikely to be able to adapt fast enough to the changing climate regimes, resulting in a lowered competitive edge and weakened resistance of ecosystems to

infestations by invasive plants and animals. Subtle changes in the diurnal (day/night) or seasonal patterns of temperature have also been shown to affect plant community composition (Carter, 2003).

Invasive species are non-native (exotic) species whose introduction is likely to cause environmental or economical damage. Increasing evidence suggests that direct or indirect impacts of extreme climate variations may give some invasive plants a competitive edge over a number of native species (Dukes and Mooney 1999). According to Dukes and Mooney (1999), usually invasive species are in a new environment, free from the natural predators, parasites or competitors of the native habitat and they often develop very high populations. Some invasive species can reduce forest productivity by reducing tree-growth rates, restricting tree seedling establishment, increasing fire hazard and increasing site preparation cost.

From this study we can know how the growth of the invasive plant in the cultivated area and also their succession. The first level of forest succession after site abandonment in the lowland moist is characterized by vegetation dominated by grasses, shrubs and forbs, which are eventually shaded out by short-lived and light demanding 'pioneer' tree species. After this period the canopy is dominated by long-lived and taller-statured (Lang and Knight 1983; Finegan, 1996). Because most of these tree species are unable to grow and/or reproduce under their own shade. (Knight, 1975; Saldarriaga *et al.*, 1988), their canopy dominance is constrained to early colonization after site abandonment. Eventually, the canopies of these secondary stands may be replaced by other shade tolerant species characteristic of

old-growth forest that usually germinate and establish during early succession (Knight, 1975; Guariguata *et al.*, 1997; Denslow and Guzman, 2000).

2.5 Dispersal of invasive tress

According to Bazaaz (1979), the dispersal of invasive species begins with the dispersal of seeds to sites suitable for germination. The dispersed of their seeds must be viable, they must escape predators, encounter the light, moisture and temperature condition required to germinate. The dispersal agents (including wind and secondary dispersal by erosion) generate individual and aggregate 'seed shadows' from the survivors of pre-dispersal seed predation. These seed shadows are then pruned by post-dispersal seed predation, germination and physical mortality (Janzen, 1986a).

Ng *et al.,* (1976) also state that different forests have very different collective reproductive biologies. For example, a Malaysian dipterocarp forest with a species poor overcanopy of wind-dispersed mast-seeding species with long inter-mast intervals and species-rich undercanopy of animal-dispersed species that seed more frequently will invade an old filed at different rates and patterns than Costa Rica species-rich dry forest that is a mix of animal and wind-dispersed species that in aggregate fruit every year.

Seed dispersal agents and processes are essential (though not sufficient) for forest to move onto land that has been cleared and for return of partly perturbed forest to its original state (Vazquez, 1984a). He also state that the dispersal agents are an essential link in the establishment of the seed shadows that will generate the seedling-environment interaction that will eventually maintain the multi species

pattern of tree species in the forest. According to Uhl and Clark (1983) the seeds have to get a gap or other safe site before they can even try to survive and grow there.

While Yap (1981) state that, most tropical forests are mixes of wind and animal-dispersed seeds. As perturbation increase, or as the forest invades an open area, these two processes are differentially affected. In a forest from which the vertebrates have been largely removed, not only do the animal-dispersed species begin to decline in numbers and change their relative abundance, but the wind-dispersed species do the opposite.

2.6 Tree composition, abundance and distribution

Forests are inherently dynamic in space and time. Their composition and distribution can change not only through continuous, subtle and slow forest development and succession, but also through discontinuous, occasional and sudden natural disturbances (Botkin, 1990; Oliver and Larson, 1996; Spices, 1997). In addition, to natural processes, human activities and disturbances are the sources of much contemporary forest change (Houghton, 1994; Meyer and Turner, 1994; Riiters *et al.*, 2002).

Above ground microhabitat differences influence early plant composition during secondary succession (Uhl *et al.*, 1981) but also small-scale variation in soil nutrients has the potential to affect the distribution, composition, and growth of colonizing species (Manuel *et al.*, 2001). Species with high growth rates may be disproportionately favoured under ample resource levels which leads to their over

dominance during early succession because slow-growing species tend to be less responsive to enhanced resource level (Chapin *et al.*, 1986).

More than 2500 tree species are found in the Sarawak area of 12.3 million hectares (Anderson, 1980). Baillie (1978) said that among them, mixed Dipterocarp forest occupies 57% of the whole Sarawak area and are estimated to contain over 2000 tree species. Ashton (1982) also found that Dipterocapaceae will be followed by Euphorbiaceae to be the two most important families in the same plot in this kind of forest. Compared to other forests, tropical rain forests give the highest composition and abundance of tree species within the highest family numbers.

The community assemblage will then converge on the pre-disturbance community at a rate that depends on the intensity, frequency and time since the distribution (Terbourgh *et al.*, 1996; Grau *et al.*, 1997). Alternatively, if the invaders do endure, fundamental, long lasting shifts in forest diversity patterns and community structure can result and a novel vegetation composition and assemblage may develop *sensu lato* (Lugo, 2004).

It has become increasingly apparent that the legacy of large-scale land uses remain imprinted on the recovered system for many decades after the perturbation event (Foster *et al.*, 1999; Thompson *et al.*, 2002; Chinea and Helmer, 2003). These disturbances influence subsequent soil conditions, available propagules, species composition, and community structure and diversity patterns. In recent years, with the abandonment of tracts of forests once used for reforestation purpose, large

regions of rehabilitate forest have regenerated (Brown and Lugo, 1990; Aide *et al.*, 1996, 2000; Finegan, 1996; Pascarella *et al.*, 2000, Aragón and Morales, 2003).

The initial colonization of invasive plants into regenerating rehabilitated forests is a function of arriving propagules from source locations (Aragón and Morales, 2003). Invasive plants that are able to respond favorable to fluctuating post-disturbance conditions will most likely establish and spread. In effect, those invasive plants that establish during the initial phases of forest regeneration can limit planted tree growth or slow the rate of change in species composition (Lichstein *et al.*, 2004; Marcano-Vega *et al.*, 2002).

2.7 Tree sampling

According to Nik Muhamad *et al.*, (2003), several researchers in the past several years; Faridah Sulaiman (1998), Faridah (1999), Faridah *et al.*, (1999a), Faridah *et al.*, (1999b), Faridah and Zamry Rosly (2000), Mazlan Awang (1996), Mohd Khairil (20001), Raja Idris (2001), Norhisyam (1999) and Zulkifli Suara (1997) have undertaken research on how much diversity is present in a 1 hectare plot in a forest. Faridah and Lepun (2004) established 1 ha plot of size 500 x 20 m with 100 sub-plots, each of size 10 x 10 m. Other example of I ha plot establishment is Abdul Kadir (2003) which contained 22 sub-plots; each of size 30 x 5 m.

CHAPTER 3

METHODOLOGY

3.1 Framework of Study

The research framework is shown in Figure 1. It is start from reconnaissance survey and followed by plot establishment and plant identification.

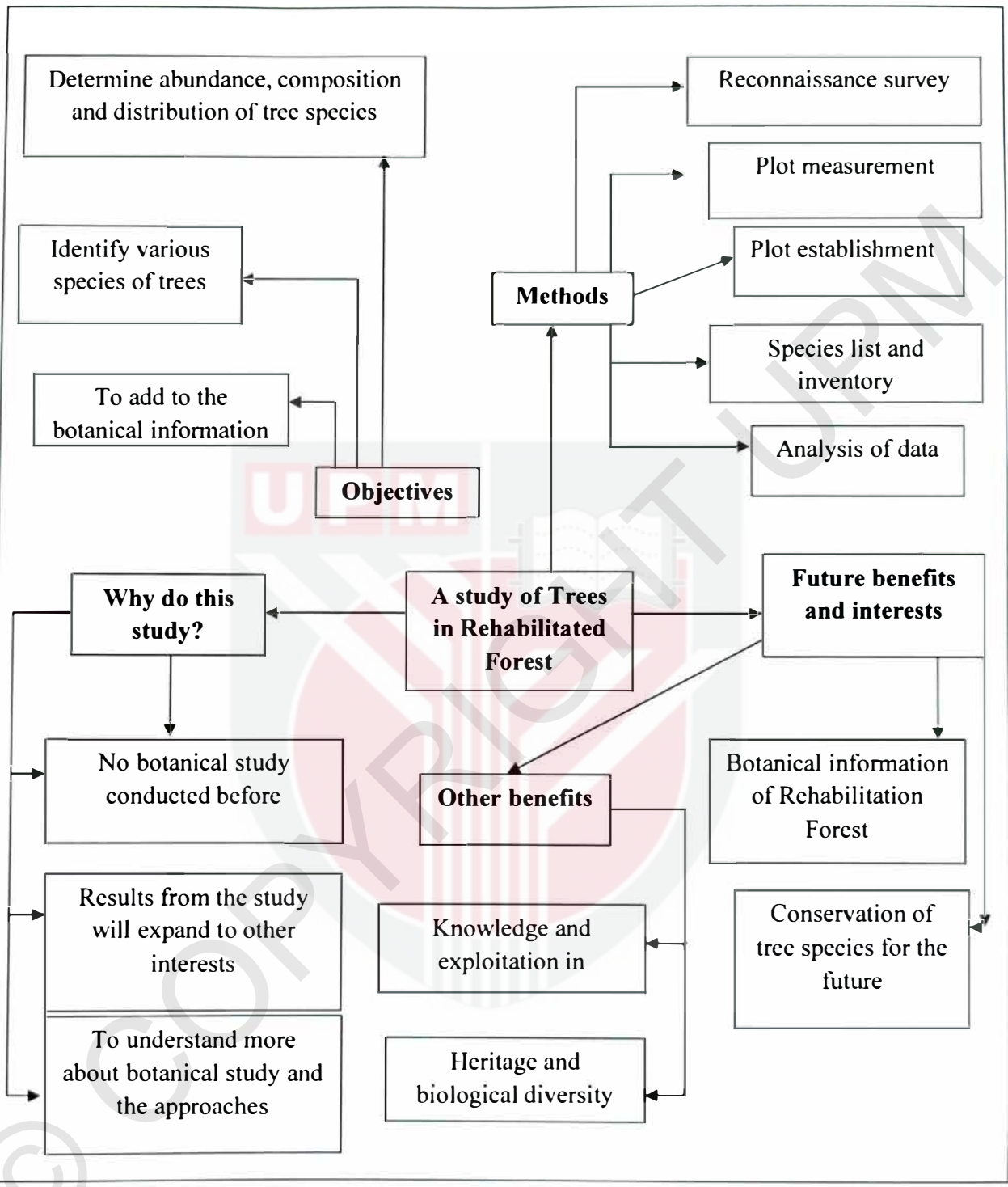

Figure 1: Study framework

3.2 Description of study area

Bintulu branch as belonging to Nyabau and Bekenu series, which is well drained. It is located about 600 kilometers northeast of Kuching, latitude rainfall 03'12'N, longitude 113°02'E and 50 meters above sea level. The location of the rehabilitated forest is shown in Figures 2 and 3. Plates 1, 2 and 3 show the view of this study area.

The mean annual rainfall is about 2993mm and the mean daily temperature recorded is 27°C. The mean monthly relative humidity of the area is usually above 80% and slightly lower during rainy season. The soil of study area is well drained. The Nyabau series is characterized by coarse loam. Light yellowish brown topsoil of 9 cm deep with brownish yellow subsoil. The Bekenu series is characterized by mix fine loam, light yellowish brown topsoil of 4-15cm deep and brownish yellow subsoil (Peli et al., 1984 and Mohamad Azani *et al.*, 2005)

Figure 2: Location of study area in UPMKB

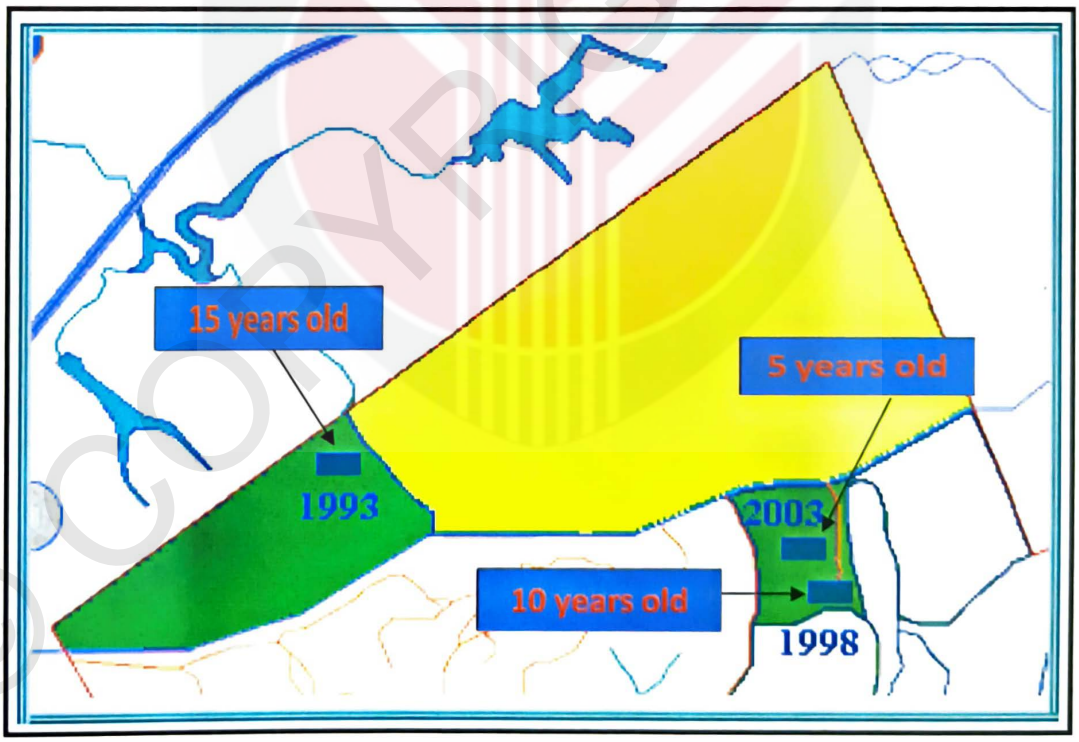

Figure 3: Experimental plot

Plate 1: 5-year old plot (1993)

Plate 2: 10-year old plot (1998)

Plate 3: 15-year old plot (2003)

3.3 Reconnaissance Survey

The reconnaissance survey is one of the important field procedures. During this phase, the preliminary information of Rehabilitated Research Plot Forest at Bukit Nyabau, Sarawak was collected. Therefore, it served as baseline data of the study. This stage consists of 'walk the woods' method to evaluate the situation of sites, sampling candidates, to estimate the length of base lines were adequate and to determine the position of starting points.

3.4 Plot Establishment

A plot of 33m x 33m (Figure 4) was established and selection of compartments was base on plots age divided into several blocks. The plots are 5, 10 and 15 years old.

Selected plots were inventoried and plant identification data was listed using herbarium voucher (Appendix I). Figure 5 shows the sub blocks in each plot.

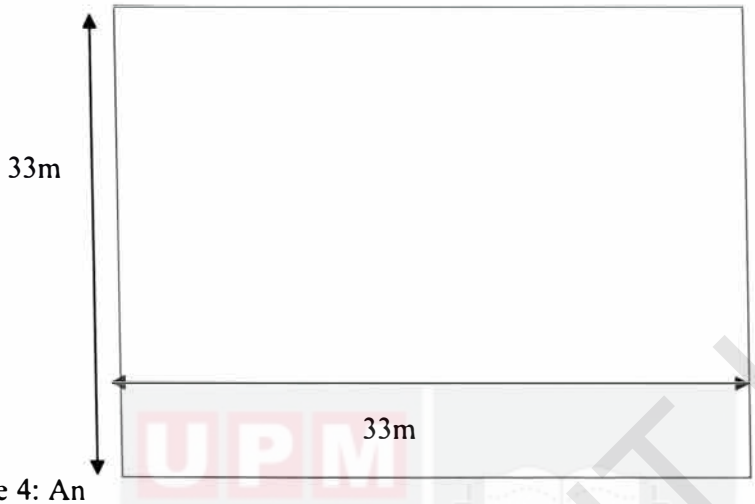

Figure 4: An inventory plan of identifying tree species

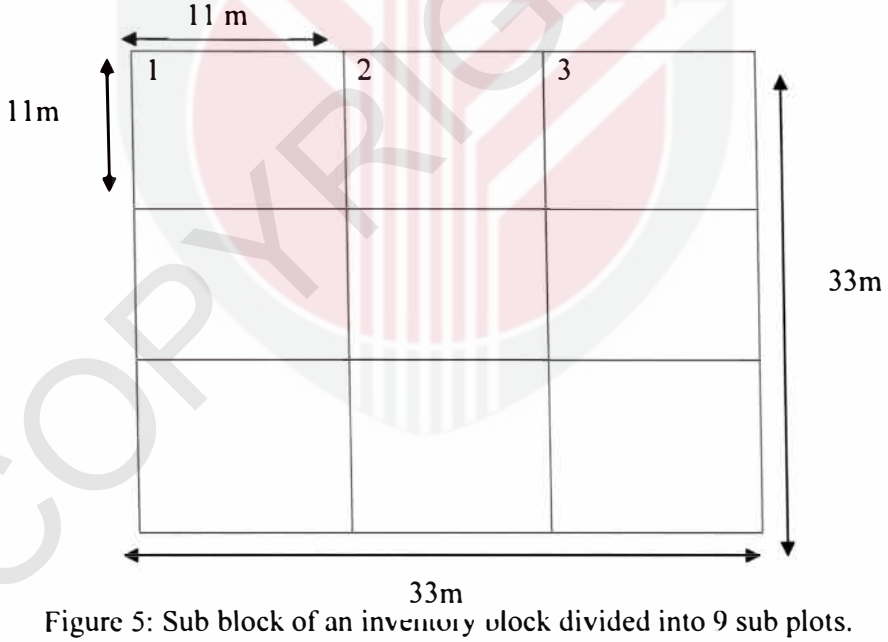

Figure 5: Sub block of an inventory block divided into 9 sub plots.

3.5 Species list and inventory

Then the data that are collected were divided by the species, genera and also the number of individual tree for each plot. The enumerations that were undertaken during the sampling and data collection stages were recorded in a species list form.

3.6 Data analysis

The plants that were identified were analyzed using descriptive analysis. The seedlings in 27 sub plots were enumerated and the population density was computed using average and percentage.

CHAPTER 4

RESULTS

4.1 Composition of invasive plant in the rehabilitated forest

The composition of the invasive plants in this study area is reported in three sections according to family, genera and species. A total of 37 species belonging to 30 genera and 24 families was recorded in the one-hectare plot. Table 1 shows the taxonomic composition of the invasive plants identified.

Table 1: Taxonomic composition of invasive plants in the study area

No	Family	No. Genera	No. Species
1	Dilleniaceae	1	1
2	Melastomataceae	2	2
3	Euphorbiaceae	4	6
4	Verbenaceae	1	1
5	Loganiaceace	1	1
6	Moraceae	2	3
7	Pedaliaceae	1	1
8	Gentianaceae	1	1
9	Theaceae	1	1
10	Lauraceae	2	3
11	Anacardiaceae	1	1
12	Tiliaceae	1	1
13	Clusiaceae	1	2
14	Myrtaceae	1	1
15	Rutaceae	1	2
16	Hypoxidaceae	1	1
17	Sapotaceae	1	1
18	Oxalidaceae	1	1
19	Linaceae	1	1
20	Burseraceae	1	1
21	Rhizophoraceae	1	1
22	Meliaceae	1	1
23	Annonaceae	1	1
24	Ebenaceae	1	1
	Total	**30**	**37**

A total of 1497 plants were found in the study area. Plot 1 which is five years old 1109 (74.08%) invasive plants, plot 2 (10 years old) has 310 invasive plant and plot 3 (15 years old) has the least number of invasive plants totaling only 78 individuals. Figure 6 shows the percentage composition of invasive plants for each plot out of a total number of 1497 plants in the study area.

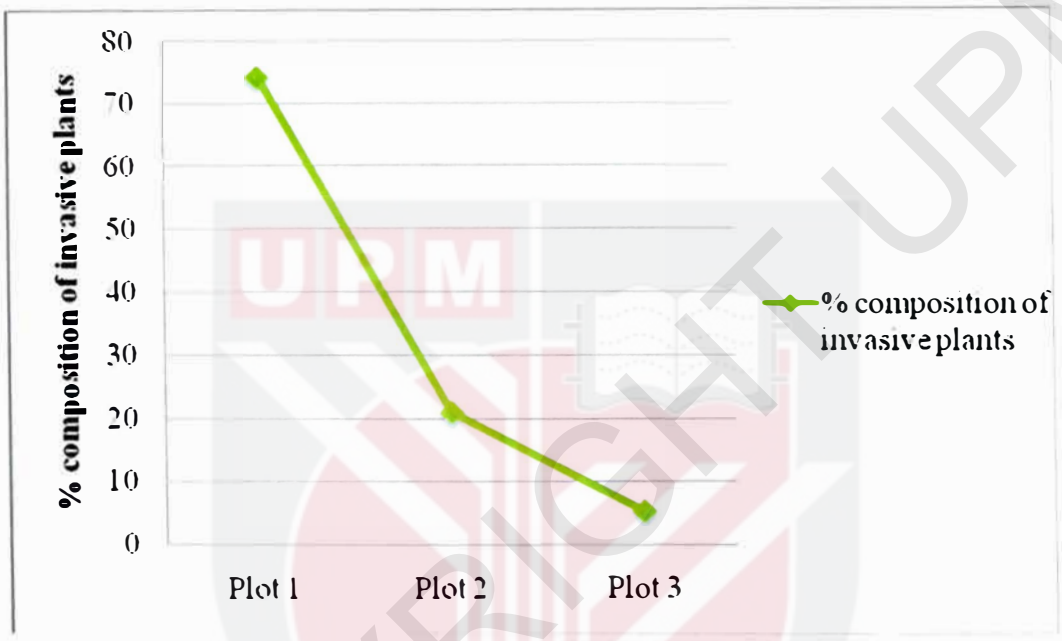

Figure 6: Percentage composition of invasive plants by age class

4.1.1 Families

Out of the total 24 families, Dilleniaceae has the highest number of individuals (596) representing 39.81% of the total number of trees in the experimental plot (1497). This is followed by Melastomatacea (350 plants), Euphorbiaceae (196 plants) and Verbenaceae (176 plants). The family Ebenaceae has the lowest number of individual and only one was found in the study area. The other families namely Lineacea, Burseraceae, Rhizophoraceae, Meliacea and Annonancea have only 2 individuals each in the study plot (Table 2). Figure 7 shows the composition by family classification for the three ages plots.

Table 2: Tree family composition in the rehabilitated forest

No	Family	P1	P2	P3	Total	%
1	Dilleniaceae	478	96	22	596	39.81
2	Melastomataceae	342	6	2	350	23.38
3	Euphorbiaceae	101	63	32	196	13.1
4	Verbenaceae	92	82	2	176	11.76
5	Loganiaceace	31	-	-	31	2.07
6	Moraceae	19	-	2	21	1.4
7	Pedaliaceae	17	-	-	17	1.14
8	Gentianaceae	14	2	-	16	1.07
9	Theaceae	-	14	-	14	0.94
10	Lauraceae	-	-	11	11	0.73
11	Anacardiaceae	-	10	-	10	0.67
12	Tiliaceae	10	-	-	10	0.67
13	Clusiaceae	-	9	-	9	0.6
14	Myrtaceae	-	9	-	9	0.6
15	Rutaceae	5	3	-	8	0.53
16	Hypoxidaceae	-	4	-	4	0.27
17	Sapotaceae	-	4	-	4	0.27
18	Oxalidaceae	-	4	-	4	0.27
19	Linaceae	-	-	2	2	0.13
20	Burseraceae	-	2	-	2	0.13
21	Rhizophoraceae	-	2	-	2	0.13
22	Meliaceae	-	-	2	2	0.13
23	Annonaceae	-	-	2	2	0.13
24	Ebenaceae	-	-	1	1	0.07
	Total	1109	310	78	1497	
	%	74.08	20.71	5.21		100

*P = Plot

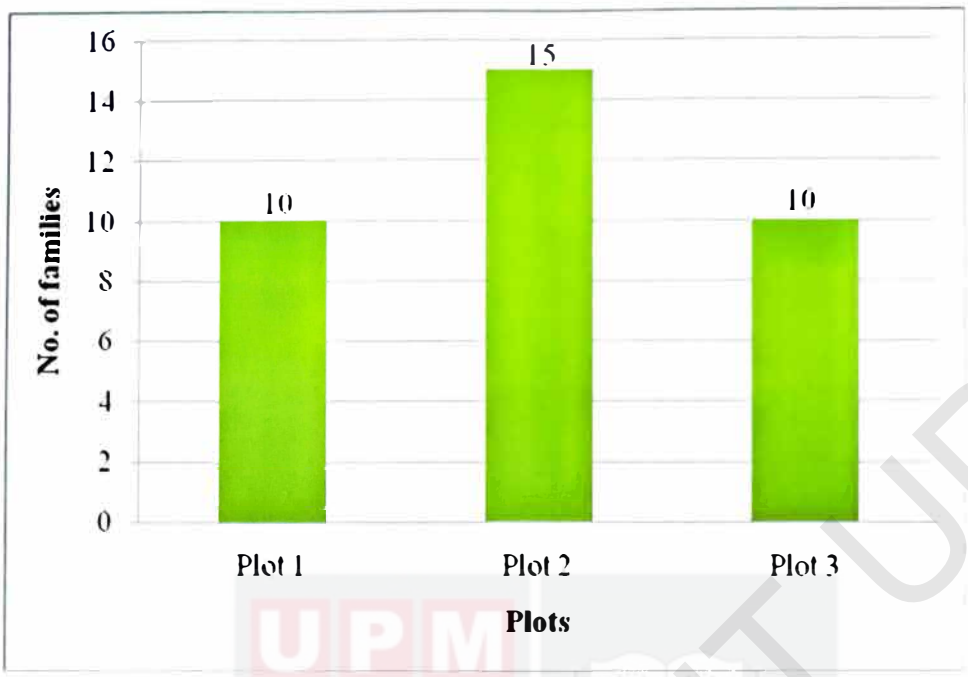

Figure 7: Composition of tree families in each plot

4.1.2 Genera

The 24 families found in the study area comprise of 30 genera (Table 3). The highest number of individuals is in genus Dillenia consisting of 596 plants. This represents 39.81% of the total number of plants in the study area. The second highest of genera is Melastoma and have 348 plants which is represent 23.25%. The lowest genera found in this rehabilitated forest are Diospyros which is only consist one plant and represent 0.07% within the whole area of the rehabilitated forest. Other lowest tree genera that consist only two plants and found in this study area are Aglaia, Pellacalyx, Ctenolophon a Cinnamomum.

Table 3: Composition of tree genera

No	Genera	P1	P2	P3	Total	%
1	Dillenia	478	96	22	596	39.81
2	Melastoma	342	5	1	348	23.25
3	Vitex	92	82	-	174	11.62
4	Macaranga	65	24	-	89	5.95
5	Endospermum	36	39	11	86	5.74
6	Fragrae	45	2	-	47	3.14
7	Glochidion	-	-	20	20	1.34
8	Ficus	19	-	-	19	1.27
9	Umcaria	17	-	-	17	1.14
10	Adinandra	-	14	-	14	0.94
11	Buchanania	-	10	-	10	0.67
12	Grewia	10	-	-	10	0.67
13	Litsea	-	-	10	10	0.67
14	Calophyllum	-	9	-	9	0.6
15	Syzgium	-	9	-	9	0.6
16	Eudia	5	3	-	8	0.53
17	Cucurligo	-	4	-	4	0.27
18	Palaquium	-	4	-	4	0.27
19	Sarcotheca	-	4	-	4	0.27
20	Aglaia	-	-	2	2	0.13
21	Artocarpus	-	-	2	2	0.13
22	Clerodendron	-	-	2	2	0.13
23	Dacryodes	-	2	-	2	0.13
24	Goniothalamus	-	-	2	2	0.13
25	Pternandra	-	1	1	2	0.13
26	Pellacalyx	-	2	-	2	0.13
27	Ctenolophon	-	-	2	2	0.13
28	Agrostistachys	-	-	1	1	0.07
29	Cinnamomum	-	-	1	1	0.07
30	Diospyros	-	-	1	1	0.07
	Total	1109	310	78	1497	
	%	74.08	20.71	5.21		100

*P=Plot

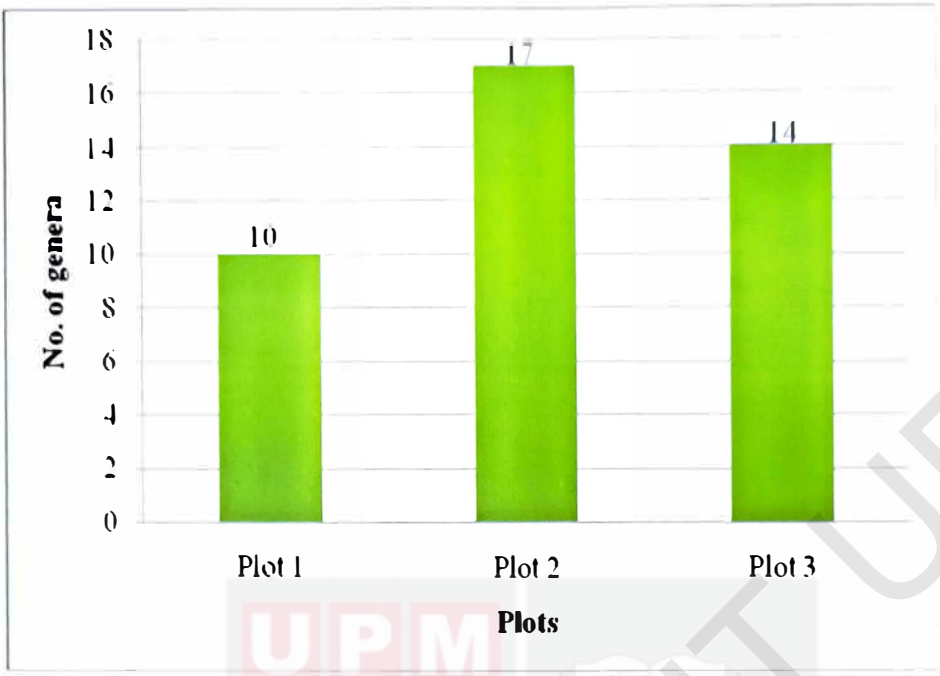

Figure 8: Composition of tree genera in each plot

This chart shows the composition by genera classification for the three ages plots and it showed that Plot 2 have the highest individual number of invasive plants.

4.1.3 Species

This study was found 37 species in 24 genera, 30 families and the total number of composition tree species in all plots is 1497. *Dillenia suffruticosa* has the highest number of individuals out of 37 species. It was consist 596 numbers out of 1497. Then it was followed by species *Melastoma malabathricum* (348) and *Vitex pubescens* (174).

There are five others species which had the lowest composition of tree species in all plots. The species are *Aglaia* sp., *Clerodendron paniculatum*, *Eudia latifolia*, *Cinnamomun iners* and *Litsea grandis* and all the species was represents 0.13% to 0.07%. From this study, Plot 2 has the highest number of individuals of invasive

species (Figure 8). Table 4 shows the composition of tree species in the rehabilitated forest.

Table 4: Composition of tree species

No	Species	P1	P2	P3	Total	%
1	*Dillenia suffruticosa*	478	96	22	596	39.8
2	*Melastoma malabathricum*	342	5	1	348	23.25
3	*Vitex pubescens*	92	82	-	174	11.62
4	*Endospermum mallacense*	36	39	11	86	5.74
5	*Macaranga gigantae*	47	8	-	55	3.67
6	*Fragrae fagrans*	31	-	-	31	2.07
7	*Glochidion littorale*	-	-	20	20	1.34
8	*Macaranga triloba*	18	2	-	20	1.34
9	*Ficus* sp.	19	-	-	19	1.27
10	*Umcaria* sp.	17	-	-	17	1.14
11	*Fragrae cuspidate*	14	2	-	16	1.07
12	*Adinandra dumosa*	-	14	-	14	0.94
13	*Macaranga javanica*	-	14	-	14	0.94
14	*Buchanania* sp.	-	10	-	10	0.67
15	*Grewia* sp.	10	-	-	10	0.67
16	*Litsea* sp.	-	-	9	9	0.6
17	*Syzgium pycnanthum*	-	9	-	9	0.6
18	*Calophyllum soulatri*	-	6	-	6	0.4
19	*Eudia glabra*	5	1	-	6	0.4
20	*Cucurligo latifolia*	-	4	-	4	0.27
21	*Palaquium maingayi*	-	4	-	4	0.27
22	*Sarcotheca glauca*	-	4	-	4	0.27
23	*Calophyllum rubiginosum*	-	3	-	3	0.2
24	*Aglaia* sp.	-	-	2	2	0.13
25	*Clerodendron paniculatum*	-	-	2	2	0.13
26	*Dacryodes macrocarpa*	-	2	-	2	0.13
27	*Eudia latifolia*	-	2	-	2	0.13
28	*Goniothalamus curtissi*	-	-	2	2	0.13
29	*Pternandra* sp.	-	1	1	2	0.13
30	*Pellacalyx saccardianus*	-	2	-	2	0.13
31	*Ctenolophon parvifolius*	-	-	2	2	0.13
32	*Agrostistachys borneensis*	-	-	1	1	0.07
33	*Artocarpus odoratissimus*	-	-	1	1	0.07
34	*Artocarpus heterophyllus*	-	-	1	1	0.07
35	*Cinnamomum iners*	-	-	1	1	0.07
36	*Diospyros pilonsanthera*	-	-	1	1	0.07
37	*Litsea grandis*	-	-	1	1	0.07
	Total	1109	310	78	1497	100

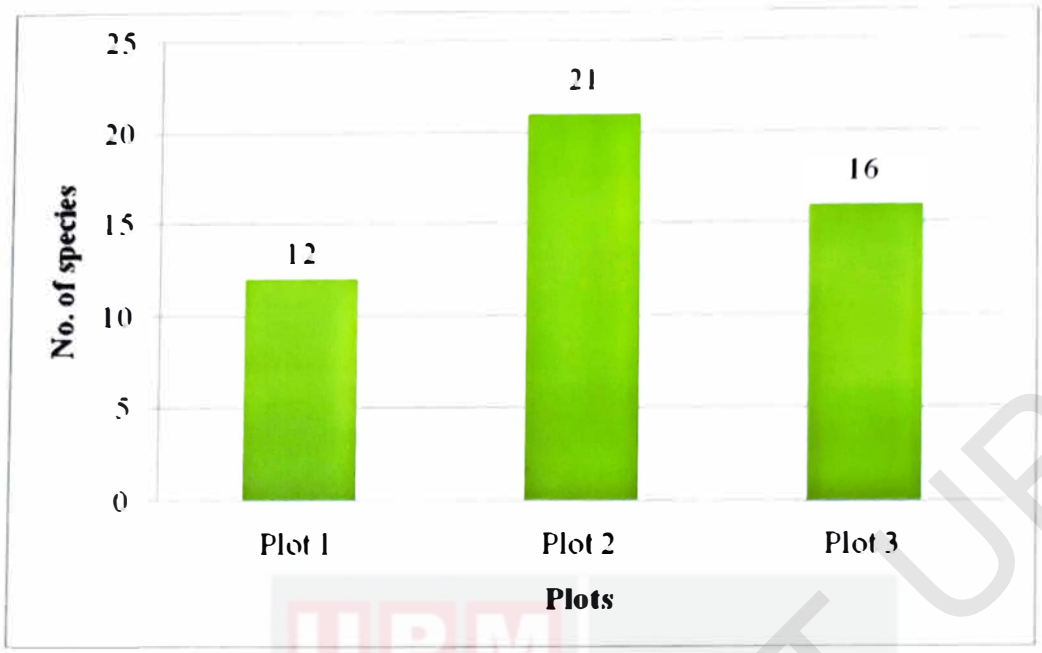

Figure 8: Composition of tree species in each plot

4.2 Distribution of trees in the rehabilitated forest

Rehabilitated Forest had 37 species of invasive plants from 30 genera in 24 families. There was 1497 numbers of invasive plants was growth in the rehabilitated forest. The distribution of these plants was identified in the 3 prepared plots.

4.2.1 Distribution of trees in all plots

Dillenia suffruticosa from family Dillenia was mostly distribute in all plots and the total number of individual of invasive plants is 596 out of 1497. Then it was followed by Melastomataceae (350). The species are *Melastoma malabathricum* and *Pternandra* sp. While the third highest percentages of invasive plants distribution are from Euphorbiacea (196) out of 1497 and the species are *Macaranga gigantae*, *Macaranga triloba*, *Macaranga javanica*, *Glochidion littorale*, *Endospermum mallacense* and *Agrostistachys borneensis*.

Out of 1497 number of individuals of invasive plants *Diospyros pilosanthera* has the lowest distribution in the study area and it was represent only one species. Table 5 shows the distribution of tree in the rehabilitated forest.

Table 5: Distribution of trees

		No. of Tree				
No	**Tree Species**	**P1**	**P2**	**P3**	**Total**	**%**
1	*Dillenia suffruticosa*	478	96	22	596	39.8
	Sub-total of Dilleniaceae	**478**	**96**	**22**	**596**	**39.8**
2	*Melastoma malabathricum*	342	5	1	348	23.25
3	*Pternandra* sp.	-	1	1	2	0.13
	Sub-total of Melastomataceae	**342**	**6**	**2**	**350**	**23.38**
4	*Macaranga gigantae*	47	8	-	55	3.67
5	*Macaranga triloba*	18	2	-	20	1.34
6	*Macaranga javanica*	-	14	-	14	0.94
7	*Glochidion littorale*	-	-	20	20	1.34
8	*Endospermum mallacense*	36	39	11	86	5.74
9	*Agrostistachys borneensis*	-	-	1	1	0.07
	Sub-total of Euphorbiaceae	**101**	**63**	**32**	**196**	**13.1**
10	*Clerodendron paniculatum*	-	-	2	2	0.13
11	*Vitex pubescens*	92	82	-	174	11.62
	Sub-total of Verbenaceae	**92**	**82**	**2**	**176**	**11.76**
12	*Fragrae fagrans*	31	-	-	31	2.07
	Sub-total of Loganiaceace	**31**	**-**	**-**	**31**	**2.07**
13	*Artocarpus odoratissimus*	-	-	1	1	0.07
14	*Artocarpus heterophyllus*	-	-	1	1	0.07
15	*Ficus* sp.	19	-	-	19	1.27
	Sub-total of Moraceae	**19**	**-**	**2**	**21**	**1.4**
16	*Umcaria* sp.	17	-	-	17	1.14
	Sub-total of Pedaliaceae	**17**	**-**	**-**	**17**	**1.14**
17	*Fragrae cuspidate*	14	2	-	16	1.07
	Sub-total of Gentianaceae	**14**	**2**	**-**	**16**	**1.07**
18	*Adinandra dumosa*	-	14	-	14	0.94
	Sub-total of Theaceae	**-**	**14**	**-**	**14**	**0.94**
19	*Litsea* sp.	-	-	9	9	0.6
20	*Litsea grandis*	-	-	1	1	0.07
21	*Cinnamomum iners*	-	-	1	1	0.07
	Sub-total of Lauraceae	**-**	**-**	**11**	**11**	**0.73**
22	*Buchanania* sp.	-	10	-	10	0.67

	Sub-total of Anacardiaceae	**-**	**10**	**-**	**10**	**0.67**
23	*Grewia* sp.	10	-	-	10	0.67
	Sub-total of Tiliaceae	**10**	**-**	**-**	**10**	**0.67**
24	*Calophyllum rubiginosum*	-	3	-	3	0.2
25	*Calophyllum soulatri*	-	6	-	6	0.4
	Sub-total of Clusiaceae	**-**	**9**	**-**	**9**	**0.6**
26	*Syzgium pycnanthum*	-	9	-	9	0.6
	Sub-total of Myrtaceae	**-**	**9**	**-**	**9**	**0.6**
27	*Eudia glabra*	5	1	-	6	0.4
28	*Eudia latifolia*	-	2	-	2	0.13
	Sub-total of Rutaceae	**5**	**3**	**-**	**8**	**0.53**
29	*Cucurligo latifolia*	-	4	-	4	0.27
	Sub-total of Hypoxidaceae	**-**	**4**	**-**	**4**	**0.27**
30	*Palaquium maingayi*	-	4	-	4	0.27
	Sub-total of Sapotaceae	**-**	**4**	**-**	**4**	**0.27**
31	*Sarcotheca glauca*	-	4	-	4	0.27
	Sub-total of Sapotaceae	**-**	**4**	**-**	**4**	**0.27**
32	*Ctenolophon parvifolius*	-	-	2	2	0.13
	Sub-total of Linaceae	**-**	**-**	**2**	**2**	**0.13**
33	*Dacryodes macrocarpa*	-	2	-	2	0.13
	Sub-total of Burseraceae	**-**	**2**	**-**	**2**	**0.13**
34	*Pellacalyx saccardianus*	-	2	-	2	0.13
	Sub-total of Rhizophoraceae	**-**	**2**	**-**	**2**	**0.13**
35	*Aglaia* sp.	-	-	2	2	0.13
	Sub-total of Meliaceae	**-**	**-**	**2**	**2**	**0.13**
36	*Goniothalamus curtissi*	-	-	2	2	0.13
	Sub-total of Annonaceae	**-**	**-**	**2**	**2**	**0.13**
37	*Diospyros pilonsanthera*	-	-	1	1	0.07
	Sub-total of Ebenaceae	**-**	**-**	**1**	**1**	**0.07**
	Total	1109	310	78	1497	100
	%	74.08	20.71	5.21	100	

4.3 Abundance of trees in the Rehabilitated Forest

The most abundant plants in this study area from family Dilleniaceae which is consist 596 number of individuals plants out of 1497 and followed by family Melastomataceae and Euphorbiaceae. The lowest abundant of invasive plants was from family Ebenaceae represent for species *Diospyros pilosanthera.*

4.3.1 Invasive species presence in each plots

There were 37 species was found in this study area and it was represent for 1497 number of individual plants.

A. Invasive plants in Plot 1

Table 6 shows that the total number of individuals species was found in this plot is 1109 and also the presence of the 12 species from 10 genera within 10 families. Out of 1109 *Dillenia suffruticosa* has the highest total number of invasive plants in this plot (478). The lowest species was found in this plot is *Eudia glabra* from Rutacea which is consist only 5 number of individuals plant. This plot was found that Euphorbiaceae have three species and there are *Macaranga triloba, Macaranga gigantae* and *Endospermum mallacense.* While the other families consist only one invasive species in this plot.

Table 6: Tree species present in Plot 1.

Family	Species	No
Dilleniaceae	*Dillenia suffruticosa*	478
Euphorbiaceae	*Macaranga triloba*	18
	Macaranga gigantae	47
	Endospermum mallacense	36
Gentianaceae	*Fragrae cuspidate*	14
Loganiaceace	*Fragrae fagrans*	31
Melastomataceae	*Melastoma malabathricum*	342
Moraceae	*Ficus* sp.	19
Pedaliaceae	*Umcaria* sp.	17
Tiliaceae	*Grewia* sp.	10
Rutaceae	*Eudia glabra*	5
Verbenaceae	*Vitex pubescens*	92
	Total	**1109**

B. Invasive plants in Plot 2

There were 310 individuals of 21 species from 17 genera within 15 families was found in Plot 2. This plot was consist many of invasive species other than Plot 1 and 3. *Dillenia suffruticosa* have the highest number of individuals plant followed by *Vitex pubescens* and *Endospermum mallacense*. *Eudia glabra* and *Pternandra* sp has the least number of individual plant .Table 7 shows the list of species occurance in Plot 2.

Table 7: Tree species present in Plot 2.

Family	Species	Number
Anacardiaceae	*Buchanania* sp.	10
Burseraceae	*Dacryodes macrocarpa*	2
Clusiaceae	*Calophyllum rubiginosum*	3
	Calophyllum soulatri	6
Dilleniaceae	*Dillenia suffruticosa*	96
Euphorbiaceae	*Macaranga javanica*	14
	Macaranga triloba	2
	Macaranga gigantae	8
	Endospermum mallacense	39
Gentianaceae	*Fragrae cuspidate*	2
Hypoxidaceae	*Cucurligo latifolia*	4
Melastomataceae	*Melastoma malabathricum*	5
	Pternandra sp.	1
Myrtaceae	*Syzgium pycnanthum*	9
Oxalidaceae	*Sarcotheca glauca*	4
Rhizophoraceae	*Pellacalyx saccardianus*	2
Rutaceae	*Eudia glabra*	1
	Eudia latifolia	2
Sapotaceae	*Palaquium maingayi*	4
Theaceae	*Adinandra dumosa*	14
Verbenaceae	*Vitex pubescens*	82
	Total	**310**

C. Invasive plants in Plot 3

Plot 3 have 16 species from 14 genera within 10 families which are listed in Table 8. The table shows that there are 78 individuals were found in this plot. Out of 78 the highest number of individual plant found in this plot is *Dillenia suffruticosa* (22). The lowest invasive plants which is consist only one plant are *Diospyros pilonsanthera*, *Agrostistachys borneensis*, *Litsea grandis*, *Cinnamomum iners*, *Melastoma malabathricum*, *Pternandra* sp., *Artocarpus odoratissimus* and *Artocarpus heterophyllus*.

Table 8: Tree species present in Plot 3

Family	Species	Number
Annonaceae	*Goniothalamus curtissi*	2
Dilleniaceae	*Dillenia suffruticosa*	22
Ebenaceae	*Diospyros pilonsanthera*	1
Euphorbiaceae	*Endospermum mallacense*	11
	Glochidion littorale	20
	Agrostistachys borneensis	1
Lauraceae	*Litsea* sp.	9
	Litsea grandis	1
	Cinnamomum iners	1
Linaceae	*Ctenolophon parvifolius*	2
Melastomataceae	*Melastoma malabathricum*	1
	Pternandra sp.	1
Meliaceae	*Aglaia* sp.	2
Moraceae	*Artocarpus odoratissimus*	1
	Artocarpus heterophyllus	1
Verbenaceae	*Clerodendron paniculatum*	2
	Total	**78**

4.3.2 The absence of tree species among plots

This study found that there were several species of plants that are absent in either plot. The species identified that did not occur in plot 3 are *Vitex pubescence, Macaranga gigantae, Macaranga triloba, Fragrae cuspidata and Eudia glabra*. There are only 1 species, *Pternandra* sp. that not occur in Plot 1. The absence and presence of all tree species among all plots are listed in table 9.

Table 9: The absence and presence of tree species among plot

No	Species	P1	P2	P3	Total	%
1	*Dillenia indica*	+	+	+	596	39.8
2	*Melastoma malabathricum*	+	+	+	348	23.25
3	*Vitex pubescens*	+	+	-	174	11.62
4	*Endospermum mallacense*	+	+	+	86	5.74
5	*Macaranga gigantae*	+	+	-	55	3.67
6	*Fragrae fagrans*	+	-	-	31	2.07
7	*Glochidion littorale*	-	-	+	20	1.34
8	*Macaranga triloba*	+	+	-	20	1.34
9	*Ficus spp.*	+	-	-	19	1.27
10	*Umcaria sp.*	+	-	-	17	1.14
11	*Fragrae cuspidate*	+	+	-	16	1.07
12	*Adinandra dumosa*	-	+	-	14	0.94
13	*Macaranga javanica*	-	+	-	14	0.94
14	*Buchanania sp*	-	+	-	10	0.67
15	*Grewia spp.*	+	-	-	10	0.67
16	*Litsea spp.*	-	-	+	9	0.6
17	*Syzgium pycnanthum*	-	+	-	9	0.6
18	*Calophyllum soulatri*	-	+	-	6	0.4
19	*Eudia glabra*	+	+	-	6	0.4
20	*Cucurligo latifolia*	-	+	-	4	0.27
21	*Palaquium maingayi*	-	+	-	4	0.27
22	*Sarcotheca glauca*	-	+	-	4	0.27
23	*Calophyllum rubiginosum*	-	+	-	3	0.2
24	*Aglaia spp.*	-	-	+	2	0.13
25	*Clerodendron paniculatum*	-	-	+	2	0.13
26	*Dacryodes macrocarpa*	-	+	-	2	0.13
27	*Eudia latifolia*	-	+	-	2	0.13
28	*Goniothalamus curtissi*	-	-	+	2	0.13

29	*Pternandra spp*	-	+	+	2	0.13
30	*Pellacalyx saccardianus*	-	+	-	2	0.13
31	*Agrostistachys borneensis*	-	-	+	1	0.07
32	*Artocarpus odoratissimus*	-	-	+	1	0.07
33	*Artocarpus heterophyllus*	-	-	+	1	0.07
34	*Cinnamomum iners*	-	-	+	1	0.07
35	*Ctenolophon parvifolius*	-	-	+	2	0.13
36	*Diospyros pilonsanthera*	-	-	+	1	0.07
37	*Litsea grandis*	-	-	+	1	0.07
	Total	**1109**	**310**	**78**	**1497**	**100**

P = Plot + = Present - = Absent

CHAPTER 5

DISCUSSION

5.1 Tree composition, distribution and abundance

Dillenia suffruticosa is the most diversified and abundant among all the 37 species. Out of the total 1497 this species numbers 596 individuals representing 39.81% of the total number of plants in the study area. The lowest number of individuals plant found in this study are *Agrostistachys borneensis, Artocarpus odoratissimus, Artocarpus heterophyllus, Cinnamomum iners, Diospyros pilonsanthera* and *Litsea grandis*. (Table 4) This might be due to the competition from other species which are more tolerant and hardy. Then the lowest number of individuals which is only one or two belongs to six families (Linaceae, Burseraceae, Rhizophoraceae, Meliaceae, Annonaceae and Ebenaceae). This is because open canopy in the Plot 1 which is five years old and this has led to exposure direct sunlight which is not conducive to seedling establishment.

The composition of invasive plants in the rehabilitated forest is generally quite high. As the total number of individuals found in 1 hectare was consisting of 1497 compared to a study by Noorazlinda (2008) found only 519 individuals of tree in a 1.2 hectare plot in the university forest. This study was estimated that in the rehabilitated forest has 37 species of trees from 30 genera within 24 families. Compared to a study of tree species composition of Forest Park in UPM Bintulu Campus by Noorazlinda (2008), she found that 125 species of trees from 82 genera within 40 families. Thus, this study shows that the composition of invasive plants

found in rehabilitated forest have lower composition of plants compare to diversity of tree recorded at Forest Park base on availability of tree species, genera and families.

As stated in the previous chapter there was total numbers of 24 families in the study area and Euphorbiaceae has the highest number of individuals. This finding supports the assertion made by Faridah *et al.,* (2004), that the presence of *Macaranga* sp. (Euphorbiaceae) shows this forest was disturbed in the past and is still at an early stage of succession. In this study the highest species in 10-year old plot which is already established. As such the microclimatic environment is more conducive for invasive plants to survive.

The distribution of plant within family, genera and species shows the differentiation in each plot. This differentiation was occurred because this study was conducted in different aged stand of the rehabilitated forest. The factor that influences the successful invasion of the invasive tree in the study area is modes of seed dispersal or the availability of the mother tree in the area. It is because, according to Bazaaz (1979), usually the dispersal of invasive species begins with the dispersal of seeds to site suitable for germination. Hence, it was proved by the succession of the invasive plants that was found in the study area. The dispersal agents are an essential link in the establishment of the trees that will generate the environmental interaction that will eventually maintain the species pattern in the forest.

5.2 Botanical Description

This section gives a more detailed description of 24 species which are found in abundance in the study plot and they also have commercial value. Appendix I shows the several photos of the most and the least abundant of invasive plants.

1. *Dillenia suffruticosa* L. sp. pl. 1:535 (1753)

Vernacular Names

Indonesia: Simpur air. Malaysia: Simpoh (Peninsular), simpoh kuning (Sarawak). Philippines: India katmon. Myanmar: Thabyu. Cambodia: 'san. Thailand: Matat.

Distribution

India, Sri Lanka, Myanmar, Indo-China, Southern China, Thailand, peninsular Malaysia, Sumatra, Java and Borneo.

Uses

The timber is used as simpoh, especially for interior construction. The wood is also used as firewood. The fruit are eaten in curries or jellies; mixed with sugar, they are used against coughs and rubbed in water as soap. The tree is often planted as an ornamental.

2. *Endospermum diadenum* (Miq.) Airy Shaw. (1960).

Vernacular names

Seduduk-seduduk, Antah bulan, Entabulan, Kemiri lawau, Merampangi, Mulan, Sesindok, Terbulan.

Distribution

Thailand, Peninsular Malaysia, Sumatra, Borneo (Sarawak, Brunei, Sabah, West-, Central-, South- and East-Kalimantan) and Philippines.

Uses

The wood is used for match boxes, splints, toys, etc. The roots and bark are medicinal. Used as plantation for reforestation and shade tree. The bark is used to cure dropsy and the roots are applied to injuries.

3. *Macaranga gigantae* (Rchb. f. & Zoll.) Mull. (1806)

Vernacular names

Elephant's ear, giant mahang (En). Malaysia: Mahang gajah, kubin, telinga gajah (Peninsular) Indonesia: Biruwak, serkubung. Singapore: Mahang gajah. Thailand: huu-chang (South Eastern), ma hang (Peninsular), tao lang (Northern).

Distribution

Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and Sulawesi.

Uses

Peeled macaranga poles are frequently used for temporary construction and especially for parts of native houses not in contact with the ground. Macaranga yields a high-quality pulp and produces high-quality particles board, and is suitable for the production of plywood. It is also provide good fuelwood.

4. *Fagraea fragrans* Roxb. (1824)

Vernacular names

Ironwood (En). Malaysia: Tembusu hutan, tembusu tembaga. Indonesia: Ki badak, kayu tammusu, ambinaton. Philippines: Urung, dolo, susulin. Myanmar: Anan, ahnyim. Cambodia: Tatraou. Laos: Man pa. Thailand: kankrao, man pla, thamsao. Vietnam: Trai.

Distribution

India, Myanmar, The Andaman Islands, Singapore, Sumatra, Indo-China, Thailand, Peninsular Malaysia, Borneo, Sulawesi, The South-Western Philippines and Yapen Islands (Irian Jaya).

Uses

It is the main source of tembusu timber. The valuable and durable timber is used both as sawn wood as well as roundwood for post and piles in the construction of houses, bridges and ships, and for railway sleepers, post for electric and telephone lines, barrels, chopping blocks, furniture, cabinet work, door and window sills and wood carvings. Besides the wood yields have a very high-quality fuelwood and charcoal. The tree is planted as a shade and ornamental tree in parks and along roads and for reforestation purpose. A decoction of the bark is used as a febrifuge, and a decoction of twigs and leaves is used to control dysentery.

5. *Glochidion littorale* Blume. Charact. (1775)

Vernacular names

Malaysia: Ubah, pokok kerenam, ubah paya (Peninsular). Indonesia: Mareme gede (Sundanase), rebambong (Bangka). Myanmar: Yuandong.

Distribution

India (Assam), Myanmar, peninsular Thailand, peninsular Malaysia, Sumatra, Java and Borneo; possibly also in Sulawesi.

Uses

The wood of *Glochidion* is used to build native and temporary houses, mainly as poles and rafters and for tool handles. The tree yield is good 'hot' fuelwood and the boles have been used in mushroom cultivation. The bark has been used to tan fishing nets and also for fishing net floats. The leaves are applied medicinally in decoction to treat stomach ache, against diarrhea and worms.

6. *Macaranga triloba* (Blume) Mull. Arg.

Vernacular names

Common mahang (En). Malaysia: Mahang merah, landas bukit, mahang tekukur (peninsular). Indonesia: Mahang kukur, mara bodas, tutup ancur. Philippines: Bula-bula. Singapore: Pahang merah. Laos: Tong khop 'hou sang[2]. Thailand: Low khao, lo ngaam and salapang.

Distribution

Southern Myanmar, Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo and Philippines.

7. *Aglaia sp* Fl. Chochinch.173 (1970)

Vernacular Names

Aglaia: Amoora (general). Indonesia: parak, langsat. Malaysia: bekak, pasak, segera, langsat-langsat, lantupak. Philippines: Guiji, makaasim, katog. Myanmar: thanatka-wa. Cambodia: chomnay poveang. Thailand: tasua, sangkhirat.

Distribution

Aglaia currently consists of 105 species, but it is expected that more will be discovered. They are distributed from southern India and Sri Lanka, through Myanmar, Thailand and Indo-China towards Malaysia area, northern Australia, New Caledonia, the Solomon Islands, Fiji and Samoa.

Uses

Aglaia wood is suitable for a wide range of purpose. The heavier timber is used where a good strength and durability are required as in house and bridge building. The moderately heavy timber is used for light and interior construction. This species is suitable for furniture, flooring, fine finishing, cabinets and face veneer as a substitute for mahagony. The frit and the aril of the seed of some species are edible. The flowers are aromatic and may be used in tea or perfume household textiles. The leaves have a wide range of traditional medicinal applications.

8. *Cinnamomum iners* Reinw. Ex Blume. (1826)

Vernacular Names

Malaysia: Medang teja, kayu manis hutan, teja lawang. Clove cinnamom, wild cinnamom, Indonesia: Ki teja. Philippines: Namog. Myanmar: Hmanthin. Laos: Chouang. Thailand: Chiat. Vietnam: Qu[ees]i[owj]n.

Distribution

India, Myanmar, Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi and the southern Philippines.

Uses

The wood is used as medang for house building and cabinet work. The mucilage has found technical application for example in the manufacture of mosquito coils, fragrant joss-sticks, plastic products, formica, glue, inner layering of tires, coating of high quality paper products, paints and fibre glass. The bark is sometimes traded and called 'mesni' in Sarawak; it is used as medicine, or together with the leaves in tea and also as a substitute for cinnamom. The oil from the leaves is used for flavoring sweets and confectionary. The tree is sometimes planted as a shade tree.

9. *Diospyros pilosanthera* Blanco.(1837)

Vernacular Names

Malaysia: Buey, kayu arang. Indonesia: Semetik, balun injuk, kayu arang. Philippines: Bolong eta. Thailand: Nian, damdong and kaling.

Distribution

Myanmar, Cambodia, Vietnam, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Moluccas and Philippines.

Uses

The wood is used as streaked ebony example for furniture.

10. *Litsea* sp. Lamk.(1792)

Vernacular names

Medang: Bollywood (En). Malaysia: Medang padang. Papua New Guinea: Litsea. Philippines: Batikuling. Myanmar: Ondon, kyese. Thailand: Tham-mang,thang-baiyai. Vietnam: Boi loi.

Distribution

Malaysia, Papua New Guinea, Philippines, Myanmar, Thailand and Vietnam.

Uses

The timber is used for interior finish, paneling, ceilings, partitioning, furniture, cabinet work, boards, rotary veneer and plywood and packing cases; the heavier timber which may be present in some species is also used for medium-heavy construction, poles, posts, planks, canoes, tool handles, agricultural implements, carving, sculpturing and pattern making. Their fruit are edible. Leaves bark and wood chips are used in traditional medicine. The seeds contain oil which is used as a medicine, for the manufacture of soap and hair cream and was formerly used for candle manufacture.

11. *Litsea grandis* (Wallich ex Nees) Hook.f. (1886)

Vernacular Names

Great laurel (En). Malaysia: Medang daun lebar, medang bulu (Sarawak). Philippines: Puso-puso, sablot, tioh. Thailand: Kathang, muedaeng, sangtong.

Uses

L. grandis is a fairly important source of medang and reportedly used for carving and furniture. Oil from the seeds is used for making hair cream.

12. *Calophyllum rubiginosum* M.R. Henderson & Wyatt-Smith. (1956)

Vernacular names

Indonesia: lancar (Sumatra). Malaysia: bintangor daun karat (Peninsular)

Distribution

Southern peninsular Malaysia, Singapore, Sumatra and Borneo (Sarawak, Brunei, Sabah, East Kalimantan)

Uses

The timber is used as bintangor. The poisonous latex is use to stupefy fish. It is also used in local medicine.

13. *Calophyllum soulattri* Burm.f. (1786)

Vernacular names

Malaysia: Bintangor labu, bintangor lanchar, mintak. Indonesia: Sulatri, slatri, malang-malang. Philippines: Bintanghol-sibat, pamintaogon, gigabit. Thailand: tanghon baiyai.

Distribution

Vietnam, Cambodia, the Andaman Islands, Thailand, throughout Malaysia, Solomon Islands and northern Australia.

Uses

The timber is used for masts and spars and in house construction throughout the area of distribution. In many places it is considered as one of the best bintangors. The latex may be used to poison dogs. The bark, roots and latex are used in local medicine. The fruits are edible but sour. The tree is sometimes planted as a shade tree or ornamental.

14. *Palaquium maingayi* (C.B Clarke) King & Gamble. (1905).

Vernacular names

Nyatoh tembaga, sundik and getah ketapang.

Distribution

Southern Thailand and Peninsular Malaysia (except Perlis, Pinang, Terengganu).

Uses

The timber is used as nyatoh. The latex makes gutta-percha of moderate quality often used an adulterant for gutta-percha from *P. gutta*.

15. *Agrostistachys borneensis* Becc., For. Borneo (1902)

Vernacular names

Bornean jenjulong (En). Malaysia: Nulong, nyonyolong (Peninsular). Philippines: Haginis-agos (tagalong)

Distribution

Peninsular Malaysia, Singapore, Sumatra and Borneo.

Uses

The wood of *Agrostistachys* has been used for walking sticks, fence poles and carrying baskets. It is suitable for the production of pulp and yields and fairly good fuel wood. The logs are also for mushroom cultivation. The large leaves are used for roofing, thatching and wrapping. The fibrous bark can be use to make rope. The resin on the terminal bud is used to secure knife blades in their handles. The gum used to varnish sheaths and handle of krises.

16. *Adinandra dumosa* Mal. (1822).

Vernacular names

Malaysia: Tetiup (Peninsular), semapak (Sarawak), bawing (Sabah). Indonesia: Palempang, tiup-tiup (general), ranu. Singapore: Tiup-tiup.

Distribution

Peninsular Malaysia, Singapore, Sumatra, Java (probably introduced) and Borneo.

Uses

The wood of *Adinandra* is used for general construction, flooring, paneling, door and window frames, joinery, furniture, planking and poles for temporary constructions and yields good quality plywood. The wood is also suitable as firewood and for the production of charcoal. *A. dumosa* may be useful for afforestation or as a cover crop.

17. *Buchanania* Speng. (1801)

Vernacular names

Buchanania, pink satin-wood (En). Malaysia: Kepala tundang (Sabah), otak udang (Peninsular, Sarawak). Brunei: Kalan tundang, salingkawang, tengawan. Indonesia: Pauhan. Papua New Guinea: Pink satinwood. Philippines: Balinghasai.

Distribution

Buchanania comprises about 25 species occurring from India to Indo-China, southern China, Taiwan, Thailand, the whole of Malaysian region, Australia and the Pacific, east to Samoa. There are 8 species in Malaysia.

Uses

Buchanania is used for light construction, canoes, furniture, drawers, mouldings, light framing, interior finish, household implements, cigar boxes, turney articles, veneer and blackboard, and also for pulp and as firewood.

18. *Ctenolophon parvifolius* Oliv. (1873)

Vernacular names

Mertas (trade name). Malaysia: Besi besi (Sabah), litoh (Iban, Sarawak), mertas (Peninsular). Brunei: Adau. Indonesia: Kalek bun cung, kayu bawang, latak manuk. Papua New Guinea: Ctenolophon (En). Philippines: Sudiang (Cebu, Samar- Leyte Bisaya).

Distribution

Peninsular Malaysia, Sumatra, Borneo, Philippines and New Guinea.

Uses

The wood of *Ctenolophon* is used for medium to heavy construction, house building, bridge building, marine constructions, ship-building, heavy duty flooring, parquet flooring, piling, power transmission posts, vehicles bodies, heavy duty pallets, fences and tool handles.

19. *Dacryodes macrocarpa* (King) H.J. Lam. (1810)

Vernacular names

Malaysia: Asam-asam (Dusun, Sabah), icerawas burung (malay, Sarawak). Brunei: Pasoh-pasoh. Indonesia: Bantar burung, lentambung (Sumtra), rarawa pipit (Kalimantan). Philippines: Marangub.

Distribution

Peninsular Malaysia, Sumatra, Borneo and Philippines.

Uses

The wood of *Dacryodes* is used for general construction under cover. It is also suitable for the production of veneer and plywood and has been applied for the manufacture of particle board. The pulp of the fruit is edible; the latter has even been cultivated for its fruits whereas its resin is used to make torches.

20. *Grewia* L. (1754).

Vernacular names

Malaysia: Chenderai (general), bunsi (Iban, Sarawak), damak-damak (Peninsular). Indonesia: Talok (general). Philippines: Dangling. Myanmar: Tayaw. Thailand: Po-lai, po-muen, yap. Vietnam: c[aa]y long man duc, c[of]ke.

Distribution

Grewia comprises about 200 species and is confined to the Old World tropics. The genus extends north to the Himalayas, China and Taiwan, east to Tonga and Samoa and south to northern Australia. It occurs throughout the Malaysia region where about 30 species are found.

Uses

The wood of grewia is generally used for small articles where toughness is required, like tool handles, spades, shafts of goal sticks, shoulder poles for carrying small loads, pestles, bows, billiard cues and shingles. The fibrous bark is used to make ropes. The fruits are edible. The leaves are used medicinally, chiefly for external applications.

21. *Pellacalyx saccardianus* Scourt. (1836)

Vernacular names

Malaysia: membuloh rimba (Peninsular), hurka hurgu and kayu johor. Thailand: Ai krack bai lek (Peninsular).

Distribution

Peninsular Thailand, Peninsular Malaysia and Singapore.

Uses

The wood of *Pellacalyx* is occasionally used for rafters and other construction purposes under cover and for fuel.

22. *Pternandra* Jack. (1822).

Vernacular names

Merubi (trade name). Cursed shade (En). Malaysia: Sial menahun (peninsular), sireh-sireh (Sarawak).

Distribution

Pternandra comprises 15 species; New Guinea may harbor several still undescribed ones. The genus is distributed from Hainan, Cambodia and Thailand to the whole of the Malaysia region and northern Australia.

Uses

The use of the wood Pternandra is restricted due to the belief that cutting the trees or using the wood brings about bad luck. When used, it is generally for house building

(under cover) and poles. It has also been used as fuelwood. The pounded fruits have been used for poulticing orchitis or hydrocele. In Sarawak an extract is drunk to induce vomiting. In Peninsular Malaysia a decoction of the roots has been administered after child birth.

23. *Ficus* L. (1754)

Vernacular names

Ficus, fig (En). Figue (Fr). Malaysia: Ara, ara ke lumping (stems figs), ara tanah (geographic figs), nunok (Dusun, Sarawak). Indonesia: ara, bunut,karet. Papua new guinea fig (trade name). Philippines: balete. Myanmar: nyaung. Thailand: sai. Vietnam: chi da, d[eef], sung.

Distribution

Ficus comprises about 1000 species and occurs in tropical and subtropical regions, about half of them in Malaysia. Few species are found in warm temperate areas.

24. *Artocarpus heteophyllus* Lam. (1789

Vernacular names

Malaysia: jak-fruit, jak, jaca. Philippines: nangka. Thailand: khanun. Cambodia: khnor. Laos: mak mi or may mi. Vietnam: mit.

Distribution

This species is indigenous to the rainforests of the Western Ghats. India, Burma, Ceylon, southern China, Malaya, East Indies and Philippines.

Uses

Jackwood is an important timber furniture, construction, turnery, masts, oars, implements, brush backs and musical instruments. For medicinal used; the root is a remedy for skin diseases and asthma. An extract of the root is taken in cases of fever and diarrhea. The bark is made into poultices. Heated leaves are placed on wounds. The wood has a sedative property; its pith is said to produce abortion. The fruits also for cattle fed.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

Dillenia suffruticosa was a permanent number of the highest tree species due to its composition, distribution and abundance. It was because this species was found in all of the study area. Three other invasive plants that were most abundant are *Melastoma malabathricum, Vitex pubescens and Endospermum mallacense*. The lowest abundant of invasive species in this study are *Agrostistachys borneensis, Artocarpus odaratissimus, Artocarpus heterophyllus, Cinnamomum iners, Diospyros pilosanthera* and *Litsea grandis*. Other than that, the most abundant family is Euphorbiaceae and the species from this family are *Macaranga javanica, Macaranga gigantae, Macaranga triloba, Endospermum mallacense, Glochidion littorale* and *Agrotistachys borneensis*.

In spite of low light intensity and competition for water and nutrients, many invasive plants can still survive well and some of these species might have commercial timber and medicinal values. Here is the recommendation to further the study on this study area which is a study should be conducted by determine the commercial potential of the invasive species

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APPENDIX 1

Scientific name: *Dillenia suffruticosa*

Common name: Simpuh air

Scientific name: *Vitex pubescens*

Common name: Leban

Scientific name: *Melastoma malabathricum*

Common name: Senduduk

Scientific name: *Macaranga gigantae*

Common name: Mahang gajah

Scientific name: *Macaranga triloba*

Common name: Mahang merah

Scientific name: *Glochidion littorale*

Common name: Ubah

PUBLICATION OF THE PROJECT UNDERTAKING

This is to certify that I have no objection to publish the project entitled "**Invasive Woody Plants in Different Aged Stands of a Rehabilitated Forest**" by the supervisor in a joint authorship. However, it has to be evaluated by the Faculty of Agriculture and Food Sciences, Universiti Putra Malaysia Bintulu Sarawak Campus and published in the form approved by faculty.

NORHIDAYAH BT MD. ARIS

DATE: 08/05/09