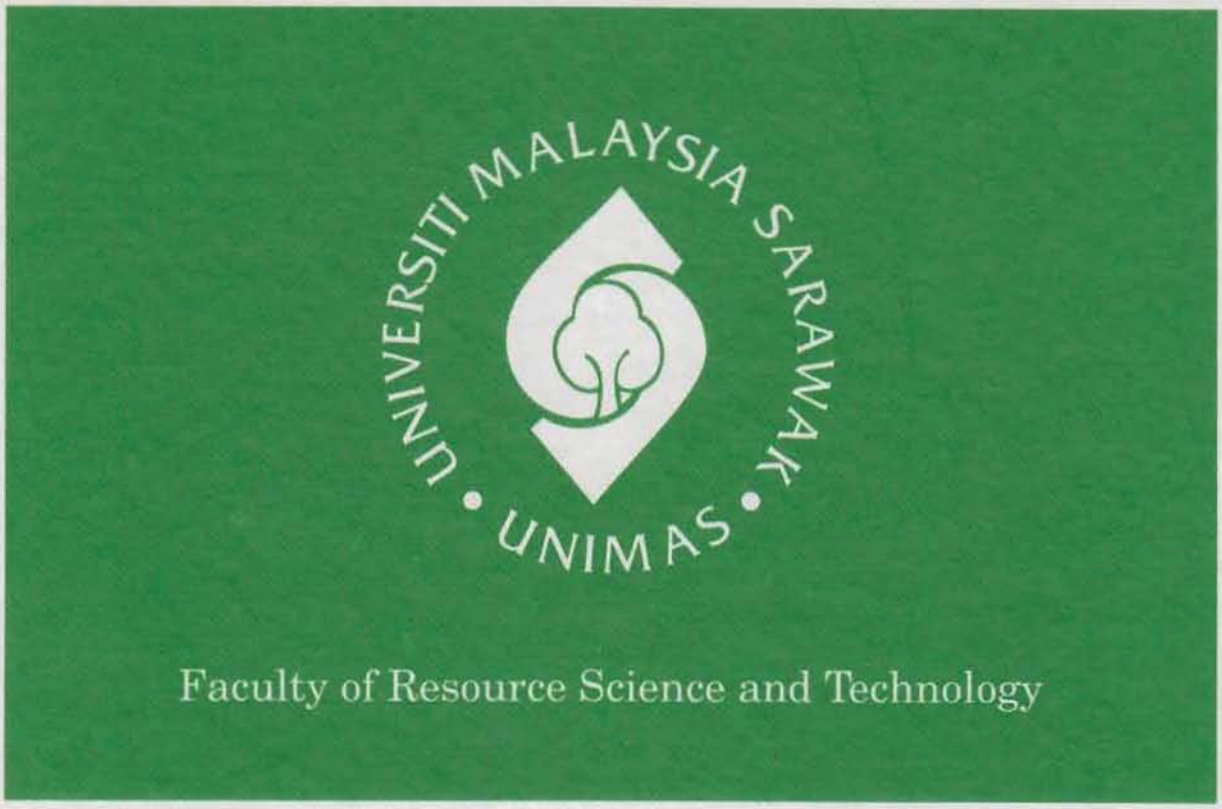

INVENTORY AND IDENTIFICATION OF PLANTS FROM SECONDARY FOREST COMMONLY USED FOR MEDICINE, FOOD PRESERVATIVES AND FOOD FLAVORS IN THE BIDAYUH COMMUNITY

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Bachelor of Science with Honours
(Plant Resource Science and Management)
2006

Inventory and identification of plants from secondary forest commonly used for medicine, food preservatives and food flavors in the Bidayuh community

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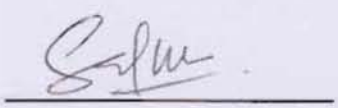
This report is submitted in partial fulfillment of the requirements or the degree of
Bachelor of Science with Honors
(Plant resource science and management)

Faculty of Resource Science and Technology
Universiti Malaysia Sarawak
2006

Declaration

No portion of the work referred to in this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.



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Acknowledgement

I would like to take this opportunity to express my highest gratitude to my supervisor Assoc. Prof Dr. Gabriel Tonga Noweg and my co- supervisor Mr. Mohd Razip Asarudin for helping me to carry out this project.

I would also like to thank Mr. Sekudan Tedong and all the laboratory assistants that contribute either in the field or in the laboratory. All the lecturers that teaching in plant resources science and management program are also appreciated for their guidance in completing this project. Besides that, I also would to thank Madam Nayel, Madam Rikeb and the local people of Kampung Serasot, Bau who had been very cooperative during the plant survey.

For my co-researchers, Mr. Amir Zunnasri and Ms. Saridahwati, appreciate both of you for being patient, co-operative and helpful during the completion of this project. My acknowledgement would not be complete without mentioning my family for their positive encouragement and continuous support throughout this project.

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Inventory and Identification of Plants from Secondary Forest Commonly Used For Medicine, Food Preservatives and Food Flavors in the Bidayuh Community

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ABSTRACT

The inventory and identification of plants for medicine, food preservatives and food flavors in the Bidayuh community is conducted in secondary forest at Kg. Serasot, Bau, Sarawak. Inventory was conducted in the 5 years, 20 years and 30-year-old secondary forests area, regenerated from shifting cultivation activity. The distribution, diversity and density of each type of secondary forests is recorded and analyzed. Twenty years old secondary forest have highest distribution with 25%, diversity index 3.70 and 24% relative density of medicinal, flavoring and preservatives plant species. All null hypotheses was rejected, that there is no significant prove that the older type of secondary forest is having more diversity, distribution and density of medicinal, flavoring and preservatives plant species. Nineteen plants species for medicinal, 6 plant species for flavoring and one plant species for preservatives uses has been identified.

Keywords: medicinal, preservatives, flavoring, diversity, distribution, density.

ABSTRAK

Kajian mengenai inventori dan pengenalpastian tumbuhan ubatan, perasa makanan dan bahan pengawet yang digunakan oleh kaum Bidayuh telah dijalankan dalam hutan sekunder di Kg. Serasot, Bau, Sarawak. Inventori telah dijalankan di hutan sekunder 5 tahun, 20 tahun dan 30 tahun yang berasal daripada aktiviti pertanian pindah yang tealh dibiarkan. Kepelbagaian, taburan dan ketumpatan setiap jenis hutan sekunder direkod dan dianalisis. Hutan sekunder 20 tahun mempunyai taburan yang tertinggi dengan 25%, dengan indeks kepelbagaian 3.70 dan ketumpatan relatif dengan 24% untuk tumbuhan ubatan, perasa makanan dan bahan pengawet. Kesemua nol hipotesis tidak diterima kerana tiada terdapat signifikan yang menyatakan bahawa hutan sekunder yang lebih tua mempunyai kepelbagaian, ketumpatan dan taburan yang lebih banyak berbanding hutan sekunder yang lebih muda untuk tumbuhan ubatan, perasa makanan dan bahan pengawet. Sembilan belas spesis tumbuhan ubatan, 6 spesis tumbuhan untuk perasa makanan dan satu spesis tumbuhan untuk pengawet makanan telah dikenalpasti.

Kata kunci: tumbuhan ubatan, behan pengawet, perasa makanan, kepelbagaian, ketumpatan, taburan.

CHAPTER 1

INTRODUCTION

1.0 Study Area

The study was conducted at Bau, Sarawak. Specifically it was situated in secondary forests in Kg. Serasot and around Gunung Jagoi. These secondary forest covers the area from N1.37 E110.05 to N1.372 E110.044 on the geographical map of Bau district, Sarawak. Area of Kg. Serasot and Gunung Jagoi are of secondary forests which are a typical tropical forest with a high humidity. The Bidayuh have lived and cultivated the Gunung Jagoi area for hundreds of years. In the past, there are about 13 villages situated on the Gunung Jagoi. Those villagers have separated nowadays with some remaining in Bau, Sarawak while the others have moved to Kalimantan, Indonesia. In Bau district there about 14 villages including Kg. Serasot located around Gunung Jagoi nowadays.

The study area is divided into 3 different areas, that is the 30-years-old secondary forest, the 20-years-old secondary forest and 5-years-old secondary forest. These secondary forests are derived from shifting cultivation activities of the Bidayuh community in the past. The study area secondary forests are categorized the number of years they have been left after the last shifting cultivation activities. The 30-years-old secondary forest is situated on N1.37 E110.05, while the 20-years-old secondary forest is situated on N1.3713 E110.0532 and the 5-years-secondary forest is situated on N1.372 E110.044 coordinate on geographical map of Bau district.

Secondary forest can also be categorized as non- dipterocarp forest, such most of the tree are of non- dipterocarp species. This characteristic is influenced by shifting cultivation history, as some species may be planted during or after the shifting cultivation activity. Planted trees are included rubber, cempedak and durian. The average height of the tree are between 17 to 25 meters, with a lot of shrubs, seedlings and climber species that living under the tree canopy. The soil is lateritic with a thick litter surface. The land is hilly towards Gunung Jagoi with some slopes deserted by small rivers.

1.1 Problem Statement

This inventory and identification of medicinal, food preservatives and food flavor plants utilized by the Bidayuh community may face some expected problems in order to accomplish this research. These problems are mainly originated from the situations in the secondary forests itself. The distribution, diversity and density of the plant species cannot be assumed the same. As the species changes according to the forest stages.

Medicinal plants, food flavor plants and food preservatives plants may distributed all over the different forests stages. This is related to the former usage the history of the secondary forest as shifting cultivation area before. Some species may be planted by the farmers. In this case, we cannot assume the forest density of different plant species is same as the other forest. This is especially true case of in the 5-years-old secondary forest, where species still consisted of the species planted in the latest shifting cultivation activity. For example, paddy, rubber seed and some Arthocarpus species. Recalcitrant species, like durians and jackfruit are also planted in the shifting cultivation in that area.

Some trees species that can be found in the secondary forest like durians are believed to be planted by the earlier farmers during the shifting cultivation. In the other forest stage, the distribution of plants may not be affected much to the shifting cultivation activity. However, there are still some emergent species or tree species that still can adapt to other new tree species. For example, the arthocarpus species like jackfruit, cempedak and some species from the bombaceae family. These tree species become the dominant trees in the 20-years-old secondary forest. Some can also be found in 30-years-old secondary forest. In this case, it's very difficult to assume that this secondary to be the same as other secondary forests. The composition the regenerated plant species is also affected by many other factors. Due to the varied distribution the medicinal, food flavor and food preservatives plants, and the inventory faces some problems.

The diversity of the plants also pose problem in conducting the research. The diversity of medicinal, food flavor and food preservative plants are different in the different stages secondary forests. Even in the same forests stage for example in the 5-years-old secondary, different plots may given different diversity of medicinal, food flavor and food preservative plants. The diversity for medicinal plants may also be different to those of food preservatives and food flavor plants. The diversity represent the number of species can be found in the secondary forest. This research determined the number of species of the medicinal, food flavoring and food preservative plants in the 5-years-old, 20-years-old and 30-years-old secondary forests. In this research, the medicinal, food flavor and food preservative plants that used by the Bidayuh community were documented. However, it included only the plants species that are used by the Bidayuh community in Bau area.

Plants species are so diversified that it is difficult to determine which stage of secondary forest will be more diverse, whether the 5-years-old, 20-years-old or the 30-years-old of secondary forest. Determining the density of a specific species in the different stages of the secondary forest is also a problem. This is because the density of the species in each secondary type is different, as well as in the different plot. For example, the density of plant for medicinal purposes may be more than the density of the food flavoring and food preservative plants. As mentioned before, the main problem in determining the density of specific species is the different density of the plant different plot in each type of secondary forests. As example, plot 1 and plot 2 are of the same age type of secondary forest may different plant density, and of course, the 20-year-old and 30-years-old secondary forests as well. So, estimating the overall density percent in categories of medicinal plants, food flavor and food preservatives plants in each type are hard to calculate. Other factors that can also affect density of plants are the soil type, temperature, light intensity, forest gap and the latest shifting cultivation activity. As a result, not all plant species densities are taken into account, only the key species in each stage of secondary forest were accounted for.

1.2 General Objectives

The general objective of this research is to record and identify the medicinal, food preservative and food flavoring plants that are used by Bidayuh community. The inventory and identification of plants for medicinal purposes, food preservatives and food flavoring were conducted in the secondary forests areas that have been used by Bidayuh communities of Kampung Serasot and Gunung Jagoi for shifting cultivation.

1.3 Specific Objectives

There are some specific objectives, which are to fulfill that the need that the general objective of this study. Thus, the specific objectives of the study are to determine the distribution, diversity and density of the medicinal, food flavoring and food preservative plant species in the secondary forests. To determine species distribution means that the plants are divided into their groups and their percentages are calculated. To determine the species density of the plant in the secondary forest means to find the frequency percentage of the occurrence the the key species in the areas. These key species should be the dominant species in every differents stages of the secondary forests. The species diversity of the species is also determined by looking at the type of species that the species in the 5-year-old, 20-year-old and 30-year-old secondary forest.

1.4 Hypotheses

There are three hypothesis used in this study. These hypotheses were proven in the Chapter 5 which is the discussion section. The hypotheses only focused on the medicinal, food flavoring and food preservative plants species, except for their diversity. This is because of the hypothesis related to the diversity must involve all plants species in the type of secondary forest. The diversity index is used to represent plants diversity within the secondary forest. The alternative hypothesis is stated that there is no significant different in the plant species distribution, species diversity and species density in the older secondary forest than younger secondary forest.

H_0 The older secondary forest has significantly more medicinal, food preservative and food flavoring plants species distribution than the younger secondary forest.

H_0 The older secondary forest has significantly more plants species diversity than the younger secondary forest.

H_0 The older secondary forest has significantly higher density of medicinal, food preservative and food flavoring plants species than the younger secondary forest.

1.5 Justification and Study Importance

The ethnobotany definitions, which define the study of human interaction with plants in rural area is an important study nowadays. Ethnobotany study involves plants used for food, medicine, edible oil, firewood, construction material and other domestic uses. People who live in the rural area have used those plants without any proper documentation. They learned to used those plants it from their parents, older people or even ancestors, while some learned from past experience. Without a proper writing or records, these all valuable information on usage of these plants may disappear in the future. The need of identification and documentation of these plants are important in order to keep those knowledge in proper writing for future uses.

The inventory and identification of plants from secondary forest commonly used for medicine, food flavors and food preservatives in the Bidayuh community is an important ethnobotany study. This study documented the usage of plants for medicinal purpose, food flavoring and food preservatives in Bidayuh community of Kg. Serasot and Gunung Jagoi. Although the area has been exposed to some forms modernization, people in the area are still using plants for medicinal purposes, food flavoring and food preservatives in their daily life. This is because of the area is near to Gunung Jagoi and the surrounding old secondary forests. These secondary forests are still the major sources of medicinal, food flavoring and food preservative plants to the villagers.

1.6 Study Scope and Limitations

In conducting this research, there must be some assumptions that should be taken as the factors which may affectiveness the results of the study. These factors are the study scope and limitations. The study scope is referring to the width and depth of the research being conducted. The study scope is the guideline to enable the researcher to conduct the research in time and place. Thus, the research was conducted according to the study scope that has been made before the study was commenced. Among the study scopes are the study area only covered the northern side of Gunung Jagoi, the research is only on the secondary forests and the sampling was conducted between September 2005 and January 2006. Besides that, there are some limitations occurred as a result of the study scope, for example the short time to do the inventory (September 2005 to January 2006), it only covered a few of forest types and the forest tracts are not large enough.

As a result of the study scope that mentioned before, some of limitations have occurred that may influence the results. For example, shorter time for sampling (September 2005 to January 2006) may limited the number of the data collected. The data may not be enough for a better analysis. The study also only covered a few types of forest that only available in the Gunung Jagoi area, which are the 5-year-old, 20-year-old and 30-year-old secondary forests. The density analysis may not be influenced by these all limitations, but the density results may not be differenced between each type of the secondary forests due to limited size of the area studied.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction To Study

Human have long been acute observers of their biological surroundings and have been involved in dynamic relationships with ambient flora and fauna since the development of the earliest medical systems and food- getting technologies. To a large extent such research has concentrated either on the biological properties of plants or on the cultural and other behavioral dimensions of their use in indigenous medicine and diet. Regardless of ideological differences, all populations define therapeutic efficiency that gives combination of symptoms relief, healing of illness, or restoration of health. (Etkin, 1986).

Long pepper, black pepper and ginger are widely used spices in many dietaries and are likely to exert the same effects when consumed as food. This extended view of contexts in which such plants are consumed and especially when medicines are taken with meals (Etkin, 1986). From endemic perspective, the medicinal and other of plants can be considered to be effective if they meet culturally defined expectations (of healer, patient and social group) and thus confirm and reaffirm shared beliefs about the nature of health (Etkin, 1986).

2.1 Key Study Components

Medicine and botany have always had close ties. Many of today's drugs have been derived from plant sources. Pharmacognosy is the study of medicinal and toxic products from natural plant sources. At one time, pharmacologists researching drugs were required to understand the natural plant world, and physicians were schooled in plant-derived remedies. However, as modern medicine and drug research advanced, chemically-synthesized drugs replaced plants as the source of most medicinal agents in industrialized countries. Although research in plant sources continued and plants are still used as the basis for some drug development, the dominant interest (and resulting research funding) shifted to the laboratory. The 1990 has seen a growing shift in interest once more; plants are reemerging as a significant source of new pharmaceuticals. Industries are now interested in exploring parts of the world where plant medicine remains the predominant form of dealing with illness. In tropical regions, has an extraordinary diversity of plant species and has been regarded as a treasure grove of medicinal plants. Scientists have also realized the study of the native cultures which inhabit these regions can provide enormously valuable clues in the search for improved health. To uncover the secrets of the rain forest, specialists are needed, well-trained and willing to spend long, hard time in the field. This is where the ethnobotanist comes in (Connie *et al.*, 1996).

All the food preservatives currently being used are synthetic, and they are limited in their ability to preserve food without altering its quality parameters such as flavour and aroma and in many cases even the chemical composition also changes. Lack of high quality food grade natural preservatives is today a major handicap in organic food

preservation. Scientists have identified many edible plants that contain complex compounds having fungicidal and bactericidal properties, which can be extracted. One bactericidal compound of a plant has been extracted and a food grade natural preservative developed. Tests are being conducted to study its efficacy, suitability, and cost effectiveness as compared to synthetic food preservatives. Experiments are also being conducted to extract more such biochemical compounds and test their application in food preservation (Morarka, 2005)

2.2 Species Distribution

Most of the dipterocarp forests at low elevations in the Lanjak- Entimau Wildlife Sanctuary have been affected by agricultural activities occurring over the past 100-150 years. Many longhouse communities, especially in the Katibas area, claimed to have resided in and around the Sanctuary for up to 200 years or longer. The areas of the old secondary forests visited are estimated to be 80- 130 years old but there have been reports of forest older than this. However, canopy height varies considerably (25- 38 m), and the five most common families are all non- dipterocarps.

The Euphorbiaceae are dominant, while only 4-9 species of the Dipterocarpaceae can be found at any site. About 81% of the enumerated trees have diameter below 30 cm dbh. Less than 3% exceed 60 cm dbh. The total number of species is 376, while the densities range from 528 – 625 trees per ha at any site. Only 20 species are common to all three sites. Details for this forest type are summarised in Table 1 (Soepadmo *et al.*, 2000)

Table 1: Number of Genera, Species and Density of Trees (≥ 10 cm dbh) in Old Secondary Forest Plots.

Family	Jela			Disribution (%)
	Genus	Species	Trees	
Eurphorbiaceae	8	16	89	34.63
Myrtaceae	2	17	50	19.46
Lauraceae	2	10	20	7.78
Annonaceae	2	2	5	1.95
Moraceae	1	3	5	1.95
Myrticaceae	2	5	7	2.72
Anacardiaceae	3	4	5	1.95
Burseraceae	3	10	31	12.06
Fagaceae	3	6	7	2.72
Dipterocarpaceae	2	4	38	14.79
Total	28	77	257	100

The abundance and distribution of medicinal plants is affected by successional stage and competition over such factors as light. Thus, it is not surprising that population vary by life form in different forest types. Epiphytic medicinal plants, for example are restricted to primary, river bench, and late successional forests where vegetation is older, forest structure were complex and specific micro- environmental conditions required for growth and reproduction exists. In contrast, shade intolerant herbaceous medicinal plants dominate the early successional forest types (Caniago, 1998).

2.3 Species Diversity and Species Density

At Bario Asal, the utilization of forest products is mainly for fire-woods, housing materials and construction of shelters in the rice-fields or fences for buffalo rearing. *Cratoxylum formosum* was identified as the most dominant species in this locality; having highest Importance Value (Iv = 117.97), relative frequency (Rf = *18.75),* relative density (Rd = 33.95) and relative dominance (RD = *65.25).* The ranking in dominance was followed by Eugenia *rugosa* (Iv = *82.57), Quercus chrysotricha* (Iv = 23.94), *Ilex cymosa* (Iv = 17.19) and *Tristania whitiana* (Iv = 16.91) as shown in Table 2. The estimated total above ground biomass was 74.24 t/ha with the basal area of *23.15* mQha and leaf area index of 1.99 ha/ha. *C. formo*sum has the highest estimated total above ground biomass of 47.56 t/ha and followed by E. *rugosa* and Q. *chrysotricha* (Ipor *et al.*, 2005).

Table 2. Relative density (Rd), relative frequency CRJ), relative dominance (RD) and importance value (Iv) of trees species with a DBH of > 5cm at Bario Asal, Bario.

Species	Rf	Rd	RD	Iv
Cratoxylum forniosum	18.75	33.96	65.26	117.97
Eugenia rugosa	18.75	39.62	24.20	82.57
Quercus chrysotncha	12.50	7.55	3.89	23.94
Ilex cyrnosa	12.50	3.77	0.92	17.19
Tristania whitiana	12.50	3.77	0.64	16.91
Cant hiuni didymum	*6.25*	3.77	1.31	11.33
Ternstroemia denticulata	6.25	1.89	2.72	10.86
Quercus sp	6.25	1.89	0.56	8.70
Vacciniuni bancanurn	6.25	1.89	0.49	8.63

A diversity index is a mathematical measure of species diversity in a community. Diversity indices provide more information about community composition than simply species richness (i.e., the number of species present); they also take the relative abundances of different species into account. Diversity indices provide important information about rarity and commonness of species in a community. The Shannon diversity index (H) is another index that is commonly used to characterize species diversity in a community. Shannon's index accounts for both abundance and evenness of the species present. The proportion of species i relative to the total number of species (p_i) is calculated, and then multiplied by the natural logarithm of this proportion ($\ln p_i$). The resulting product is summed across species, and multiplied by -1. Shannon's equitability (E_H) can be calculated by dividing H by H_{max} (here $H_{max} = \ln S$). Equitability assumes a value between 0 and 1 with 1 being complete evenness (Magurran, 1988).

The calculations for various phytosociological parameters are performed as follows. Density is the total number of individuals in unit sample area. Frequency is the number of sample plots in which a species occurred. Relative values of frequency, density and basal area of a species are obtained by dividing its frequency, density and basal areas by the sum of frequency, densities and basal areas of total all the species respectively. Relative values were multiplied by 100 in order to be expressed as a percentage. Importance values index (IVI) for each species is calculated as the sum of the relative values of frequency, density and basal area. Shannons's diversity index (H) is used to calculate the diversity of certain area according to the plot (Shankar *et al.*, 1998).

2.4 Plant Survey Techniques

There are various may of plant survey techniques that has been used by the past researchers in the forest inventories. We decided t make our own plant survey techniques, because in the past researchs, the plants survey techniques may not suitable for using in our research. However, we have modified and used the past research techniques as a guide in designing our own plants survey techniques. Plants survey techniques that we used are mainly based on the advice of our supervisor. Popular plant survey techniques are like those used by Shankar, Hall and Bawa, Izefri and Stephen. We also used several techniques that we have learned in the lecture of forestry.

The species sampled in the three layers of vegetation were classified into the following five growth forms, namely large tree, medium tree, small tree, shrub and woody climber. All the emergent species were grouped under large trees. Both adults and saplings (i.e. all individuals of 10 cm girth) were sampled in the entire 2 ha area. For each individual, the girth was measured at 1.3 m height from the ground level and the height was measured to the nearest metre, using a clinometers. The seedlings were sampled by laying a 2 m × 2 m quadrate in the centre of each sub-plot. Thus, twenty quadrates accounted for a total area of 80 m^2. The species that are shade-loving, prevalent in under storey and do not cross 15 m height were labeled as small trees. The species that are characterized by short stature, armed and irregular multiple stems and spiny structures (thorns and prickles) were classified as shrubs. However, we enumerated only those woody climbers that attained a girth of at least 10 cm. For the girth measurement of climbers, breast height was not recorded (Shankar, 2001).

Briefly, the sampling consisted of a stratified random sampling design, in which a total of 50 transects in Ipeti and 52 transects in Nurna. The abundance of the species and habitat characteristics were recorded in three 12-m radius circular plots (452 m2) located at 250-m intervals along each transect. For trees and palms, abundance was recorded separately for each of five size classes. Size classes (SC) for the trees were defined as follows: 0.5 m height, 0.5 m height and 10 cm dbh, 10– 20 cm dbh, 20–40 cm dbh, and 40cm dbh. For the palms, size classes were 0.5 m height, 0.5 m height, trunk less, 3 m height, 3–7 m height, 7 m height (Sarah, 2004).

In the earliest succession stage, where densities of some medicinal species were very high, we established 2 × 2 m random sample plots. In young secondary forests, which had densities at relatively few medicinal species and occupied a smaller area, we established 2 × 2 m plots. In later succession stages where densities of individual medicinal plants were lower and land areas larger, but sites remained clustered, we sampled using larger sample plots and like transects, specifically: 10 × 10 m plots in early young succession sites, 100 × 2 m plots in early old sites and 100 × 2 m plots in late succession sites in primary and loosed forests, where plant densities were low, land areas large and sites not clustered, we samples using 2 m wide × 1000 m long transects. Finally, in river bench forests we sampled using 10 × 10 m plots (Hall and Bawa, 1993). Next, inventory the plants within the plot to genus, while trying not to trample the plot. It is ideal if one or two people walk the plot and a third person records their observations. To walk the plot, we begin at the first corner, walk just inside the plot toward corner 2, and identify the plants as you encounter them in the plot. Then, record each plant in the appropriate category in the Field data sheet and add new plants as you encounter them.

Plants inside the border are counted in. Plants, rooted outside the border but with branches extending over the sides of the plot are also included in the sample. Continue walking the plot, proceeding past corners 2, 3, and 4. After passing corner 4 proceed about 1/3 of the way down the plot, cut through the plot to the opposite side. When you get to the opposite side, move down another 1/3 of the side and cut through to return to corner 1. The plant inventory step should now be complete. Note any unidentified plants you encounter by coding them: unidentified A, B, and so on. There is no need to collect any plants (Anon, 2005).

2.5 Study Approach

The research in documenting and identification of plants for medicinal purposes, food flavoring and food preservatives in secondary forest are limited, through there are many researchers conduct in primary forest in order to conserve the primary forest. In Sarawak, a number of studies on ethnobotany have been carried out (Soepadmo et al., 2000). The Forest Department is continuing the work to collect information from various ethnic groups in Sarawak (Soepadmo *et al.*, 2000).

Surveys on Sarawak's rich ethnobotanical knowledge began in late 1970s among the major ethnic groups. The first report mainly on medicinal plants uses of 285 species compiled in 1989 (Soepadmo et al., 2000). This number has since been increased by more then three- fold with information assembled from the following ethnic groups by the Sarawak Forest Department Forest Botany Unit Ethnic groups; and numbers of identified plants are as followed; Iban (234 species), Bidayuh (216 species), Malay and

Melanau (164 species), Orang Ulu (387 species) and Chinese (57 species). (Soepadmo et al, 2000). The Orang Ulu are included the group of Kelabit, Kayan, Kenyah, Penan and Kedayan.

During the research conducted in Lanjak- Entimau Widlife Sanctuary, the documenting and identification of some secondary forest about 30 years has prove more medicinal plants. For the skin disease, the *Cratoxylum glaucum* (Hypericaceae), *Cassia alata* (leguminose) and *Scoparia dulcis* (Scrophalariaceae) are used to treat ringworm and dhobe itch due to fungal infection. The *Homalanthus populnes* (Euphorbiaceae) and *Willughbia sarawakinensis* (Apocynaceae) for shingles due to viral infection. For the body pains and swellings, the *Dischidia bengalensis* (Asclepiadaceae), *Rourea mimosoides* (Connaraceae) and *Nephrolepsis biserrata* (Oleandraceae). For the fever and malaria, the *Baccaura puncticulata* (Euphorbiaceae), *Thottea rhizantha* (Aristolochiaceae) and *Eurycoma longifolia* (Simaroubaceae). For the stomache, gastric and diarrhea, the *Alpinia ligulata* (Zingiberaceae), *Lygodium scandes* (Schizaeceae) and *Artocarpus kemando* (Moraceae) (Soepadmo *et al.*, 2000).

Remedies for other ailments are less known, such as *Grammatophyllum speciosum*, a giant orchid, for jaundice in newborn babies, *Torenia polyonoides* (Scrophulariaceae) for goiter, *Mussaenda spp.* (Rubiaceae) for birth control and *Adenostemma lavenia* (Compositae) for beast cancer. In less obvious instances, the disease was diagnosed based on the information's description of the symptoms. The '*sakit kuning*' (yellow sickness) in newborn babies is recorded as jaundice, swollen neck is linked to goiter, *sakit pinggang* or lower back pain not caused by physical injuries may be associated with kidney problems (Soepadmo *et al.*, 2000).

CHAPTER 3

METHODOLOGY

3.0 Introduction

In this chapter, the methods used in the study are presented. It covered all the methods used from the early stage of the study to the final discussion phase. Some of the methods were adopted from the literature reviews, but have been modified to suit the study. This is true especially in the data analysis. These research methods have also been modified from other researchers in other types of forest where the identification and inventory of plant have been conducted.

3.1 Study Location

The study location is located in the Bau district, within the Kuching division, Sarawak. To be specific, the study area is in the secondary forests are around Kampung Serasot in Bau district. There are also villages located within the studied secondary forests. These secondary forests are the result of former shifting cultivation activities in that area. These secondary forests are of different stages the 30-years-old secondary forest, 20-years-old secondary forest and 5-years-old secondary forest, i.e depend on the number of years since the last shifting cultivating activities. The 30-years-old secondary forest is situated on N1.37 E110.05 coordinate, the 20-years-old secondary forest is situated on N1.3713 E110.0532 coordinate and 5-years-old secondary forest situated on N1.372 E110.044 coordinate.

3.2 Location of Plots

For each 20-year-old and 30-year-old secondary forests, there are about 15 main plots. Each of these main plots consisted of 4 sub- plots. However, in the 5-years-old secondary forests, we only used 10 main plots because of the limited availability of this type of forest. These main plots are also divided into 4 sub- plots. So, there were 60 subplots in each the 20-year-old and 30-year-old secondary forests while the 5-year-old secondary forest has 40 subplots. The plot selection are based on the plot design as shown in Figure 1. The location of every plot is also depending to the land condition. The existing of the obstacles like the small stream and steep slope may interfere the inventory method. Thus, those areas are not chosen as plot locations. If there still some obstacles in the plot design, the plot design were then changed or adjusted along the baseline or the inventory line. This does not change the number of the main plots which are quantities that are approximately 15 for each of the 20-year-old and 30-year-old secondary forests and 10 main plots for the 5-year-old secondary forest..

3.3 Sampling Design and Data Collection

The same inventory method also has been shared by three students. Each student identified and recorded the plant species of their studies in forests. However, the inventory and identification of plants for medicinal purposes, food flavor and food preservatives may different from inventory of food plants and food for wildlife.

They were 10 to 15 main plots (20m × 20m) constructed in each type of the secondary forests. There were 40 to 45 main plots in all three types of secondary forests. Every main has 4 sub- plots of (10m × 10m).

The forest inventory was conducted with the supervisor and one local guide. The local guide helped to identify the local Bidayuh names of the plants. The trees also measured in diameter and height. For the shrub species and the seedlings, the identified species were counted, and their number in each subplot were recorded. A form used to record the Bidayuh names, the scientific names, the types of the plants, as example either it a shrub or tree, the uses of the plants either for medicinal, flavoring, food preservatives, human food and wildlife food and the part of the plants used.

3.3.1 Sampling Plots

The plot design for this research is used for conducting the inventory method. This plot design was shared by three students that conducting their research in the same areas, i.e. the 5-year-old, 20-year-old and 30-year-old secondary forests of Gunung Jagoi. All three students were using same method, but they have a different interest. The first student was conducting the inventory and identification of the wild tree that bear berries fruit for wildlife, the second student was conducting the inventory and identification of plants for medicinal, food flavoring and food preservatives plants, and while third student was conducting the inventory and identification of wild plants of other uses to human.

The plot design is adopted from what we have learned in the forestry courses. The plot design was of 2 different sizes, i.e. the 20m × 20m and the 10m × 10m plots. The existing jungle paths were used as the baselines. This do not interfere the results even through the path is not very straight because the interval between each inventory line is 50 meters. We have constructed the plot systematically according to the figure below. Each forest category has 10 to 15 main plots. The outline of the plot design is as the Appendix 1 at the list of Appendices.

3.3.2 Tree Inventory

The tree inventory was conducted by according to their forms. All the vegetation in the plot were recorded, as either the seedlings or the big tree. Only the trees that have medicinal value, food flavoring and food preservatives purposes were recorded. However, the other tree species that have ethnobotanical aspects were also recorded as the additional data. The number of existing species in each plot which are for the medicinal, flavoring and food preservatives then were recorded as too. The parts that used of the tree species for each purpose were also recorded.

3.3.3 Herbaceous Plant Inventory

The inventory of the herbaceous plant is not very different from those of tree inventory. The information is still recorded in the same form as those for tree inventory. Herbaceous plants are identified according to the types. Other than tree plants are classified into herbaceous plant, palms, bamboo and climbers. The inventory and identification was the same as the herbaceous plant. The number of individual of each plant types also recorded in the form. As the tree inventory, only the herbaceous, palms, bamboo and climbers that have medicinal, flavoring and food preservatives purposes with are recorded in the form. Comments on the plants, including the parts used and other information regarding to the medicinal, flavoring and food preservative properties are also recorded based on the information told by the villager and the laboratory assistant.

3.4 Data Processing and Analysis

After the field data collection, the form would be analyzed in the data analysis. Firstly, the compilation of all species by use types, has been categorized by the purpose of each plants use, in this research he categorize is the medicinal purposes plants, the food preservatives purposes plants and the food flavoring purposes plants. As an example, a medicinal plant, used in the Bidayuh community. The parts of the plants, how it is used as a medicine, how it is prepared and the kind of disease if can cure are recorded. In the end, the listing of all medicinal purposes, food preservatives and food flavoring are obtained. This study will be a good reference for further study of those plants species. A sample of the form for the tree inventory and herbaceous inventory are shown in the Appendix 2 and Appendix 3 in the Appendices.

For the identification of the plants species, the help of laboratory assistant, our supervisor and other lecturers were soughed. Identification is also done referring the books and articles. The books and other readings used for identifying all those plants species are (Voon *et al.*, 1992), (Paul *et al.*, 1989), (Noweg *et al.*, 2003), (Noweg *et al.*, 1992), (Gillison *et al.*, 1996), (Ibrahim, 2004), (Said *et al.*, 1998), (Sarah and Catherine, 2004), (Jacob *et al.*, 2003), (Mohamed *et al.*, 1999) and (Angela, 2006).

3.4.1 Data Analysis for Species Diversity

For the data analysis, the diversity pattern for key species which indicates the most abundance species by the forests type age are obtained. This was done by finding the most abundance species in each the 5-year-old, 20-year-old and 30-years-old secondary forests. These key species are an important indicator for each type of secondary forest for the most abundance species. The key species used for identifying which are the factors that make it successful abundance than other plants species. The species diversity can be obtained by using the Shannon Index (H). The Shannon Index is equal to the negative sum of the relative abundance times Ln of the relative abundance. The relative abundance is obtained by dividing the number of species per total number of all species in the sub- plot. Then, for the Shannon Equitability, is the indicator to the evenness. It is calculated by dividing the Ln of all species with the Shannon Index value. The value is between 0 to 1. The more the value exceed 1 is the more evenness or diversity for the type of secondary forest. The formula for Shannon Index and Shannon Equitability as shown below. These calculations are based on (Magurran, 1988).

Shannon Index (H) $= - \sum Pi \; Ln \; Pi$

$p_i =$ Relative abundance

Shannon's equitability (E_H) can be calculated by dividing H by H_{max} (here $H_{max} = \ln S$).

Equitability assumes a value 0 - 1 with 1 being complete evenness.

$E_H = H/H_{max} = H/ Ln \; S$

Importance value (IV) = (Rf) + (Rd)

In this study, the Shannon Index and Shannon Equitability were used to prove the hypothesis stated before. The null hypothesis for species diversity is that the older secondary forest will be significantly more plants species diversity than the younger secondary forest. The alternative hypothesis is there is no significant different in the species diversity, or less species diversity between the older and the younger secondary forest.

3.4.2 Data Analysis for Species Distribution

The data analysis for the species distribution is done by dividing the data information according to the each species in a sub- plot. The data information form that obtained from the data collection are convert to the table, graph and pie chart to see the most distribution of plant species in each sub- plot. No calculation formula is used in finding the species distribution. Each sub- plot would have the results of species distribution and each types of secondary forest would have the results of species distribution. The highest number distribution of the certain species indicated the key species. The highest number of distribution in each types of secondary forest is the key species for the certain types of secondary forest.

The null hypothesis for the species distribution is that the older ages of secondary forest has a significantly more medicinal, preservatives and flavoring plants species distribution than the younger secondary forest. The alternative hypothesis is there is no significant different in species distribution, or less species distribution between the older and the younger secondary forests.

3.4.3 Data Analysis for Species Density

Finding the density of key species in each forest is the data most important type of analysis. Density is the total number of individuals in a unit sample area, which is a sub-plot in this study. The relative density key species indicates importance of traditional medicinal, food preservatives plants and food flavoring plants that can be found in each the 5-year-old, 20-year-old and 30-year-old secondary forests. Microsoft Excel was used to calculate the species density. This is to make the Relative Frequency (Rf) by species and Relative density (Rd) calculations are more quickly. The formulas for finding the relative frequency by species, Relative density (Rd) and Relative frequency (Rf) are listed below (Soepadmo, 1985). For the Importance Value (Ipor, 2005).

$$\text{Frequency (F)} = \frac{\text{No. of plots in which a species occurred}}{\text{Total all subplots used}} \times 100$$

$$\text{Relative frequency by species (Rf)} = \frac{\text{Value of (F) for a species}}{\text{Total (F) for all species}} \times 100$$

Density (D) = Total of a plants species in all subplots

$$\text{Relative density (Rd)} = \frac{\text{(D) value for a species}}{\text{Total all plants species}} \times 100$$

The null hypothesis for the species density is that the older secondary forest was significantly has more medicinal, preservatives and flavoring plants species density than the younger secondary forest. The alternative hypothesis was there is no significant different in species density, or less species density between the older and the younger secondary forest.

3.5 Hypothesis Testing

In this research, the using of the Microsoft Excel was preferred for the calculations of species density. It is easier to find the relative density, relative dominance, relative frequency for the key species by using his software. It is more manually than the Statistic Program for Social Science (SPSS). This software is required because of there was a lot of data collected. The software, helped to reduce time for doing the calculation and getting the results. In this Microsoft Excel, the calculations of Shannon Index can be presented; the relative density and relative frequency can be calculated easily. We do not need the significance value, confidence interval and other test like in the SPSS. This is because the purposes of this data analysis is only to prove whether the older secondary forests have more species diversity, more dense and more distributed than the younger type of secondary forest.

After the results of the data analysis have been obtained, they were then discussed. The discussion would be about the key species, reasons for their abundance and what makes them very important as medicinal, food preservatives and flavoring plants purposes. The discussions were also on the factors that help in species regeneration in the secondary forests. The discussion explored the regeneration that help them thrive in the secondary forests. Discussion involved all types of secondary forests i.e. the 5-year-old, 20-year-old and 30-year-old secondary forests.

CHAPTER 4

RESULTS

4.0 Introduction

Results of the study are presented in three sections, based on three different ages of secondary forests which are; 5-year-old, 20-year-old and 30-year-old secondary forests. In each type of the secondary forest, there were three results to test the hypothesis. The hypotheses were tested in each sections or type of secondary forest, except for the species diversity. This is because the species diversity was calculated for the whole vegetation in each type of the secondary forest. The medicinal, flavoring and preservatives plants species are combined in the result for each of the type of the secondary forest.

4.1 Five Years Old Secondary Forest

The 5 years old secondary forest is located on the N1.372, E110.044 coordinate, is situated at the west side of Kampung Serasot. The area is a former shifting cultivation area, used for planting of rice and left abandoned for about 5 years. The main vegetation is shrub with trees up to 4-meter height. Only 10 plots with size of 20 x 20 meters, were constructed to make up an overall plot areas of 4000 m^2. The soil in the area is clayey with lateritic characteristics. The species distribution of 5 years old secondary forest is presented in Appendix 5. The following pie chart indicates the distributions of species in the 5-year-old secondary forest.

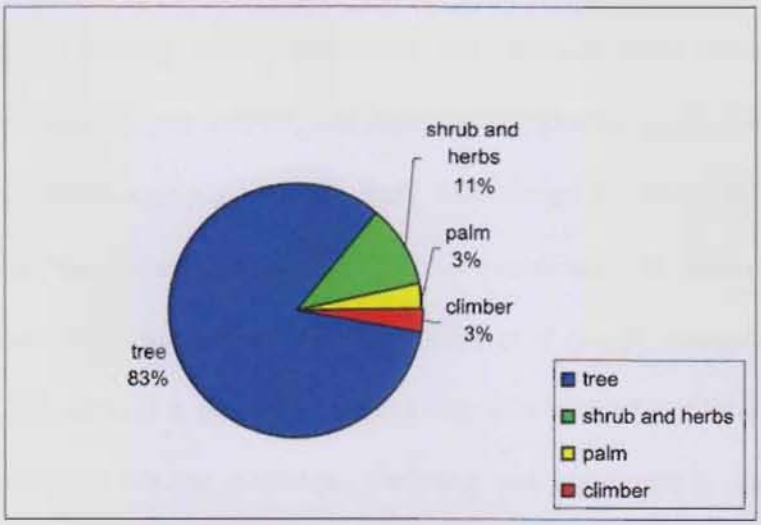

Figure 1. Distribution of plants species in the 5-year-old secondary forest.

Figure 1, indicated the distribution of plant species in the 5 years old secondary forest. About of 83% are of tree species, 3% are climber species, 3% are palm species and 11% are shrubs and herbs. A total of 66 plants species has been recorded in the area with total of 3306 individual plants. The calculated Shannon Diversity index is 3.58 and the Shannon Equitability is 0.85. The most dominant species in the 5-year-old secondary forest is *Flacaurtia sp.*, known as "Senakan" by the locals. The Importance Value for Flacaurtia sp. is 11.14.

The cover vegetation in the 5-year-old secondary forest is made up of the species from Cyperaceae family. These vegetative groups, however, were not inventoried. There are also other species which include climbers and palm species such as *Cucurligo latifolia* (Glomang), *Melastoma malabathricum* (Lusak), *Vernonia arborea* (Mupuad), *Anisophyllea disthica* (Pejulut), *Etlingera sp.* (Sibodoh), *Arenga sp.* (Sidudui), *Dendrobium sp.* (Spijol), *Humuleana sp* (Tunguon), *Hornstedia scyphimera* (Tiongak) and *Etlingera sp.* (Tipu'). The Bidayuh names of those plants are written in the brackets.

The trees species that can be found in the 5-year-old secondary forest are mainly the pioneer and fast growing species that can tolerate the high level of sunlight. All the trees are up to 4 meters height with the diameters being between 5 to 20 cm. Examples of tree species are *Macaranga gigantea* (Badad), *Macaranga sp.* (Benuak), *Aporusa sp.* (Bitopuk), *Leucosyke capitellata* (Kirangan), *Ficus grossulariodes* (Lokan), *Flacaurtia sp.* (Senakan) and others. Aside from the trees, seedlings of canopy trees are also found in small numbers. The ground is generally covered with thin layer of leaf litter.

The distribution for the medicinal, flavoring and preservatives plants species is determined by the local use. Only the plants species that are used by the Bidayuh community especially to the Kampung Serasot community are recorded. As a whole, the medicinal, food preservatives and flavoring plants compromise 19% of the plant species in the 5-year-old secondary forest. The other 81% are of other species. This 19% represents 639 plant individuals out of total 3306 individuals plants recorded. The distribution of medicinal, preservatives and flavoring plants species in the 5 years old secondary forest is represented in the Figure 2.

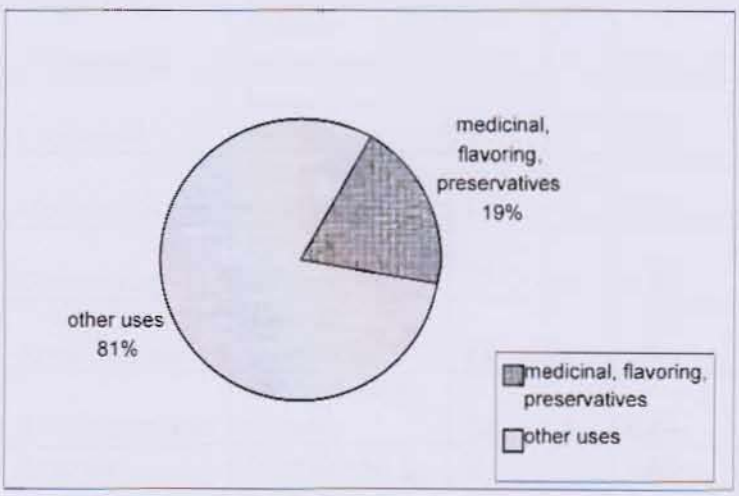

Figure 2. Distribution of medicinal, preservatives and flavoring plants species in the 5-year-old secondary forest.

The species that are used for medicine, flavoring and preservatives by the local community are rarely used nowadays due to the modern lifestyle. However, some older persons in Kampung Serasot and neighboring area still use those plants especially in times of emergency cases. This is because the wild medicinal, flavoring and preservatives plants can easily be obtained from neighboring secondary forests.

The species recorded for medicine, flavoring and preservatives purposes are of Araceae, Rubiaceae, Dillineaceae, Urticaceae, Melastomaceae, Compositae, Apocynaceae, Rhizoporaceae and Zingiberaceae families. Examples of medicinal plants recorded are *Timonius lasianthoides* (Botud), *Melastoma malabathricum* (Lusak) and *Humuleana sp.* (Tunguon). The examples of flavoring plants are *Etlingera elatoir* (Tipu' tuhau) and *Etlingera sp.* (Tipu'oyung). There were no preservative plant recorded.

Table 3. Distribution list of the medicinal, flavoring and preservatives plants species shown in the 5 years old secondary forest.

Local name	Family	Species	total	(F)	Rd (%)	Rf (%)
Biting	Araceae	Not identified	8	1	0.24	0.49
Botud	Rubiaceae	*Timonius lasianthoides*	10	3	0.30	1.46
Buan	Dillineaceae	*Dillenia suffruticosa*	242	4	7.32	1.94
Kirangan	Urticaceae	*Leucosyke capitellata*	9	2	0.27	0.97
Lusak	Melastomaceae	*Melastoma malabathricum*	135	4	1.08	1.94
Mupuod	Compositae	*Vernonia arborea*	37	4	1.12	1.94
Ngetatok	Apocynaceae	*Alstonia sphatulata*	61	4	1.85	1.94
Pejulut	Rhizophoraceae	*Anisophyllea disthica*	21	3	0.64	1.46
Tungon	Araceae	*Humuleana sp*	2	1	0.06	0.49
Tipu' oyung	Zingiberaceae	*Etlingera sp.*	17	3	0.51	1.46
Tipu' tuhau	Zingiberaceae	*Etlingera elatoir*	97	3	2.93	1.46

The relative density of the medicinal, flavoring and preservatives plant species in the 5 years old secondary forest is also not very significant to the overall distribution. The total relative density of the medicinal, flavoring and preservatives is 16% while the relative density for plants of other uses is 84%. The relative density of medicinal, preservatives and flavoring plants species in the 5-year-old secondary forest is shown in Figure 3 below. The relative density will be compared in the discussion chapter.

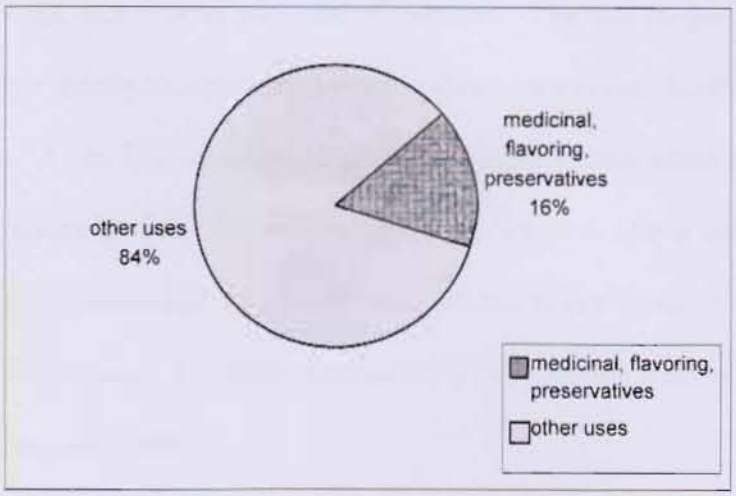

Figure 3. Relative density of medicinal, preservatives and flavoringplants species in the 5-year-old secondary forest.

4.2 Twenty Years Old Secondary Forest

The 20-year-old secondary forest is located on the N1.3713, E110.0532 coordinate, situated on a location near to Kampung Serasot. This is the nearest secondary forest from Kampung Serasot. The area is a former rice shifting cultivation area and rubber plantation. The tree height is up to 15 to 20 meters. A total of 15 plots sized 20 x 20 meters were set up, with a total plot area of 6000 m^2. The soil in the 20 years old secondary forest was mostly clayey with lateritic characteristics and the litter depth on the ground is up to 15 cm. The 20-year-old secondary forest is also situated near to the other forest that is situated on the foot of Gunung Jagoi. There is also a small stream in this area. The species distribution of the 20-year-old secondary forest is presented in Appendix 6 in the Appendices. The following pie chart indicates the species distributions in the 20 years old secondary forest.

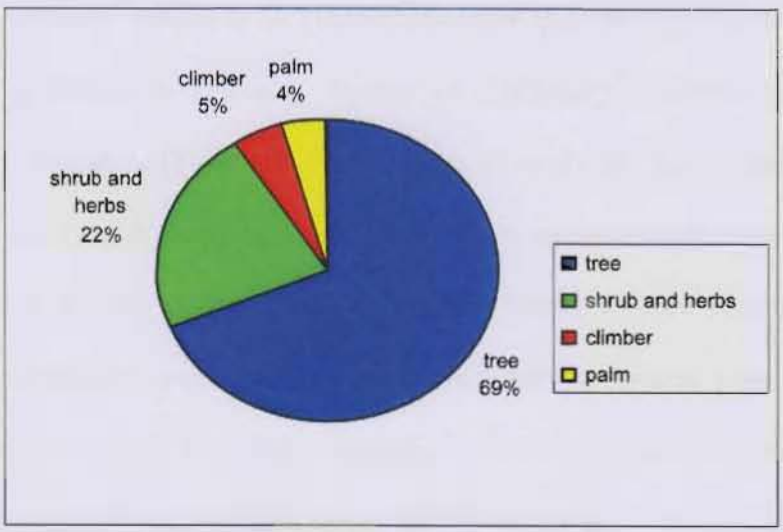

Figure 4. Distribution of species in the 20-year-old secondary forest.

As shown in the Figure 4 plant distribution in the 20-year-old secondary forest are consisting of 69% tree species, 5% climber species, 4% palm species and 22% shrubs and herbs. A total 121 plants species have been recorded in the area with total of 7041 individual plants. The Shannon Diversity index is 3.70 and the Shannon Equitability is 0.77. The most dominant species in the 20 years old secondary forest is *Calamus sp.*, and locally known as Rotan Smambu. The Importance Value for *Calamus sp.* is 18.26.

The vegetation in the 20-year-old secondary forest was very rich, with the shrubs make up 22% of the vegetation. There are rubber trees in most of the plots. Rubber trees are among of the highest growing trees. The shrub species are thriving well on the floor of the forest because the forest canopy is still allowing the sunlight to reach the forest floor. This is the factor ensure the success shrub and palms species growing in the forests.

The example of shrub species recorded, including palms and climbers that can be found in the 20 years old secondary forest are *Piper vesticum* (Boid Tibung), *Adenia clementis* (Bokah girakat), *Pandanus sp.* (Gilliet), *Gnetum sp.* (Gnetum), *Labisia pumila* (Kacip fatimah), *Bauhinia sp* (Pakia'), *Arenga sp.* (Pejagok), *Calamus sp.* (Rotan smambu), *Zalacca magnifica* (Telisum), *Pandanus sp.* (Tonuh) and some others species of Zingiberaceae and Palmae families. There are also fern species found on the floor of the secondary forest, but we did not count it. We only recorded those with medicinal, flavoring and preservatives uses. There are seven fern families which were recorded. Those fern families are the Polypodiaceae, Gleicheniaceae, Lycopodiaceae, Selanginelaceae, Dennstaedtiaceae, Blechnaceae and Olendraceae.

Tree species consists of 69% of all the vegetation in the 20-year-old secondary forests. The diameter of the tree species is between 10 to 35 cm and the height is up to 20 meters. The example of tree species that recorded in the 20-year-old secondary forest are *Mangifera pajang* (Asam bowang), *Fragrea sp.* (Atap), *Castanopsis sp.* (Berangan), *Calophllum sp.* (Bintangor), *Goniothalamus sp.* (Kinamai), *Homalanthus sp.* (Ngibulan), *Astonia spatulata* (Ngitatok), *Diospyrus diepenhorstii* (Ungun oran) and others. Other than trees, there are tree seedlings present in small numbers. The ground is covered with mostly shrubs and thin layer of leaf litter. The seedlings are not counted if they cannot be identified due to unavailability of their mature traits.

The distribution of the medicinal, preservatives and flavoring plants in the 20 years old secondary forest is 25% the plants of other uses make up the other 75%. This 25% represents 1773 plant individuals out of total 7041 individuals plants inventoried. The distribution of medicinal, preservatives and flavoring plants species in the 20-year-old secondary forest is represented in the Figure 5.

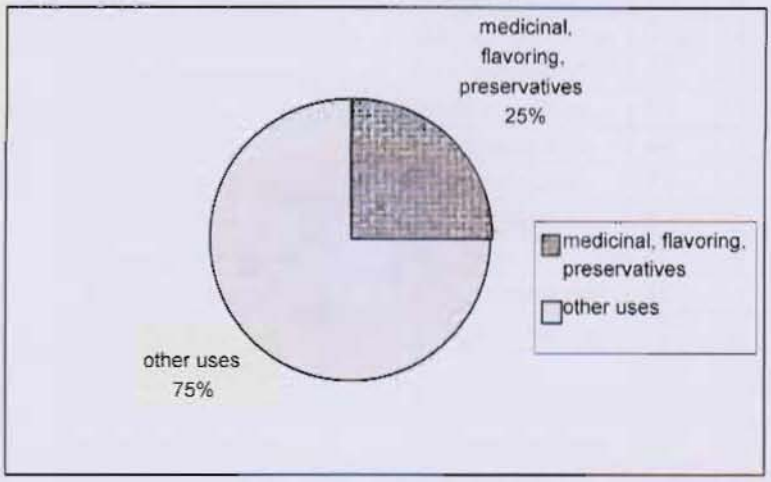

Figure 5. Distribution of medicinal, flavoring and preservatives plants species in the 20-year-old secondary forest.

The number of species recorded for medicinal, flavoring and preservatives purposes in the 20-year-old secondary forest is 21. These species are the families of Piperaceae family, Dilleniaceae, Rubiaceae, Leguminosae, Annonaceae, Lecythidaceae, Apocynaceae, Rhizoporaceae, Nephenteceae, Lauraceae, Araceae, Zingiberaceae, Euphorbiaceae and Arecaceae. One family cannot be identified. There are 15 of medicinal plants, 7 species of food flavoring plants and one preservative plant recorded in the 20 years old secondary plots. The distribution list of the species is shown in Table 4 below.

Table 4. Distribution list of medicinal, flavoring and preservatives plants species in the 20 years old secondary forest.

Local name	Species	Family	total	(F)	Rd (%)	Rf (%)
Boid tibug	*Piper vesticum*	Piperaceae	26	4	0.37	1.04
Botud	*Timonius lasianthoides*	Rubiaceae	34	4	0.48	1.04
Buan	*Dillenia suffruticosa*	Dileneaceae	116	4	1.65	1.04
Joring	*Pithecolobium lobatum*	Leguminosae	17	4	0.24	1.04
Kinamai	*Goniothalamus sp.*	Annonaceae	16	3	0.23	0.78
Kirangan	*Leucosyke capitellata*	Urticaceae	18	4	0.26	1.04
Lakot	*Barringtonia resmosa*	Lecythidaceae	11	4	0.16	1.04
Ngitatok	*Astonia spatulata*	Apocynaceae	17	4	0.24	1.04
Pejulut	*Anisophyllea distichla*	Rhizophoraceae	976	4	13.86	1.04
Serumah	*Ploiarium anternifolium*	Not identified	44	4	0.62	1.04
Tilambuak manah	*Nephentes sp*	Nephentaceae	59	4	0.84	1.04
Tilambuak pulut	*Nephentes sp*	Nephentaceae	44	4	0.62	1.04
Tilambuak tajau	*Nephentes sp*	Nephentaceae	73	4	1.04	1.04
Tu'ang	*Litsea garciae*	Lauraceae	8	3	0.12	0.78
Tunguon	*Humuleana sp.*	Araceae	75	4	0.07	1.04
Tipu'	*Etlingera sp.*	Zingerberaceae	32	4	0.45	1.04
Tipu' oyung	*Etlingera sp.*	Zingerberaceae	125	4	1.78	1.04
Telisum	*Zalacca magnifica*	Arecaceae	8	3	0.11	0.78
Tampoi	*Baccaurea puncticulata*	Euphorbiaceaee	16	4	0.23	1.04
Sibilai	*plagiostachys sp*	Zingerberaceae	56	4	0.80	1.04
Inyuk	*Arenga pinnata*	Arecaceae	2	2	0.03	0.52

The relative density of the medicinal, flavoring and preservatives plant species in the 20-year-old secondary forest is also not very different from the distribution. The total relative density of the medicinal, flavoring and preservatives is 24% while the relative density of the plants for other uses is 76%. Relative density of medicinal, preservatives and flavoring plants species in the 20 years old secondary forest is shown in Figure 6.

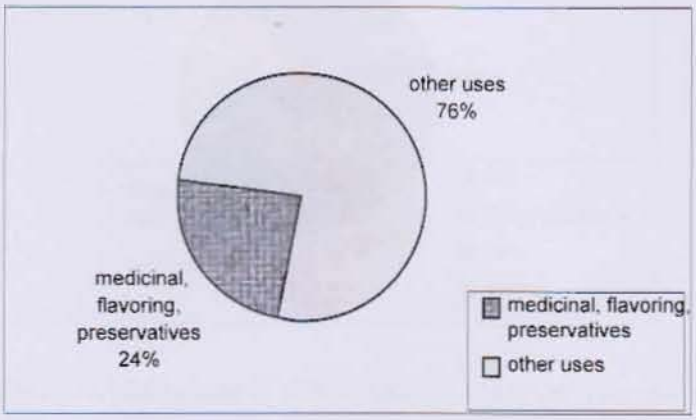

Figure 6. Relative density of medicinal, flavoring and preservatives plants species in the 20-year-old secondary forest.

4.3 Thirty Years Old Secondary Forest

The 30-year-old secondary forest is located on N1.37, E110.05 coordinate, situated on the west of Kampung Serasot. This is the farthest secondary forest from Kampung Serasot. The area is a former shifting cultivation as well as a rubber plantation. Besides that the area is also had been as a fruit orchard and left abandoned for at least 30 years. The tree height is up to 20 to 30 meters. We have set up 15 plots of 20 x 20 meters with the whole plotted areas are 6000 m^2. The soil in the 30-year-old secondary forest is mostly clayey with lateritic characteristics. Litter depth on the ground is up to 20 cm. There is also a small stream that drains into a small river in this area.

The species distribution of the 30-year-old secondary forest is presented in Appendix 7 in the Appendices. Below is the pie chart showing the distributions of the 30-year-old secondary forest.

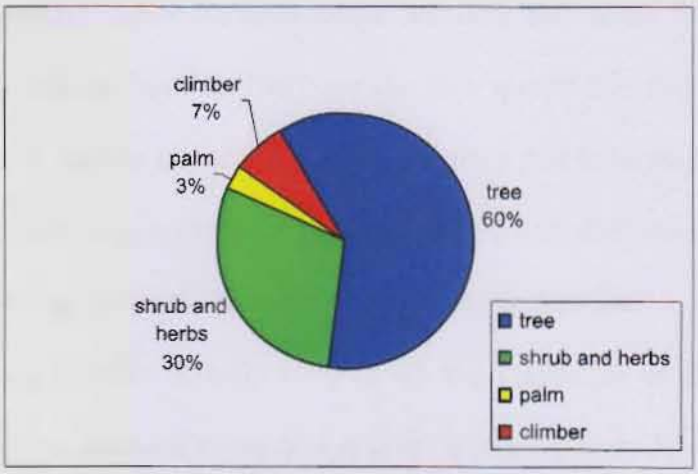

Figure 7. Distribution of plants species in the 30-year-old secondary forest.

As shown in Figure 7 above, the 30-year-old secondary forest distributions are consisting of 60% tree species, 7% climber species, 3% palm species and 30% shrubs and herbs. One hundred plants species have been recorded in the area with a total of 6625 individual plants. The Shannon Diversity index is 3.59 and the Shannon Equitability is 0.78. The most dominant species in the 30 years old secondary forest is *Pinaga sp,* Which is known as Pejagok by the locals. The Importance Value for *Pinaga sp.* is 17.80.

The 30-year-old secondary forest characteristics nearly resemble the characteristics of a primary forest. The canopy of the forest is made of some of the emergent dominant trees like *Tristanopsis sp.*, *Diospyrus diepenhorstii* and *Shorea macrophylla* with the canopy height up to 25 meters.

The example shrub species recorded in the 30-year-old forest including palms and climbers are *Eurycoma longifolia* (Tongkat Ali), *Adenia clementis* (Bokah girakat), *Bauhinia sp* (Pakia'), *Arenga sp.* (Pejagok), *Calamus sp.* (Rotan), *Pandanus sp.* (Tonuh), *Bambosa sp.* (Toring), *Anisophyllea disthica* (Pejulut) and some others species of Zingiberaceae and Palmae families. There are also fern species that found in the floor of the secondary forest, but are not counted. Only the ferns that have medicinal, flavoring and preservatives uses were recorded. The fern families recorded were Gleicheniaceae, Lycopodiaceae, Selanginelaceae, Dennstaedtiaceae and Blechnaceae.

Tree species consists of only 60% of all the vegetation of the 30 years old secondary forests. The diameter of the tree species is ranging from 20 to 45 cm and the height is reaching up to 30 meters. The example of tree species that recorded in the 30 years old secondary forest are *Fragrea sp.* (Atap), *Syzgium sp.* (Bah), *Leea indica* (Bakaluang), *Durio sp.* (Durian), *Havea brasiliensis* (Getah), *Pithecellobium lobatum* (Jaolin), *Shore macrophylla* (Kabang), *Tristanopsis sp.* (Limuban), *Diospyrus diepenhorstii* (Unguon oran) and *Adinandra gumusa* (Simupak). Aside from the trees, there are plant seedlings occurred in small numbers. The ground is covered with mostly shrubs and thin layer of leaf litter. Some seedlings are not counted since they cannot be identified due to the missing of their true traits.

Distribution of the medicinal, preservatives and flavoring plants in the 30 years old secondary forest is 13% while of plants of other uses make up the 87%. This 13% represents 848 plant individuals out of the total of 6625 individuals plants recorded. The distribution of medicinal, preservatives and flavoring plants species in the 30-year-old secondary forest is shown in the Figure 8 below.

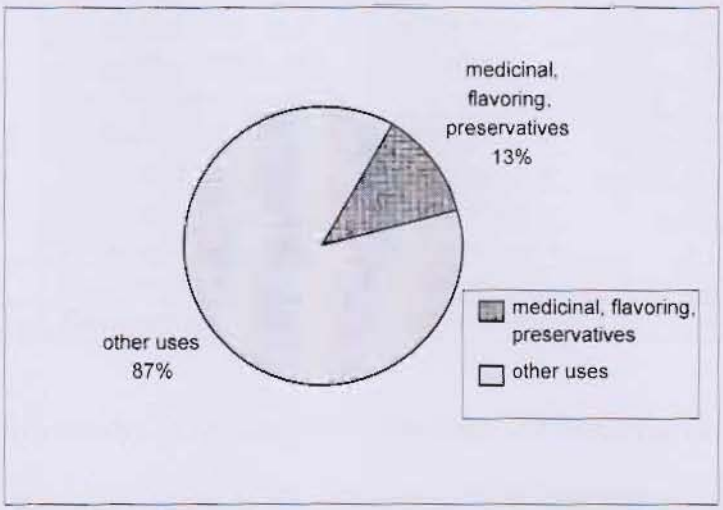

Figure 8. Distribution of medicinal, flavoring and preservatives plants species in the 30-year-old secondary forest.

The number of plant species recorded for medicinal, flavoring and preservatives purposes in the 30 years old secondary forest are 13 species, which are from the Piperaceae family, Dilleniaceae, Leguminosae, Annonaceae, Meliaceae, Rhizoporaceae, Nephenteceae, Simaroubaceae, Araceae, Zingiberaceae and Arecaceae. The number of medicinal plants recorded is 11 while the numbers of flavoring plants recorded are two. There is no preservatives plant recorded in the 30-year-old secondary forest plots.

The distribution list of the medicinal, flavoring and preservatives plants species is shown in Table 5 below.

Table 5. Distribution list of medicinal, flavoring and preservatives plants use in the 30 years old secondary forest.

Local name	Species	Family	total	(F)	Rd (%)	Rf (%)
Boid tibug	*Piper vesticum*	Piperaceae	3	1	0.05	0.33
Buan biasa	*Dillenia suffruticosa*	Dilleniaceae	133	4	2.01	1.33
Jaolin	*Pithecellobium lobatum*	Leguminosae	7	3	0.11	1
Kenamai	*Goniothalamus sp.*	Annonaceae	18	4	0.27	1.33
Lasot	*Lansium domesticum*	Meliaceae	9	4	0.14	1.33
Pejulut	*Anisophyllea distichla*	Rhizophoraceae	262	4	3.95	1.33
Telimbuak manah	*Nephentes sp*	Nephentaceae	52	4	0.78	1.33
Telimbuak pulut	*Nephentes sp*	Nephentaceae	17	3	0.26	1
Telimbuak tajau	*Nephentes sp*	Nephentaceae	7	2	0.11	0.67
Tongkat ali	*Eurycoma longifolia*	Simaroubaceae	14	1	0.21	0.33
Tungon	*Humuleana sp.*	Araceae	2	2	0.03	0.67
Tipuk oyung	*Etlingera sp*	Zingerberaceae	217	4	3.28	1.33

The relative density of the medicinal, flavoring and preservatives plant species in the 30-year-old secondary forest is no different to their distribution. The total relative density of the medicinal, flavoring and preservatives is 13% while the relative density of plant other uses is 87%. According to the species distribution, there is also 13% of medicinal, flavoring and preservatives species distribution. This same value of species distribution and relative density did not occur in the 5-year-old and 20-year-old secondary forests although the values are not very different.

The relative density of medicinal, preservatives and flavoring plants species in the 20-year-old secondary forest is shown in Figure 9 below.

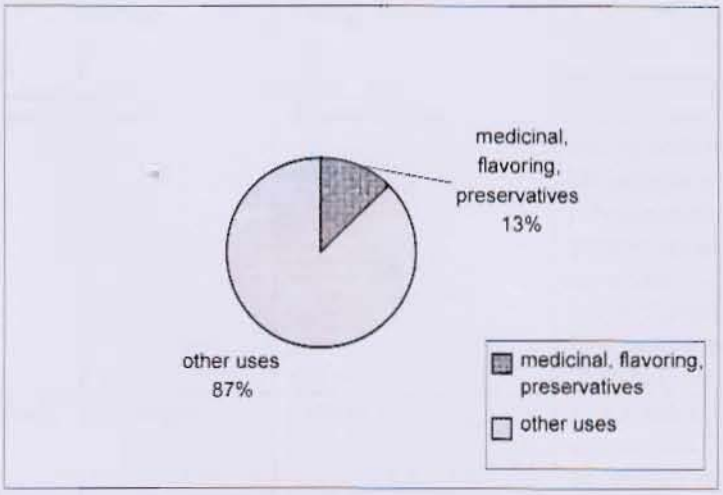

Figure 9. Relative density of medicinal, flavoring and preservatives plant species in the 30-year-old secondary forest.

There were 19 medicinal plants species that had been recorded in these three types of secondary forests. Identified medicinal plants are of those used as medicine by the Bidayuh community that lives in Bau only. These medicinal plants have been used traditionally in rituals and practices and as well as herbal medicine. A total of six food flavoring plants and one food preservative plant were recorded. The list of identified medicinal plant species is shown in Table 6 below, while the list of identified flavoring and preservative plant species is shown in Table 7 below.

Table 6. List of identified medicinal plants species from all three types of secondary forests.

Species (family)	Local name	Parts collected/used	Method of preparation
Timonius lasianthoides (Rubiaceae)	Botud	Young leaves	1. Skin diseases, rub young leaves between palms until lather exudes.
Dillenia suffruticosa (Dillineaceae)	Buan	Young leaves Shoots	1. For wounds, collect young leaves with those of Melastoma sp (Melastomatacae) in equal proportion and pound. Apply on wound. 2. For flavoring, the young fruit can be cooked with 'Sambal' for bitterness.
Leucosyke capitellata (Urticaceae)	Kirangan	Leaves	1. For enhance blood circulation. The leaves dried, boiled and taken as ordinary tea.
Melastoma malabathricum (Melastomataceae)	Lusak	Young leaves	1. For treat stomach ache. Eat young leaves with Buan leaves. 2. Treat diarrhea. Pound young leaves and rub on the affected part.
Vernonia arborea (Compositae)	Mupuod	Leaves	1. For cuts and wounds. Pound leaves into paste and squeeze paste to get the extract. Apply the extract on the affected part.
Alstonia spatulata (Apocynaceae)	Ngetatok	Young leaves	1. For skin disease called"Kayap"in malay. Pound fresh leaves into paste for poultice.
Anisophyllea disticha (Rhizoporaceae)	Pejulut	Young leaves	1. for cuts and wounds. Pound young leaves and apply as poultice.
Homalomena sagittifolia (Araceae)	Tunguon	Tuber	1. For cut and wounds. Pound tuber into paste, wrap in leaves and warm over fire. Squeeze juice from warm paste into wound.
Piper vesticum (Piperaceae)	Boid Tibung	Leaves	1. For bulging tummy in babies. Warm leaves over fire and spread on abdomen.

Table 6. Continued.

Pithecolobium lobatum (Leguminosae)	Joring	Fruit	1. Good for high blood pressure. Fruit is eaten raw as Sambal.
Goniothalamus sp. (Annonaceae)	Kenamai	Roots Bark	1. For treatment of stomach ache. Chew roots and swallow the juice. 2. As mosquito repellent. Burn the bark.
Barringtonia racemosa (Lecytidaceae)	Lakot	Bark	1. For stomach ache and fever in children. Scrape bark and wrap in palm leaves. Warm over fire and apply on the abdomen.
Nephentes sp. (Nephenthaceae)	Tilambuak	Pitcher	1. In the culture, it can enhance children to speak. Blow the unopened pitcher into the mouth.
Litsea garciae Vidal (Lauraceae)	Tu'ang	Bark	1. For caterpillar strings. Burn bark until it is just to turn into ash. Apply bark on affected part and apply bandage.
Lansium domesticum (Meliaceae)	Lasot	Leaves	1. For fever. Pound leaves and boils in water to make a drink.
Eurycoma longifolia (Simaroubaceae)	Tongkat ali	Whole part & root	1. To cure impotence, as an aphrodisiac and for hypertension. The tap root is cut into slices and boiled to make a drink.
Not identified	Biting	Leaves	1. For cuts and wound. Pound the leaves and applies on the wound.
Ploiarium alternifolium	Serumah	Leaves	1. For cuts and wound. Pound leaves and applies on the wound.
Lycopodium cernuum L. (Lycopodiaceae)	Saliniang	Whole plant	1. For liver inflammation, sore eyes, rheumatism and cough. Boil plant in water to make a drink.

Table 7. : List of identified food flavoring and preservatives plant species from all three types of secondary forests.

Species (family)	Local name	Parts collected/used	Method of preparation
Dillenia suffructicosa (Dilleniaceae)	Buan	Shoots	1. The shoots giving sourish taste for cooking.
Achasma sp. (Zingiberaceae)	Tipu'	Young soft shoot	1. Eaten raw with sambal belacan or other ulam.
Arenga pinnata (Arecaceae)	Inyuk	Heart of the trunk	1. The heart of the trunk can be eaten raw or cooked with vegetables. Giving sweet taste.
Plagiostachys sp. (Zingiberaceae)	Sibilai	Young shoot	1. Eaten raw or cooked with other vegetables.
Baccaurea puncticulata (Euphorbiaceae)	Tampoi	Fruits	1. Eaten raw. Giving sweet and tangy flavor.
Zalacca magnifica (Arecaceae)	Telisum	Fruits	1. Eaten raw. Giving sweet taste when ripe and sour when unripe.
Piper vesticum (Piperaceae)	Boid Tibung	Fruits	1. For preservatives. The dried fruit are preserved with meat and other perishable foods.

CHAPTER 5

DISSCUSSION

According to the results, the total species distributions are 66, 121 and 100 for the 5-year-old, 20-year-old and the 30-year-old secondary forests respectively. The total numbers of plant families recorded are 23, 40 and 41 for the 5-year-old, the 20-year-old and the 30-year-old secondary forests respectively. The medicinal, flavoring and preservatives plants species comprised 19%, 25% and 13% of the total number of plant species in each of 5-year-old, 20-year-old and 30-year-old secondary forests.

As the summary above indicates, plant species are most distributed in the 20-year-old secondary forest which recorded 121 species, followed by the 30-year-old secondary forest with 100 species and the 5-year-old secondary forest with 23 species. This result, proved that the null hypothesis cannot be accepted. The alternative hypothesis is accepted, which the 20-year-old secondary forest has the most distributed plant species compared to the 5 and 30-year-old secondary forests.

For the medicinal, flavoring and preservatives plants species distribution, the 20-year-old secondary forest recorded the most number of those species with 25%, followed with the 5-year-old secondary forest with 19% and the 30-year-old secondary forest with 13%. This result, proved that the null hypothesis cannot be accepted. The alternative hypothesis is accepted, where the 20-year-old secondary forest has the high numbers of medicinal, food flavoring and preservative plant than the 5 and 30-year-old secondary forests. All the results are summarized in the Table 8.

The null hypothesis is not accepted because the result indicates that the 20-year-old secondary forest is having the most distribution among the three types of secondary forests. This result may due to many factors that affect plant distribution such as the soil type, elevation, climate, succession activity and sunlight. The soil may not significantly affect plant species distribution because there is not much different in soil type between 3 types of secondary forests. The elevation of the land, including the slope, the land structure is also did not affect plant species distribution all three types of secondary forests. This is because the land structure in the 20 and 30-year-old secondary forests is almost same. The study plot also situated on the sloping land and some between the streams for both the 20 and 30-year-old secondary forests. Climate should not affect plant species distribution since there is not different in climate for all types of secondary forests.

There is a significant plant species distribution in the 20-year-old secondary forest. This is because in the 20-year-old secondary forest, there still sunlight passing through the canopy towards the forest floor. This will makes the shrub species, palms and some climbers to grow up. So, in the 20-year-old secondary forest is full with shrubs on the floor and trees on the canopy. Another significant factor is the succession activity. This is because all three types of secondary forest are of post shifting cultivation activities, so the succession activity is still going in the 5, 20 and 30-year-old secondary forests. In fact, the number of herbaceous plant species in the forest floor may be high in the early stage of succession following a gap formation and decline as the succession proceeds (Shankar, 2001). Therefore, the 20-year-old secondary forest has the optimum plants succession activities and declining in the 30-year-old secondary forest.

For the results of diversity hypothesis, we cannot determine the medicinal, flavoring and preservatives plants species diversity because the diversity can only be determined in each type of secondary forest. Shannon Diversity index indicates that the 20-year-old secondary forest has the highest diversity with 3.70, followed by 30-year-old secondary forest with 3.59 and 5-year-old secondary forest with 3.58. Shannon Equitability however, was not used it to prove the hypothesis.

Shannon Index indicates that the most diversified secondary forest is the 20-year-old secondary forest. Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted. The alternative hypothesis states that there is no significance between the increasing ages of secondary forest with the diversity. It is proven that the older secondary forest does not necessarily more diverse than the younger type of secondary forest.

Forest diversity is increasing with the increasing number of plants species. This may due to the same factors as discussed before. The succession activity is optimum in the 20-year-old, then decreased in the 30-year-old as indicated by the number of plant species. This causes the increase in diversity of plant species in the 20-year-old secondary forest. The forest canopy in the 20-year-old secondary forest is not as dense as the 30-year-old secondary forest, allowing the sunlight can reach the forest floor. As a result more shrub species can grow, thus increasing number of species and the diversity of plant species in the 20-year-old secondary forests.

Only the density of medicinal, flavoring and preservatives plant species in each type of secondary forest were tested the hypothesis. The highest value of relative density of medicinal, flavoring and preservatives plants species is in the 20-year-old secondary forest which recorded 24%, followed by the 5-year-old secondary forest which recorded 13%. The null hypothesis which that is that the older secondary forest has higher density of medicinal, flavoring and preservatives plant species than younger secondary forest. The relative density results shown in Table 8.

Based on these results, the null hypothesis is rejected. This is because the densest population of medicinal, flavoring and preservatives plants species is in the 20-year-old secondary forest, not in the oldest site of the 30-year-old secondary forest. Therefore, the alternative hypothesis is accepted, and there is no significant different on the number of medicinal, flavoring and preservatives plants species between the older and younger secondary forests.

The factors that may cause the rejection of the null hypothesis are the soil type, steep topography, succession activity and light intensity. Other natural factors that may affect the species density are the usage of the medicinal, flavoring and preservative plant species by the local community. The usage of medicinal, flavoring and preservative plants species among the local community may depend on the perspective of the local community to the usage of wild plants. They may easier to get those species from the 20-year-old secondary forest than in the 5-year-old secondary forest because it is too young forest, and the 30-year-old secondary forest is too old forest withless number of medicinal, food flavoring and food preservative plants.

Table 8. Summary of data analysis for the 5, 20 and 30-years-old secondary forests.

Parameters	5 Years old secondary forest	20 Years old secondary forest	30 Years old secondary forest
Plot size (m^2)	4000	6000	6000
No. of species	66	121	100
No. family	23	40	41
Species distribution a) Tree (%) b) Shrub and herbs, palm, climber (%)	83 17	69 31	60 40
Shannon Index	3.58	3.70	3.59
Shannon equitability	0.86	0.77	0.78
Most dominant (key species) a) Local name b) Family c) Species d) Importance Value	 Senakan Flacaurtiaceae Flacaurtia sp. 11.14	 Rotan smambu Arecaceae Calamus sp. 18.26	 Pejagok Arecaceae Pinaga sp. 17.80
No. of medicinal, flavoring and preservatives species	11	21	13
Distribution of medicinal, flavoring and preservatives plants species (%)	19	25	13
Relative density of medicinal, flavoring and preservatives plants species (%)	16	24	13

After being tested, the entire null hypotheses have been rejected and the alternative hypotheses were accepted. Therefore, it is proven that older secondary forest does not necessarily has more medicinal, food flavoring and food preservative plants than the younger secondary forests.

There are many factors that affecting the result of the study. For examples, there may be error in data collection, plant identification of (both local and scientific names). The medicinal, flavoring and preservative plant, and the suitability of time for conducting the study. The data collections is less accurate for some reasons. For example, there are some plant may be left uncounted because not enough person doing the inventory. They were only four persons including one representatives from the local community. As the result, the inventory is less effective. More representatives from local community and laboratory assistant should be asked to help in the inventory because of short period of data collection.

There are also problems in identifying both local and scientific names of plants species. All three researchers cannot identify both the Bidayuh and scientific names of most of the plants. During the inventory in the field, only one local assistant was hired to help. The local assistant, was also having problem identifying the Bidayuh names for all plant species in the plot. The spelling of Bidayuh name also poised problem to researchers since the spelling may not reflects the actual pronunciations of those particular names.

There also problem in identifying plants for the medicinal, flavoring and preservatives uses. The local assistant that assisted in the inventory method is not the medicine man, so it was difficult for him to identifying of the medicinal plants. For food flavoring, the use of wild plants for flavoring is decreasing towards the modern era. Most of the flavoring and preservatives plants species had been domesticated and cultivated. After for generations they have been used and collected from the primary forests. The study area is an abandoned area from post shifting cultivation, thus some of plants species that can be found in primary forest cannot be found here. More local assistants should be hired to ensure more plant species can be identified and counted. This will help to make the study more comprehensive and correct information.

The inventory was conducted in four weeks, or one month between September 2005 to January 2006. We did the inventory on holidays and at the weekends. Conducting the study in the 5-year-old secondary forest, the 20-year-old secondary forest and the 30-year-old secondary forest with only 3 persons and one Bidayuh local individual in that period of time, that is not suitable. There should be more assistance from the laboratory assistant and local Bidayuh assistants to obtain better results of the research in such a limited time. If only 4 persons conducting the study, the period for the study should be longer. The activities that took most of our time are the setting up plots, counting plants species and identifying their scientific names.

The results of identified medicinal, flavoring and preservatives as presented in the Table 6 and Table 7. There were only 19 medicinal plant species, six food flavoring plant species and only one preservative plant species used have been recorded. Therefore, there is less number of plants identified and recorded in this study compare to the other plant inventory study.

The identifying of the plants species for medicinal, flavoring and preservatives to the Bidayuh community was only focusing on the Bidayuh of Bau district, specifically the Bidayuh of Kampung Serasot. We only referred to 4 persons from Kampung Serasot to identify the medicinal, flavoring and preservatives plants and their uses. There may be other plant species that left not identified. The other study of medicinal, flavoring and preservative plant and their uses in several other kampungs around Jagoi area could yield better understanding of this subject. Combination of the survey results and the inventory of plant species in the study area is the most appropriate method to gather comprehensive set of information in a fast manner (Ogle, 1995).

Other factor that contributes to the less identified plant species for medicinal, flavoring and preservatives is the plot area. The area for inventory is only $4000m^2$ in the 5-year-old secondary forest, and $6000m^2$ for both the 20 and 30-year-old secondary forests. We used $4000m^2$ for the 5-year-old secondary forest because the limited track of the 5-year-old secondary forest. With less one hectare of each type of secondary forests, there are only 19 medicinal plants, six flavoring plants and one preservatives plants species were identified and recorded. By increasing the size of study area, many more medicinal, food flavoring and preservative plant species may be recorded and identified. However, the study will take longer time and more local assistants needed.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

The inventory and identification of plants commonly used for medicine, food preservatives and food flavors in the Bidayuh community is conducted in three types of secondary forests which are the 5, 20 and 30-year-old secondary forests. The most diverse forest type is the 20-year-old secondary forest with Shannon index of 3.70, followed by the 30-year-old secondary forest with 3.59 and the 5-year-old secondary forest with 3.58. Most of the medicinal, flavoring and preservative plant species were found in the 20-year-old secondary forest which recorded 25% of the total plant species, followed by the 5-year-old secondary forest with 19% and the 30-year-old secondary forest with 13%. The densest population of the medicinal, flavoring and preservatives plant species is also in the 20-year-old secondary forest with 24% of the total number of plant, followed with the 5-year-old secondary forest with 16% and the 30-year-old secondary forest with 13%. According to these results, the alternative hypothesis, which states that there is no significant different in diversity, distribution and density of medicinal, flavoring and preservatives plant species in the older and younger secondary forests is accepted.

For recommendations, there should be some changes in the methodology to make the data collection more accurate. The study period must be longer so there will be more time for the field data collection. More assistance sought to identify the local Bidayuh and scientific plants names of the plants. Households' survey on the uses of medicinal, flavoring and preservatives in the community makes better understanding of this matter.

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Appendices

Appendix 1: The study plot

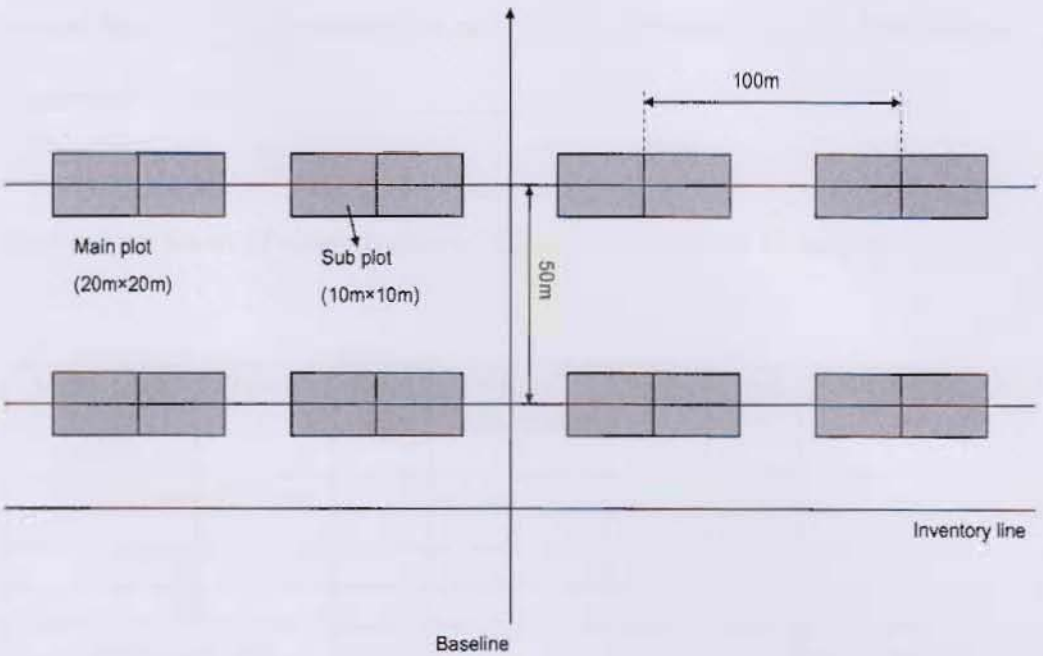


Figure 1 : The study plot

Appendix 2: Form for herbaceous inventory

Form for herbaceous inventory

Forest Age:_______ Inventory line no.:________ Plot no.:_______ Sub- Plot no.:______

General description:____________________

Herbaceous plants / Palms / Bamboo / Climbers / Seedlings (Plant types)

	Vernacular (Local name)	Taxon	Plant type	No. of individuals	Fruits	Food	Medicinal	Others	Comments

Appendix 3: Form for tree inventory

Form for tree inventory

Forest Age:_______ Inventory line no.:________ Plot no.:_______ Sub- Plot no.:______

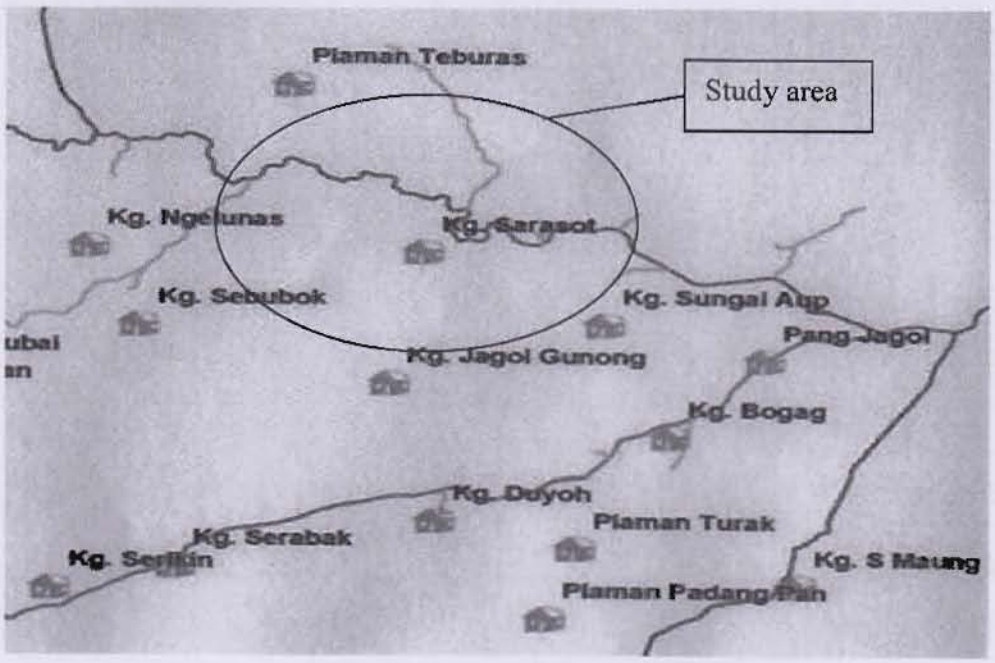
General description:____________________

Trees / Treelets / Saplings

	Vernacular (Local name)	Taxon	DBH	HT	Fruits	Food	Medicinal	Others	Comments

Appendix 4: Map of study area

Map of study area



Source: (Noweg, 2005)

Appendix 5: 5 Years Old Secondary Forest Data

5 years old secondary forest data								
Local name	**Family**	**Species**	**total**	**total sp**	**Rd (%)**	**Rf(%)**	**Diveristy**	**Iv**
Atap	Rubiaceae	Nauclea sp.	27	3	0.8166969	1.4563107	-0.03926399	2.273007594
Badad	Euphorbiaceae	Macaranga gigantea	130	4	3.9322444	1.9417476	-0.127245849	5.873991977
Bah boru	Myrtaceae	Eugenia sp.	19	2	0.5747126	0.9708738	-0.029649743	1.54558643
Bah jambu	Myrtaceae	Syzygium sp.	11	3	0.3327284	1.4563107	-0.018984147	1.789039052
Bah payak	Myrtaceae	Eugenia sp.	23	4	0.6957048	1.9417476	-0.034562614	2.637452352
Benuak	Euphorbiaceae	Macaranga sp.	44	4	1.3309135	1.9417476	-0.057486208	3.272661063
Biting	Araceae	Not identified	8	1	0.2419843	0.4854369	-0.01457726	0.727421164
Bitopuk	Euphorbiaceae	Aporusa sp	104	4	3.1457955	1.9417476	-0.108816319	5.087543096
Botud	Rubiaceae	Timonius lasianthoides	10	3	0.3024803	1.4563107	-0.01754661	1.758791018
Boyu	Moraceae	Artocarpus elasticus	17	3	0.5142166	1.4563107	-0.027100658	1.970527256
Buan	Dilleniaceae	Dillenia suffruticosa	242	4	7.3200242	1.9417476	-0.191386172	9.261771771
Buan kaking	Dilleniaceae	Dillinea sp.	11	1	0.3327284	0.4854369	-0.018984147	0.818165266
Dawon sibogok	Not identified	Not identified	57	4	1.7241379	1.9417476	-0.070007638	3.665885504
Dawon siko'ot	Moraceae	Ficus sp.	18	4	0.5444646	1.9417476	-0.028383607	2.486212183
Glomang	Hypoxidaceae	Curculigo latifolia	261	4	7.8947368	1.9417476	-0.200445306	9.836484415
Jambu putih	Melastomaceae	Not identified	11	4	0.3327284	1.9417476	-0.018984147	2.274475945
Kalibodok	Sarauiaceae	Sarauia sp	2	1	0.0604961	0.4854369	-0.004482969	0.545932961
Kalipiti	Leguminosae	Pithecellobium clypenna	16	3	0.4839685	1.4563107	-0.025799906	1.940279222
Kalipoit	Not identified	Not identified	47	4	1.4216576	1.9417476	-0.060468026	3.363405165
Kirangan	Urticaceae	Leucosyke capitellata	9	2	0.2722323	0.9708738	-0.016078774	1.243106091
Konis	Guttifereae	Garcinia nitidia	32	4	0.9679371	1.9417476	-0.044890583	2.909684657
Lidian	Ixonanthaceae	Ixonanthes reticulata	30	4	0.907441	1.9417476	-0.042670571	2.849188589
Lokan	Moraceae	Ficus grossulariodes	186	4	5.6261343	1.9417476	-0.161905945	7.567881874
Lusak	Melastomaceae	Melastoma malabathricum	135	4	4.0834846	1.9417476	-0.1305988	6.025232146
Mupuod	Compositae	Vernonia arborea	37	4	1.1191773	1.9417476	-0.050279893	3.060924826
Ngeliwat	Verbenaceae	Vitex pubescens	55	4	1.6636419	1.9417476	-0.068145451	3.605389436
Ngetatok	Apocynaceae	Alstonia sphatulata	61	4	1.8451301	1.9417476	-0.07366904	3.786877639
Ngibulan	Euphorbiaceae	Homalanthus sp.	71	4	2.1476104	1.9417476	-0.08248573	4.089357978
Ngidodod	Myrtaceae	Tristanopsis sp	27	4	0.8166969	1.9417476	-0.03926399	2.758444488
Ngidumam	Polygalaceae	Xanthophyllum sp	9	2	0.2722323	0.9708738	-0.016078774	1.243106091

Appendix 5 (Continued)								
Ngiliyes	Not identified	Not identified	9	4	0.2722323	1.9417476	-0.016078774	2.213979878
Ngilogang	Not identified	Not identified	71	3	2.1476104	1.4563107	-0.08248573	3.603921085
Ngipodos	Rhizophoraceae	Gynotroches axillaris	5	3	0.1512402	1.4563107	-0.009821622	1.607550849
Nyah	Euphorbiaceae	Not identified	25	4	0.7562008	1.9417476	-0.036937526	2.69794842
Nyam badak	Euphorbiaceae	Glochidion sp	6	1	0.1814882	0.4854369	-0.011455054	0.666925096
Nyam manah	Euphorbiaceae	Glochidion sp	21	4	0.6352087	1.9417476	-0.03213503	2.576956284
Opak	Not identified	Not identified	54	4	1.6333938	1.9417476	-0.067206156	3.575141402
Owid	Not identified	Not identified	3	2	0.0907441	0.9708738	-0.006356517	1.061617888
Pang	Myristicaceae	Horsefieldia grandis	2	1	0.0604961	0.4854369	-0.004482969	0.545932961
Pejulut	Rhizophoraceae	Anisophyllea disthica	21	3	0.6352087	1.4563107	-0.03213503	2.091519391
Pijali	Not identified	Not identified	23	3	0.6957048	1.4563107	-0.034562614	2.152015459
Pijar	Rubiaceae	Chassalia sp	11	2	0.3327284	0.9708738	-0.018984147	1.303602159
Plotju	Meliaceae	Pentaspadum motleyi	52	4	1.5728978	1.9417476	-0.065310656	3.514645334
Popan	Moraceae	Ficus sp	90	4	2.722323	1.9417476	-0.098103937	4.664070622
Puduh	Moraceae	Artocarpus kemando	82	4	2.4803388	1.9417476	-0.091692545	4.422086351
Senakan	Flacaurtiaceae	Flacaurtia	304	4	9.1954023	1.9417476	-0.219445202	11.13714987
Serumah	Not identified	Ploiarium alternifolium	41	3	1.2401694	1.4563107	-0.054442471	2.696480069
sibodoh	Zingiberaceae	Etlingera sp.	40	2	1.2099214	0.9708738	-0.053413368	2.180795142
Sidoli	Not identified	Not identified	11	1	0.3327284	0.4854369	-0.018984147	0.818165266
Sidudui	Arecaceae	Arenga sp.	2	1	0.0604961	0.4854369	-0.004482969	0.545932961
Simupak	Theaceae	Adinandra gumusa	23	4	0.6957048	1.9417476	-0.034562614	2.637452352
Sipagar	Scrophulariaceae	Brookea tomentosa	8	2	0.2419843	0.9708738	-0.01457726	1.212858057
Sipin	Moraceae	Ficus orata	34	4	1.0284332	1.9417476	-0.047072761	2.970180725
Songoh	Eleocarpaceae	Not identified	1	1	0.030248	0.4854369	-0.002451148	0.515684927
Spijol	Orchidaceae	Dendrobium sp	72	4	2.1778584	1.9417476	-0.0833429	4.119606012
Tibedak	Moraceae	Artocarpus integer	3	2	0.0907441	0.9708738	-0.006356517	1.061617888
Timu'	Moraceae	Ficus koeringhii	73	4	2.2081065	1.9417476	-0.084195869	4.149854046
Ti'nuong	Not identified	Not identified	43	4	1.3006655	1.9417476	-0.05647872	3.24241303
Tiongak	Zingiberaceae	Hornstedia scyphimera	252	4	7.6225045	1.9417476	-0.196208236	9.56425211
Tipu' oyung	Zingiberaceae	Etlingera sp.	17	3	0.5142166	1.4563107	-0.027100658	1.970527256
Tipu' tuhau	Zingiberaceae	Etlingera elatoir	97	3	2.9340593	1.4563107	-0.103536594	4.390369966
Totang manok	Campnosperma sp	Anacardiaceae	10	3	0.3024803	1.4563107	-0.01754661	1.758791018

Appendix 5 (Continued)								
Towie	Not identified	Not identified	57	4	1.7241379	1.9417476	-0.070007638	3.665885504
Tumah	Guttifereae	Crotoxylon sp	24	4	0.7259528	1.9417476	-0.035756373	2.667700386
Tungon	Araceae	Humuleana sp	2	1	0.0604961	0.4854369	-0.004482969	0.545932961
Unguon oran	Ebenaceae	Diospyrus diepenhorstii	7	2	0.2117362	0.9708738	-0.013037837	1.182610024
		Total	3306	206		(H)	3.575474032	
						E_H	0.853405412	

Appendix 6: 20 Years Old Secondary Forest Data

20 years old secondary forest data								
Local name	**Family**	**Species**	**total**	**total sp**	**Rd (%)**	**Rf(%)**	**Diveristy**	**Iv**
Asam bowang	Mangifera pajang	Anacardiaceae	1	1	0.0142025	0.2604167	-0.001258274	0.274619195
Atap	Nauclea sp.	Rubiaceae	6	3	0.0852152	0.78125	-0.006022792	0.866465168
Badad	Macaranga gigantea	Euphorbiaceae	7	4	0.0994177	1.0416667	-0.006873337	1.141084363
Bah	Syzygium sp.	Myrtaceae	107	4	1.5196705	1.0416667	-0.06362369	2.561337168
Bah jambu	Syzygium sp.	Myrtaceae	202	4	2.8689107	1.0416667	-0.10188184	3.910577333
Bah paya'	Syzygium sp.	Myrtaceae	27	4	0.3834683	1.0416667	-0.021334903	1.425134924
Bah samok	Syzygium sp.	Myrtaceae	27	4	0.3834683	1.0416667	-0.021334903	1.425134924
Bakuluang	Lcea indica	Emplidaceae	4	1	0.0568101	0.2604167	-0.00424554	0.317226779
Benuak	Macaranga sp.	Euphorbiaceae	109	4	1.5480756	1.0416667	-0.064526229	2.589742224
Berangan	Castanopsis sp	Fagaceae	1	1	0.0142025	0.2604167	-0.001258274	0.274619195
Biih	Not identified	Not identified	3	1	0.0426076	0.2604167	-0.003306729	0.303024251
Bintangor	Calophyllum sp.	Guttiferae	2	2	0.0284051	0.5208333	-0.002319659	0.549238389
Bitawa'	Artocarpus anisophyllus	Moraceae	1	1	0.0142025	0.2604167	-0.001258274	0.274619195
Bitopuk	Aporusa sp.	Euphorbiaceae	7	1	0.0994177	0.2604167	-0.006873337	0.359834363
karibodok	Sarauia sp	Sarauiaceae	21	4	0.2982531	1.0416667	-0.017343367	1.339919756
Boid tibug	Piper vesticum	Piperaceae	26	4	0.3692657	1.0416667	-0.020684084	1.410932396
Bokah garuak	Not identified	Not identified	23	4	0.3266581	1.0416667	-0.018697949	1.368324812
Bokah girakat	Adenia clementis	Passifloraceae	15	4	0.2130379	1.0416667	-0.013104932	1.254704587
Bokah piuh	Not identified	Not identified	21	3	0.2982531	0.78125	-0.017343367	1.079503089
Bongan	Aporusa nitida	Euphorbiaceae	27	3	0.3834683	0.78125	-0.021334903	1.164718257

Appendix 6 (Continued)								
Botud	Timonius lasianthoides	Rubiaceae	34	4	0.482886	1.0416667	-0.025753008	1.52455262
Boyu	Artocarpus elasticus	Moraceae	69	4	0.9799744	1.0416667	-0.045327728	2.021641102
Buan	Dillenia suffruticosa	Dileneaceae	116	4	1.6474933	1.0416667	-0.067644677	2.68915992
Buan kaking	Dillenia sp. 2	Dileneaceae	65	4	0.9231643	1.0416667	-0.04325134	1.96483099
Bumbun	Not identified	Not identified	2	1	0.0284051	0.2604167	-0.002319659	0.288821723
Cempedak	Artocarpus integer	Moraceae	127	4	1.8037211	1.0416667	-0.072425144	2.845387729
Daun ulik	Not identified	Araceae	68	4	0.9657719	1.0416667	-0.044811795	2.007438574
Donuk (akar kayu)	Not identified	Not identified	22	4	0.3124556	1.0416667	-0.018023887	1.354122284
Durian	Durio sp	Bombaceae	7	3	0.0994177	0.78125	-0.006873337	0.880667696
Getah	Havea brasiliensis	Euphorbiaceaee	317	4	4.5022014	1.0416667	-0.139595423	5.543868059
Getah merah	Ganua sp	Sapotaceae	12	3	0.1704303	0.78125	-0.01086425	0.951680337
Gilliet (pandan2)	Pandanus sp.	Pandanaceae	28	4	0.3976708	1.0416667	-0.021980461	1.439337452
Glomang	Curculigo latifolia	Hypoxidaceae	128	4	1.8179236	1.0416667	-0.072852837	2.859590257
Gnetum	Gnetum sp	Gnetaceae	6	2	0.0852152	0.5208333	-0.006022792	0.606048502
Inyuk	Arenga pinnata	Arecaceae	2	2	0.0284051	0.5208333	-0.002319659	0.549238389
Japak	Not identified	Not identified	49	3	0.6959239	0.78125	-0.034571307	1.477173874
Johtu biliah	Palaqium sp	Sapotaceae	30	4	0.4260758	1.0416667	-0.023256532	1.467742508
Johtu ligu	Not identified	Sapotaceae	37	4	0.5254935	1.0416667	-0.027580989	1.567160205
Joring	Pithecolobium lobatum	Leguminosae	17	4	0.241443	1.0416667	-0.014550059	1.283109644
kacip fatimah	Labisia pumila	Labitaceae	18	4	0.2556455	1.0416667	-0.015259822	1.297312172
Kalipiti	Pithecellobium clypenna	Leguminosae	71	4	1.0083795	1.0416667	-0.046353447	2.050046158
Kinamai	Goniothalamus sp.	Annonaceae	16	3	0.2272404	0.78125	-0.013831937	1.008490449
Kirangan	Leucosyke capitellata	Urticaceae	18	4	0.2556455	1.0416667	-0.015259822	1.297312172
Klaki	Lithocarpus sp	Fagaceae	1	1	0.0142025	0.2604167	-0.001258274	0.274619195
Kolon	Arthocarpus nitidus	Moraceae	6	2	0.0852152	0.5208333	-0.006022792	0.606048502
Konis (kandis)	Garcinia nitidia	Guttiferae	9	2	0.1278228	0.5208333	-0.008515911	0.648656086
Lakot	Barringtonia resmosa	Lecythidaceae	11	4	0.1562278	1.0416667	-0.010094832	1.197894475
Lidian	Ixonanthes reticulata	Ixonanthaceae	1	1	0.0142025	0.2604167	-0.001258274	0.274619195
Limutan	Nephelium sp	Sapindaceae	31	4	0.4402784	1.0416667	-0.023887383	1.481945036
Lokan	Ficus grossulariodes	Moraceae	1	1	0.0142025	0.2604167	-0.001258274	0.274619195

Appendix 6 (continued)								
Luboh	Diospyros sp	Ebenaceae	74	4	1.0509871	1.0416667	-0.04787709	2.092653742
Mobi	Not identified	Not identified	9	4	0.1278228	1.0416667	-0.008515911	1.169489419
Mupuad	Vernonia arborea	Compositae	7	2	0.0994177	0.5208333	-0.006873337	0.62025103
Ngibulan	Homalanthus sp.	Euphorbiaceae	6	4	0.0852152	1.0416667	-0.006022792	1.126881835
Ngidodod	Tristanopsis sp	Myrtaceae	66	4	0.9373669	1.0416667	-0.043773633	1.979033518
Ngidumam	Xanthophyllum sp	Polygalaceae	3	2	0.0426076	0.5208333	-0.003306729	0.563440917
Ngilies	Not identified	Not identified	14	4	0.1988354	1.0416667	-0.012368453	1.240502059
Ngiliwat	Vitex pubescens	Verbenaceae	17	4	0.241443	1.0416667	-0.014550059	1.283109644
Ngipodos	Gynotroches axillaris	Rhizophoraceae	12	4	0.1704303	1.0416667	-0.01086425	1.212097003
Ngisiruk	Archidendron sp.	Leguminosae	67	4	0.9515694	1.0416667	-0.044293774	1.993236046
Ngitanuk	Not identified	Not identified	8	3	0.1136202	0.78125	-0.007703524	0.894870224
Ngitatok	Astonia spatulata	Apocynaceae	17	4	0.241443	1.0416667	-0.014550059	1.283109644
Ngitiban	Not identified	Myristicaceae	85	4	1.2072149	1.0416667	-0.053320922	2.248881551
Nyah	Not identified	Euphorbiaceae	13	4	0.1846329	1.0416667	-0.011621819	1.226299531
Nyatuh	Palaqium	Sapotaceae	12	3	0.1704303	0.78125	-0.01086425	0.951680337
Onak ngorum	Etlingera sp.	Zingerberaceae	4	2	0.0568101	0.5208333	-0.00424554	0.577643446
Onak ondu	Etlingera sp.	Zingerberaceae	54	3	0.7669365	0.78125	-0.037353807	1.548186515
Opid	Arenga sp	Arecaceae	9	1	0.1278228	0.2604167	-0.008515911	0.388239419
Pakia'	Bauhinia sp.	Leguminosae	27	2	0.3834683	0.5208333	-0.021334903	0.904301591
Pala' soie	Not identified	Melastomaceae	93	4	1.3208351	1.0416667	-0.057151293	2.362501775
Pang	Horsefildiea grandis	Myristicaceae	124	4	1.7611135	1.0416667	-0.071135317	2.802780145
Pejagok	Arenga sp	Arecaceae	102	4	1.4486579	1.0416667	-0.06134389	2.490324528
Pejulut	Anisophyllea distichla	Rhizophoraceae	976	4	13.861667	1.0416667	-0.273912494	14.90333404
Pijar	Chassalia sp	Rubiaceae	135	4	1.9173413	1.0416667	-0.075816098	2.959007953
Plotju	Lepisanthes sp	Sapindaceae	30	4	0.4260758	1.0416667	-0.023256532	1.467742508
Pola	Fragrea sp.	Loganiaceae	7	3	0.0994177	0.78125	-0.006873337	0.880667696
Popan	Ficus sp.	Moraceae	6	4	0.0852152	1.0416667	-0.006022792	1.126881835
Porriet	Lancium domesticum	Meliaceae	49	4	0.6959239	1.0416667	-0.034571307	1.737590541
Posia'k	Garcinia sp	Guttiferae	3	1	0.0426076	0.2604167	-0.003306729	0.303024251
Poyak	Caesaria rugulosa	Flacaurtiaceae	19	4	0.269848	1.0416667	-0.015961691	1.3115147
Puduh	Arthocarpus kemando	Moraceae	2	1	0.0284051	0.2604167	-0.002319659	0.288821723
Puti'/ buluh	Bambusa sp	Poaceae	75	4	1.0651896	1.0416667	-0.048381097	2.10685627

Appendix 6 (continued)

Rimuban (selunsur)	Tristanopsis sp	Myrtaceae	187	4	2.6558727	1.0416667	-0.096365604	3.697539412
Rotan	Calamus sp	Arecaceae	124	4	1.7611135	1.0416667	-0.071135317	2.802780145
Rotan smambu	Calamus sp	Arecaceae	1212	4	17.213464	1.0416667	-0.302867167	18.25513066
Sagar	Not identified	Leguminosae	14	4	0.1988354	1.0416667	-0.012368453	1.240502059
Samok	Not identified	Myrtaceae	24	4	0.3408607	1.0416667	-0.019365834	1.38252734
Sejongan	Not identified	Guttiferae	1	1	0.0142025	0.2604167	-0.001258274	0.274619195
Sematang	Not identified	Not identified	1	1	0.0142025	0.2604167	-0.001258274	0.274619195
Sepijol	Dendrobium sp.	Orchidaceae	3	1	0.0426076	0.2604167	-0.003306729	0.303024251
Serumah	Ploiarium anternifolium	Not identified	44	4	0.6249112	1.0416667	-0.031716219	1.666577901
Sibilai	plagiostachys sp	Zingerberaceae	56	4	0.7953416	1.0416667	-0.038448035	1.837008237
Sibodoh		Zingerberaceae	117	4	1.6616958	1.0416667	-0.068085186	2.703362449
Sibung	Castanopsis sp	Fagaceae	27	4	0.3834683	1.0416667	-0.021334903	1.425134924
Sidoli	Not identified	Not identified	1	1	0.0142025	0.2604167	-0.001258274	0.274619195
Sidudui	Arenga sp	Arecaceae	2	2	0.0284051	0.5208333	-0.002319659	0.549238389
Sikorung	Not identified	Ophioglossaceae	122	4	1.7327084	1.0416667	-0.07026972	2.774375089
Simupak	Adinandra gumusa	Theaceae	3	1	0.0426076	0.2604167	-0.003306729	0.303024251
Sinakan	Flacaurtia sp.	Flacaurtiaceae	55	4	0.781139	1.0416667	-0.037902212	1.822805709
Sipagar	Brookea tomentosa	Scrophulariaceae	3	1	0.0426076	0.2604167	-0.003306729	0.303024251
Sipin	Ficus orata	Moraceae	16	4	0.2272404	1.0416667	-0.013831937	1.268907115
Songoh	Not identified	Eleaocarpaceae	153	4	2.1729868	1.0416667	-0.083205132	3.214653458
Spuruam(bokah)	Not identified	Not identified	4	2	0.0568101	0.5208333	-0.00424554	0.577643446
Tampoi	Baccaurea puncticulata	Euphorbiaceaee	16	4	0.2272404	1.0416667	-0.013831937	1.268907115
Tebodu(bokah)	Not identified	Not identified	1	1	0.0142025	0.2604167	-0.001258274	0.274619195
Telisum	Zalacca magnifica	Arecaceae	8	3	0.1136202	0.78125	-0.007703524	0.894870224
Tibulus	Litsea lucida	Lauraceae	67	4	0.9515694	1.0416667	-0.044293774	1.993236046
Tigang Jualak	pyrenium sp.	Araceae	6	2	0.0852152	0.5208333	-0.006022792	0.606048502
Tigundiak	Globba sp	Zingerbeaceae	132	4	1.8747337	1.0416667	-0.074552602	2.916400369
Tilambuak manah	Nephentes sp	Nephentaceae	59	4	0.8379492	1.0416667	-0.040070461	1.879615822
Tilambuak pulut	Nephentes sp	Nephentaceae	44	4	0.6249112	1.0416667	-0.031716219	1.666577901
Tilambuak tajau	Nephentes sp	Nephentaceae	73	4	1.0367845	1.0416667	-0.047371163	2.078451214

Appendix 6 (continued)								
Tipu'	Etlingera sp.	Zingerberaceae	32	4	0.4544809	1.0416667	-0.024513652	1.496147564
Tipu' oyung	Etlingera sp.	Zingerberaceae	125	4	1.775316	1.0416667	-0.071566392	2.816982673
Tonuh (pandan1)	Pandanus sp.	Pandanaceae	3	2	0.0426076	0.5208333	-0.003306729	0.563440917
Totang bonah	Garcinia sp	Guttiferae	44	4	0.6249112	1.0416667	-0.031716219	1.666577901
Totang manok	Campnospermum	Anacardiaceae	76	4	1.0793921	1.0416667	-0.04888321	2.121058798
Tu'ang	Litsea garciae	Lauraceae	8	3	0.1136202	0.78125	-0.007703524	0.894870224
Tumah	Crotoxylon sp	Guttiferae	12	4	0.1704303	1.0416667	-0.01086425	1.212097003
Tunguon	Humuleana sp.	Araceae	75	4	1.0651896	1.0416667	-0.048381097	2.10685627
Ungun oran	Diospyrus diepenhorstii	Ebenaceae	10	3	0.1420253	0.78125	-0.009312485	0.92327528
		Total	7041	384		(H)	3.695885259	
						E_H	0.770651934	

Appendix 7: 30 years old secondary forest data

30 years old secondary forest data								
Local name	**Family**	**Species**	**total**	**total sp**	**Rd (%)**	**Rf(%)**	**Diveristy**	**Iv**
Angel sp	Not identified	Rhizophoraceae	44	4	0.6641509	1.3333333	-0.033303291	1.997484277
Cempedak	Artocarpus integer	Moraceae	36	4	0.5433962	1.3333333	-0.028338584	1.87672956
Atap	Nauclea sp.	Rubiaceae	3	2	0.045283	0.6666667	-0.003486789	0.711949686
Bah	Syzygium sp.	Myrtaceae	253	4	3.8188679	1.3333333	-0.124694293	5.152201258
Bah boru	Syzygium sp.	Myrtaceae	9	2	0.1358491	0.6666667	-0.008967914	0.802515723
Bah jambu	Syzygium sp.	Myrtaceae	121	4	1.8264151	1.3333333	-0.073108019	3.159748428
Bah payak	Syzygium sp.	Myrtaceae	4	1	0.0603774	0.3333333	-0.004475358	0.393710692
Bakaluang	Leea indica	Leeaceae	3	1	0.045283	0.3333333	-0.003486789	0.378616352
Benuak	Macaranga sp.	Euphorbiaceae	74	4	1.1169811	1.3333333	-0.05020317	2.450314465
Bitopuk	Apolusa sp	Euphorbiaceae	15	3	0.2264151	1	-0.013789937	1.226415094
Bitowak	Artocarpus anisophyllus	Moraceae	2	1	0.0301887	0.3333333	-0.002446931	0.363522013
Boid tibug	Piper vesticum	Piperaceae	3	1	0.045283	0.3333333	-0.003486789	0.378616352
Bokah bongak	Not identified	Not identified	7	2	0.1056604	0.6666667	-0.007240584	0.772327044
Bokah garuak	Not identified	Not identified	2	1	0.0301887	0.3333333	-0.002446931	0.363522013
Bokah mopuk	Not identified	Not identified	3	1	0.045283	0.3333333	-0.003486789	0.378616352
Bokah sibabuak	Smilax sp	Smilacaceae	35	4	0.5283019	1.3333333	-0.027700229	1.86163522

Appendix 7 (continued)								
Bokah spuruom	Not identified	Not identified	11	2	0.1660377	0.6666667	-0.010627595	0.832704403
Bongan	Castanopsis sp	Fagaceae	128	4	1.9320755	1.3333333	-0.076250815	3.265408805
Bongan silun	Castanopsis sp	Fagaceae	49	4	0.7396226	1.3333333	-0.036291695	2.072955975
Boyu	Artocarpus elasticus	Moraceae	69	4	1.0415094	1.3333333	-0.047539689	2.374842767
Buah kecil di batang	Clidemia Hirta	Melastomaceae	44	4	0.6641509	1.3333333	-0.033303291	1.997484277
Buan biasa	Dillenia suffruticosa	Dilleniaceae	133	4	2.0075472	1.3333333	-0.078460093	3.340880503
Buan kaking	Dillenia sp. 2	Dilleniaceae	17	4	0.2566038	1.3333333	-0.015307422	1.589937107
Buluh	Bambusa sp	Poaceae	14	1	0.2113208	0.3333333	-0.013016404	0.544654088
Dowon manah	Not identified	Araceae	87	4	1.3132075	1.3333333	-0.056897311	2.646540881
Daun ulik	Not identified	Liliaceae	155	4	2.3396226	1.3333333	-0.087857054	3.672955975
Durian	Durio sp	Bombaceae	10	3	0.1509434	1	-0.009805314	1.150943396
Getah	Havea brasiliensis	Euphorbiaceaee	2	1	0.0301887	0.3333333	-0.002446931	0.363522013
Gilliet	Pandan sp	Pandanaceae	12	4	0.1811321	1.3333333	-0.011436134	1.514465409
Girakat	Adenia clementis	Passifloraceae	2	1	0.0301887	0.3333333	-0.002446931	0.363522013
Glomang anjing	Cucurligo sp	Hypoxidaceae	8	2	0.1207547	0.6666667	-0.008113708	0.787421384
Glomang biasa	Curculigo latifolia	Hypoxidaceae	162	4	2.445283	1.3333333	-0.090744681	3.778616352
Jaolin	Pithecellobium lobatum	Leguminosae	7	3	0.1056604	1	-0.007240584	1.105660377
Japak	Not identified	Not identified	33	4	0.4981132	1.3333333	-0.026410451	1.831446541
Johtu biliah	Palaqium sp	Sapotaceae	22	3	0.3320755	1	-0.018953417	1.332075472
Kabang	Shorea macrophylla	Dipterocarpaceae	14	2	0.2113208	0.6666667	-0.013016404	0.877987421
Kait-kait	Not identified	Not identified	9	2	0.1358491	0.6666667	-0.008967914	0.802515723
Kalipiti	Pithecellobium clypenna	Leguminosae	27	4	0.4075472	1.3333333	-0.022426378	1.740880503
Kapuang (buluh)	Bambusa sp	Poaceae	18	2	0.2716981	0.6666667	-0.01605256	0.93836478
Kenamai	Goniothalamus sp.	Annonaceae	18	4	0.2716981	1.3333333	-0.01605256	1.605031447
Konis	Garcinia nitidia	Guttiferae	10	3	0.1509434	1	-0.009805314	1.150943396
Koyu bodok	Sarauia sp	Sarauiaceae	23	4	0.3471698	1.3333333	-0.019660613	1.680503145
Lasot	Lansium domesticum	Meliaceae	9	4	0.1358491	1.3333333	-0.008967914	1.46918239
Lidian	Ixonanthes reticulata	Ixonanthaceae	33	4	0.4981132	1.3333333	-0.026410451	1.831446541
Limuban	Tristanopsis sp	Myrtaceae	5	2	0.0754717	0.6666667	-0.005425787	0.742138365
Limutan	Nephelium sp	Sapindaceae	3	1	0.045283	0.3333333	-0.003486789	0.378616352
Luboh	Diospyros sp	Ebenaceae	28	4	0.4226415	1.3333333	-0.02310328	1.755974843
Ngeliwat	Vitex pubescens	Verbenaceae	2	2	0.0301887	0.6666667	-0.002446931	0.696855346

Appendix 7 (continued)								
Ngetatok	Alstonia sphatulata	Apocynaceae	48	4	0.7245283	1.3333333	-0.035700441	2.057861635
Ngibulan	Homalanthus sp.	Euphorbiaceae	90	4	1.3584906	1.3333333	-0.058398738	2.691823899
Ngidodod	Tristania obovata	Myrtaceae	2	1	0.0301887	0.3333333	-0.002446931	0.363522013
Ngidumam	Xanthophyllum sp	Polygalaceae	10	3	0.1509434	1	-0.009805314	1.150943396
Ngipodos	Gynotroches axillaris	Rhizophoraceae	22	4	0.3320755	1.3333333	-0.018953417	1.665408805
Ngitanuk	Not identified	Not identified	1	1	0.0150943	0.3333333	-0.001328091	0.348427673
Ngitiban	Not identified	Myristicaceae	6	3	0.090566	1	-0.006345823	1.090566038
Onak ngorum	Etlingera sp	Zingerberaceae	28	4	0.4226415	1.3333333	-0.02310328	1.755974843
Pakia'	Bauhinia sp.	Leguminosae	19	3	0.2867925	1	-0.016789308	1.286792453
Palak soie	Not identified	Melastomaceae	81	4	1.2226415	1.3333333	-0.053847045	2.555974843
Pang	Horsfildiea grandis	Myristicaceae	62	4	0.9358491	1.3333333	-0.04371792	2.26918239
Pejagok	Pinanga sp	Arecaceae	1091	4	16.467925	1.3333333	-0.297041122	17.80125786
Pejulut	Anisophyllea distichla	Rhizophoraceae	262	4	3.954717	1.3333333	-0.127747686	5.288050314
Pijar	Chassalia sp	Rubiaceae	67	4	1.0113208	1.3333333	-0.046459196	2.344654088
Pla'us	Not identified	Anacardiaceae	3	2	0.045283	0.6666667	-0.003486789	0.711949686
Plotju	Lepisanthes sp	Sapindaceae	36	4	0.5433962	1.3333333	-0.028338584	1.87672956
Popan	Ficus sp.	Moraceae	4	2	0.0603774	0.6666667	-0.004475358	0.727044025
Posia'k	Garcinia sp	Guttiferae	66	4	0.9962264	1.3333333	-0.045915586	2.329559748
Poyak (btg berduri)	Caesaria rugulosa	Flacaurtiaceae	12	3	0.1811321	1	-0.011436134	1.181132075
Puduh	Arthocarpus kemando	Moraceae	164	4	2.4754717	1.3333333	-0.091561243	3.808805031
Puti'	Bambusa sp	Poaceae	287	4	4.3320755	1.3333333	-0.135989196	5.665408805
Rotan	Calamus sp.	Arecaceae	785	4	11.849057	1.3333333	-0.252731127	13.18238994
Rotan simambu	Calamus sp.	Arecaceae	89	4	1.3433962	1.3333333	-0.057899965	2.67672956
Rubiaceae sp (B-biru)	Not identified	Rubiaceae	4	2	0.0603774	0.6666667	-0.004475358	0.727044025
Sagar	Not identified	Leguminosae	6	1	0.090566	0.3333333	-0.006345823	0.423899371
Senakan	Flacaurtia sp	Flacaurtiaceae	188	4	2.8377358	1.3333333	-0.101084796	4.171069182
Sibilai	Plagiostachys sp.	Zingerberaceae	107	4	1.6150943	1.3333333	-0.066635188	2.948427673
Sibodoh	Etlingera sp	Zingerberaceae	83	4	1.2528302	1.3333333	-0.054871019	2.586163522
Sidudui	Arenga sp	Arecaceae	127	4	1.9169811	1.3333333	-0.075805458	3.250314465
Simundun	Not identified	Not identified	2	1	0.0301887	0.3333333	-0.002446931	0.363522013
Simupak	Adinandra gumusa	Theaceae	167	4	2.5207547	1.3333333	-0.092779197	3.85408805
Sipagar	Brookea tomentosa	Scrophulariaceae	5	2	0.0754717	0.6666667	-0.005425787	0.742138365

Appendix 7 (continued)								
Songoh	Elaeocarpus sp	Eleaocarpaceae	13	3	0.1962264	1	-0.01223208	1.196226415
Sp A	Cyrtandra sp	Gesnerineaceae	8	2	0.1207547	0.6666667	-0.008113708	0.787421384
Sp B	Stenochlaena palustris	Pteridophyta	107	4	1.6150943	1.3333333	-0.066635188	2.948427673
Spijol	Dendrobium sp.	Orchidaceae	74	4	1.1169811	1.3333333	-0.05020317	2.450314465
Stotoh	Lygodium sp	Schizaeaceae	20	2	0.3018868	0.6666667	-0.017518108	0.968553459
Telimbuak manah	Nephentes sp	Nephentaceae	52	4	0.7849057	1.3333333	-0.038047218	2.118238994
Telimbuak pulut	Nephentes sp	Nephentaceae	17	3	0.2566038	1	-0.015307422	1.256603774
Telimbuak tajau	Nephentes sp	Nephentaceae	7	2	0.1056604	0.6666667	-0.007240584	0.772327044
Telisum	Salacca sp	Arecaceae	29	4	0.4377358	1.3333333	-0.02377479	1.771069182
Tibulus	Litsea lucida	Lauraceae	7	3	0.1056604	1	-0.007240584	1.105660377
Tigang jolak	pyrenium sp.	Araceae	21	2	0.3169811	0.6666667	-0.018239358	0.983647799
Tigundiak	Globba sp	Zingerberaceae	5	2	0.0754717	0.6666667	-0.005425787	0.742138365
Tipuk oyung	Etlingera sp	Zingerberaceae	217	4	3.2754717	1.3333333	-0.111978823	4.608805031
Tongkat ali	Eurycoma longifolia	Simaroubaceae	14	1	0.2113208	0.3333333	-0.013016404	0.544654088
Toring	*Bambusa sp*	Poaceae	8	1	0.1207547	0.3333333	-0.008113708	0.45408805
Totang bonah	*Garcinia sp*	Guttiferae	39	4	0.5886792	1.3333333	-0.030228938	1.922012579
Totang manok	*Camnospermum*	Anacardiaceae	204	4	3.0792453	1.3333333	-0.10717269	4.412578616
Tumah	*Crotoxylon sp*	Guttiferae	26	4	0.3924528	1.3333333	-0.021743885	1.725786164
Tungon	*Humuleana sp.*	Araceae	2	2	0.0301887	0.6666667	-0.002446931	0.696855346
unguon oran	*Diospyrus diepenhorstii*	Ebenaceae	53	4	0.8	1.3333333	-0.03862651	2.133333333
		total	6625	300		(H)	3.586328551	
						E_H	0.77876135	