Sains Malaysiana 42(10)(2013): 1409–1424

Tree Species Composition and Diversity in One Ha Forest, Ulu Muda Forest Reserve, Kedah

(Komposisi Spesies Pokok dan Kepelbagaian dalam Satu Ha Hutan, Hutan Simpan Ulu Muda, Kedah)

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ABSTRACT

The present study was carried out to investigate the composition of species and species diversity at Compartment 28A in the Ulu Muda Forest Reserve (UMFR), located in north-west of Peninsular Malaysia. The area covered was one ha. Stems with diameter at breast height (dbh)as ≥ 1 cm were enumerated, identified and their height measured. The importance value index (IVI) was estimated to show which species have the highest value, since species density was also estimated. We recorded 722 species from 81 genera belonging to 42 families. The highest IVI was recorded for Macaranga hosei *(42.40). It was also the highest in stand density (33 individuals / 4.43 %) in one ha. Species from Euphorbiaceae were represented at the highest level, with 11 genera (about 210 individuals). The total above-ground biomass (TAGB) in one ha using three different modifications from Kato et al. (190.3 t/ha), Kueh and Lim (2522.8 t/ha) and Lim (174.7 t/ha) were noted from family Dipterocarpaceae.*

Keywords: Importance value index; species composition; species diversity; stand density; Ulu Muda Forest Reserve

ABSTRAK

Penyelidikan ini telah dijalankan untuk mengkaji komposisi spesies dan kepelbagaian spesies di Kompartmen 28A, di Hutan Simpan Ulu Muda (UMFR), terletak di barat laut Semenanjung Malaysia. Kawasan yang dikaji ialah satu ha. Batang berdiameter pada paras dada (dbh) pada ≥ 1 cm telah dikira, dicam dan ketinggiannya diukur. Indeks Nilai Kepentingan (IVI) telah dianggarkan untuk menunjukkan spesies yang mempunyai nilai tertinggi, kerana kepadatan spesies turut dianggarkan. Data merekodkan 722 spesies daripada 81 genus tergolong kepada 42 famili. IVI tertinggi telah direkodkan untuk Macaranga hosei *(42.40). Ia juga tertinggi bagi kepadatan dirian (33 individu/ 4.43%) dalam satu hektar. Spesies daripada Euphorbiaceae diwakili paling tinggi dengan 11 genus (210 individu). Jumlah biojisim atas tanah dengan menggunakan ubahsuaian yang berbeza kepada Kato et al. (190.3 t/ha), Kueh dan Lim (2522.8 t/ha) dan Lim (174.7 t/ha) telah didapati bagi Dipterocarpaceae.*

Kata kunci: Hutan Simpan Ulu Muda; indeks nilai kepentingan; kepadatan dirian; kepelbagaian spesies; komposisi spesies

INTRODUCTION

Tropical rainforests have higher species diversity especially in Peninsular Malaysia. A perusal of the previous studies have revealed that the biodiversity investigations have been undertaken to assess species richness, diversity and similarity of various forest ecosystems (Faridah-Hanum et al. 2001a, 2001b; Rusea et al. 2001). Species diversity in the tropics varies dramatically from place to place (Pitman et al. 2002) and much attention has been given to tropical forests due to their species richness (Whitmore 1984), high standing biomass (Bruenig 1983) and greater productivity (Jordan 1983).

Ulu Muda Forest Reserve (UMFR), located in the north-west of Peninsular Malaysia, is an outstanding area for wildlife conservation and nature tourism. From 1948 to 1989 most part of Ulu Muda was delimited as 'restricted area'. The UMFR was gazetted in 1932 as a permanent forest reserve and it remains till now just as impermeable to most of us as it was then. The forest covers an area of approximately 160000 ha (about twice the size of Perlis), located within the district of Baling, Padang Terap and Sik in the north-eastern corner of the Kedah interior border with Thai province of Yala. It contributes about half of the forest cover of Kedah (Table 1).

TABLE 1. Forest Reserve (FR) in Ulu Muda

Name of Forest Reserve (FR)	Area (ha)
Ulu Muda FR	105060
Pedu FR	15299
Padang Terap FR	12785
Proposed Bukit Keramat FR	10226
Chabar Besar FR	8827
Proposed Bukit Saiong FR	8191
Chabar Kecil FR	1184
Proposed Ulu Muda FR (Addition)	1359
Total	162931

According to Nizam and Zakaria (2005), Malaysian forests harbour a very large portion of diversity and forests have an important role in the socio-economic development of country as well as environmental conservation. Abdul Rashid (2005) reported that, total forested area in Peninsular Malaysia is 44.7% of its land area. There are 16 types of forests, based on altitude and soil types from coastal areas to the mountain (Whitmore & Sayar 1992). The main forest types found at Ulu Muda are; the Lowland Dipterocarp Forest, Hill Dipterocarp Forest and the Upper Hill Dipterocarp Forest.

Natural and semi-natural tropical rain forests are structurally stable, maintaining an approximately logarithmic decline in numbers of trees with increasing size. This kind of size-class distribution is the consequence of forest dynamics, in which the available space restricts the number of trees that can be accommodated in any size class. Continuous tree mortality (at about 1-2% annually) permits further growth of the surviving trees and recruitment of new trees (Swaine & Lieberman 1987).

Mortality rates among trees greater than 5 cm dbh are independent of tree size, as large trees are no more at risk of death as compared with the small trees. Latter are more numerous, however, most deaths create small gaps without opening the upper canopy. Studies of forest dynamics based on gaps with openings in the upper canopy, generally ignore the great majority of disturbances in the forest.

The features of forest dynamics outlined above also appear to apply to individual species populations and two groups of ecologically similar species. Growth autocorrelation and growth related mortality occurs in small statured understory species as well as in those capable of forming the upper canopy.

Understanding the species composition and diversity can enlighten our knowledge of newer species as well as their behaviour in a particular forest type. Previously the data about the Hill dipterocarp forest has not been explored fully. In this investigation, we have studied the species composition and diversity of UMFR (compartment 28a) for one ha and also calculated the biomass.

Materials and Methods

STUDY SITE

The study site was located at the Ulu Muda Forest Reserve (UMFR), Kedah. The total area of UMFR is 160000 ha (about twice the size of Perlis) located within the district of Baling, Padang Terap and Sik in the north-eastern corner of the Kedah interior border with the Thai province of Yala. The study covered one ha from the total area in Ulu Muda Forest Reserve, focusing on compartment 28a with coordinates 332194 and 648546.

FIELD SURVEYS AND DATA COLLECTION

For each plot, one ha size of the main plot was established. The plot size was 50 m × 20 m. These were placed along a transect line. The total number of plots were 10, all in compartment 28a. The distance between two plots along the transect line was 50 m. The degree of baseline was 83°, and for the transect line on the left side it was 353° and to the right side 173°. The elevation for one ha study area was around 550 m above the mean sea level. The following parameters were recorded; the diameter of breast height (dbh) which is dbh ≥ 1 cm, tree height, name of species and number of species.

STATISTICAL ANALYSIS

The species composition and diversity were calculated by including Important Value Index (IVI) which describes the species composition. It was calculated as the sum of three variables (Curtis & McIntosh 1951). IVI was measured as follows: IVI = RD + RF + RD_o; where RD_o is the total basal area for a species/total basal area all species × 100, RD is the number of individuals of species/total number of individuals × 100 and RF is the frequency of a species/sum frequencies all species × 100.

Biomass estimation was calculated by using three equations modified from Kato et al. (1978), Roland and Lim (1999) and Lim (1986) and biomass value determined. According to Roland and Lim (1999), there are three variable parts for calculating the biomass using the parameters diameter at breast height (DBH) and height (H), then the total biomass is estimated as: $W_T = W_S + W_B + W_L$:

Stem weight-DBH regression,

$$W_S = 0.313*(Dbh^2H)^{0.9733}$$

where W_s is stem biomass (kg), Branch weight-DBH regression,

$$W_B = 0.0390*(Dbh^2H)^{1.041}$$

where W_B is branch biomass (kg) Leaf weight-Stem weight allometry,

$$1/W_L = 1/0.124*(W_S^{0.794}) + 1/125$$

where $1/W_L$ is leaf biomass (kg) and W_s is stem biomass (kg).

The modified equation in Kato et al. (1978) as follows; $Y = 0.2544*(Dbh)^{2.3684}$ and Lim (1988) as follow; $Y = 0.0380*(Dbh)^{2.8320}$ where Y is biomass (kg) and diameter breast height (cm).

Results

SPECIES COMPOSITION

In UMFR, there are 722 individuals of trees with dbh ≥ 1 cm representing 81 genera from 42 families in one ha (Table 2). The largest family is represented by Euphorbiaceae

TABLE 2. Species composition in 1 ha plot of Ulu Muda Forest Reserve

Family	Species name	Vernacular name
Anacardiaceae	*Bouea macrophylla*	Kundang Daun Besar
Anacardiaceae	*Swintonia floribunda*	Merpauh
Annonaceae	*Monocarpia marginalis*	Mempisang
Annonaceae	*Polyalthia cauliflora*	Mempisang
Annonaceae	*Polyalthia cinnamomea*	Mempisang
Annonaceae	*Popowia pisocarpa*	Mempisang
Apocynaceae	*Kibatalia maingayi*	Jelutong Pipit
Aquifoliaceae	*Ilex sclerophlloides*	Mensirah
Araliaceae	*Arthrophyllum diversifolium*	-
Bombacaceae	*Durio zibethinus*	Durian
Burseraceae	*Canarium littorale*	Kedondong
Burseraceae	*Dacryodes rubiginosa*	Kedondong
Burseraceae	*Santiria rubiginosa*	Kedondong
Burseraceae	*Santiria tomentosa*	Kedondong
Celastraceae	*Kokoona littoralis*	Mata Ulat
Dilleniaceae	*Dillenia grandiflora*	Simpoh Daun Merah
Dilleniaceae	*Dillenia reticulata*	Simpoh Gajah
Dilleniaceae	*Dillenia ovata*	Simpoh Beludu
Dipterocarpaceae	*Hopea odorata*	Merawan Siput Jantan
Dipterocarpaceae	*Shorea curtisii*	Meranti Seraya
Dipterocarpaceae	*Shorea macroptera*	Meranti Melantai
Dipterocarpaceae	*Shorea parvifolia*	Meranti Sarang Punai
Ebenaceae	*Diospyros areolata*	Kayu Arang
Ebenaceae	*Diospyros buxifolia*	Kayu Arang
Ebenaceae	*Diospyros scortechinii*	Kayu Arang
Elaeocarpaceae	*Elaeocarpus griffithii*	Mendong
Elaeocarpaceae	*Elaeocarpus petiolatus*	Mendong
Euphorbiaceae	*Antidesma orthogyne*	Bruni
Euphorbiaceae	*Aporusa aurea*	Sebasah
Euphorbiaceae	*Aporusa bentamiana*	Sebasah
Euphorbiaceae	*Aporusa blume*	Sebasah
Euphorbiaceae	*Baccaurea griffithii*	Rambai
Euphorbiaceae	*Croton caudatus*	-
Euphorbiaceae	*Croton leavifolius*	-
Euphorbiaceae	*Drypetes pendula*	Lidah-Lidah
Euphorbiaceae	*Elateriospermum tapos*	Perah
Euphorbiaceae	*Epiprinus malayanus*	Scarlet Oak
Euphorbiaceae	*Macaranga gigantea*	Mahang
Euphorbiaceae	*Macaranga hosei*	Mahang
Euphorbiaceae	*Macaranga hypoleuca*	Mahang
Euphorbiaceae	*Macaranga recurvata*	Mahang
Euphorbiaceae	*Macaranga triloba*	Mahang
Euphorbiaceae	*Mallotus griffithianus*	Balek Angin
Euphorbiaceae	*Mallotus kingii*	Balek Angin

(continue)

Continued (TABLE 2)

Family	Species name	Vernacular
Euphorbiaceae	*Mallotus oblongifolius*	Balek Angin
Euphorbiaceae	*Sapium baccatum*	Ludai
Euphorbiaceae	*Vitex pinnata*	Leban
Fabaceae	*Dialium kingii*	Keranji Bulu
Fabaceae	*Archidendron contortum*	Kerdas
Fabaceae	*Archidendron ellipticum*	Kerdas
Fabaceae	*Archidendron splendens*	Kerdas
Fagaceae	*Castanopsis curtisii*	Berangan Babi
Fagaceae	*Lithocarpus kunstleri*	Mempening
Fagaceae	*Lithocarpus lucidus*	Mempening
Fagaceae	*Lithocarpus maingayi*	Mempening
Lauraceae	*Cinnamomum rhyncophyllum*	Medang
Lauraceae	*Cryptocarya tomentosa*	Medang
Lauraceae	*Litsea myristicaefolia*	Medang
Lauraceae	*Dehaasia pauciflora*	Medang
Lauraceae	*Litsea curtisii*	Medang
Lecythidaceae	*Barringtonia acutagula*	Putat
Lecythidaceae	*Barringtonia scortechinii*	Putat
Lecythidaceae	*Barringtonia pendula*	Putat
Lecythidaceae	*Parkia speciosa*	Petai
Leguminosae	*Cynometra malaccensis*	Kekatong
Leguminosae	*Intsia palembanica*	Merbau
Leguminosae	*Koompassia malaccensis*	Kempas
Linaceae	*Ixonanthes icosandra*	Pagar Anak
Loganiaceae	*Fagraea fragrans*	Tembusu Padang
Melastomataceae	*Memecylon oligoneurum*	Nipis Kulit
Meliaceae	*Aglaia elliptica*	Bekak
Meliaceae	*Aglaia rubiginosa*	Bekak
Meliaceae	*Aglaia forbesii*	Bekak
Meliaceae	*Aglaia hernii*	Bekak
Meliaceae	*Aglaia tomentosa*	Bekak
Meliaceae	*Aphanamixis sumatrana*	-
Meliaceae	*Chisocheton macrophyllus*	-
Meliaceae	*Chisocheton patens*	-
Meliaceae	*Sandoricum koetjape*	Sentul
Moraceae	*Artocarpus anisophyllus*	Cempedak
Moraceae	*Artocarpus lanceifolius*	Cempedak
Moraceae	*Artocarpus scortechinii*	Cempedak
Moraceae	*Cyathocalyx sumatranus*	Antoi
Moraceae	*Ficus seyet*	Ara
Moraceae	*Ficus laevis*	Ara
Myristicaceae	*Gymnacranthera forbesii*	Penarahan
Myristicaceae	*Horsfieldia macrocoma*	Penarahan
Myristicaceae	*Horsfieldia sucosa*	Penarahan

(continue)

Continued (TABLE 2)

Family	Species name	Vernacular name
Myristicaceae	*Knema hookeriana*	Penarahan
Myristicaceae	*Knema intermedia*	Penarahan
Myrsinaceae	*Ardisia lanceolata*	-
Myrtaceae	*Syzygium kunstleri*	Kelat
Myrtaceae	*Syzygium griffithii*	Kelat
Olacaceae	*Ochanostachys amentacea*	Petaling
Opiliaceae	*Champereia manillana*	Cemperai
Polygalaceae	*Xanthophyllum kunstleri*	Minyak Berok
Polygalaceae	*Xanthophyllum rufum*	Minyak Berok
Polygalaceae	*Xanthophyllum affine*	Minyak Berok
Rhizophoraceae	*Gynotroches axillaris*	Mata Keli
Rhizophoraceae	*Pellacalyx axillaris*	Membuluh
Rubiaceae	*Aidia wallichiana*	Menterbang
Rubiaceae	*Diplospora kunstleri*	Gading-Gading
Rubiaceae	*Diplospora malaccensis*	Gading-Gading
Rubiaceae	*Porterandia anisophylla*	Tinjau Belukar
Salicaceae	*Salix tetrasperma*	Dedali India
Sapindaceae	*Lepisanthes rubiginosa*	Mertajam
Sapindaceae	*Nephelium humulatum*	Rambutan
Sapindaceae	*Paranephelium macrophyllum*	Rambutan
Sapotaceae	*Payena lanceolata*	Nyatoh Ekor
Sapotaceae	*Payena maingayi*	Nyatoh Durian
Sapotaceae	*Pouteria malaccensis*	Nyatoh Nangka Kuning
Sapotaceae	*Pouteria paucinervia*	Nyatoh
Sapotaceae	*Pouteria malaccensis*	Nyatoh Nangka Kuning
Sterculiaceae	*Scaphium macropodum*	Kembang Semangkuk Jantung
Styracaceae	*Styrax benzoin*	Kemenyan
Symplocaceae	*Symplocos barringtoniifolia*	-
Symplocaceae	*Symplocos adenophylla*	-
Thymelaeaceae	*Gonystylus affinis*	Ramin
Thymelaeaceae	*Gonystylus confusus*	Ramin
Tiliaceae	*Microcos sp.*	Chenderai
Tiliaceae	*Microcos tomentosa*	Chenderai
Tiliaceae	*Pentace strychnoidea*	Melunak
Ulmaceae	*Gironiera subequalis*	Hampas Tebu
Ulmaceae	*Gironniera nervosa*	Hampas Tebu
Verbenaceae	*Teijsmanniodendron coriaceum*	Leban
Verbenaceae	*Vitex siamica*	Leban
Verbenaceae	*Vitex vestita*	Leban
Violaceae	*Rinorea anguifera*	-

with 11 genera, 20 species (210 trees) e.g. *Antidesma orthogyne, Aporusa aurea, A. benthamina, A. blumei, Baccaurea griffithii, Croton candatus, C. leavifolius, Drypetes pendula, Elateriospermum tapos, Epiprinus malayanus, Macaranga gigantea, M. hosei, M. hypoleuca, M. recurvata, M. triloba, Mallotus griffithianum, M. kingii, M. oblongifolius, Sapium baccatum* and *Vitex pinnata*. Species from Annonaceae are the second highest, with 3

genera, 4 species (around 67 trees) namely; *Monocarpia marginalis*, *Polyalthia cauliflora*, *P. cinnamomea* and *Popowia pisocarpa*.

STAND DENSITY IN ONE HA PLOT

Total stand density for one ha UMFR was 722 trees/ ha (Table 3). *Macaranga hosei* contributed 4.57% (33 tress/ ha) of the total number of trees, followed by *Polyalthia cauliflora* which contributed 4.43% (32 trees/ha) and *Macaranga hosei* (0.40 m^2/ha) had higher basal area (BA) than *Polyalthia cauliflora* (0.26 m^2/ha).

IMPORTANT VALUE INDEX (IVI) BY SPECIES IN ONE HA PLOT

The important value index (IVI) was used to describe the species composition of the plots (Table 4). *Macaranga hosei* contributed 42.40, meaning the basal area of the *Macaranga hosei* was higher than other species for this one ha plot, which contributed to the high IVI.

TABLE 3. Stand density in 1 ha plot at Ulu Muda Forest Reserve

Family	Species name	Stand density (no. stem/ha)	Percentage (%)
Euphorbiaceae	*Macaranga hosei*	33	4.57
Annonaceae	*Polyalthia cauliflora*	32	4.43
Euphorbiaceae	*Mallotus griffithianus*	27	3.74
Annonaceae	*Monocarpia marginalis*	23	3.19
Euphorbiaceae	*Macaranga gigantea*	23	3.19
Fabaceae	*Archidendron ellipticum*	21	2.91
Olacaceae	*Ochanostachys amentacea*	21	2.91
Euphorbiaceae	*Mallotus kingii*	19	2.63
Meliaceae	*Aglaia forbesii*	19	2.63
Dipterocarpaceae	*Shorea macroptera*	17	2.35
Euphorbiaceae	*Antidesma orthogyne*	17	2.35
Myrtaceae	*Syzygium kunstleri*	16	2.22
Fabaceae	*Archidendron splendens*	15	2.08
Euphorbiaceae	*Macaranga hypoleuca*	14	1.94
Euphorbiaceae	*Aporusa aurea*	13	1.80
Euphorbiaceae	*Epiprinus malayanus*	12	1.66
Polygalaceae	*Xanthophyllum kunstleri*	12	1.66
Sapotaceae	*Pouteria malaccensis*	12	1.66
Euphorbiaceae	*Vitex pinnata*	11	1.52
Sapotaceae	*Payena lanceolata*	11	1.52
Verbenaceae	*Vitex vestita*	11	1.52
Burseraceae	*Canarium littorale*	10	1.39
Thymelaeaceae	*Gonystylus affinis*	10	1.39
Meliaceae	*Aphanamixis sumatrana*	9	1.25
Myristicaceae	*Knema hookeriana*	9	1.25
Sapotaceae	*Pouteria malaccensis*	9	1.25
Annonaceae	*Polyalthia cinnamomea*	8	1.11
Burseraceae	*Dacryodes rubiginosa*	8	1.11
Euphorbiaceae	*Sapium baccatum*	8	1.11
Meliaceae	*Aglaia hernii*	8	1.11
Euphorbiaceae	*Croton leavifolius*	7	0.97
Fagaceae	*Lithocarpus kunstleri*	7	0.97
Polygalaceae	*Xanthophyllum affine*	7	0.97
Sapotaceae	*Pouteria paucinervia*	7	0.97
Ebenaceae	*Diospyros scortechinii*	6	0.83

(continue)

Continued (TABLE 3)

Family	Species name	Stand density (no. stem/ha)	Percentage (%)
Elaeocarpaceae	*Elaeocarpus griffithii*	6	0.83
Elaeocarpaceae	*Elaeocarpus petiolatus*	6	0.83
Euphorbiaceae	*Macaranga recurvata*	6	0.83
Euphorbiaceae	*Baccaurea griffithii*	6	0.83
Rubiaceae	*Diplospora malaccensis*	6	0.83
Dilleniaceae	*Dillenia grandiflora*	5	0.69
Lauraceae	*Litsea curtisii*	5	0.69
Lauraceae	*Litsea myristicaefolia*	5	0.69
Lecythidaceae	*Barringtonia pendula*	5	0.69
Myristicaceae	*Horsfieldia sucosa*	5	0.69
Symplocaceae	*Symplocos barringtoniifolia*	5	0.69
Ulmaceae	*Gironera subequalis*	5	0.69
Annonaceae	*Popowia pisocarpa*	4	0.55
Burseraceae	*Santiria tomentosa*	4	0.55
Dipterocarpaceae	*Shorea parvifolia*	4	0.55
Ebenaceae	*Diospyros buxifolia*	4	0.55
Euphorbiaceae	*Drypetes pendula*	4	0.55
Euphorbiaceae	*Macaranga triloba*	4	0.55
Euphorbiaceae	*Croton caudatus*	4	0.55
Lecythidaceae	*Barringtonia scortechinii*	4	0.55
Meliaceae	*Chisocheton macrophyllus*	4	0.55
Meliaceae	*Aglaia rubiginosa*	4	0.55
Meliaceae	*Aglaia elliptica*	4	0.55
Rubiaceae	*Porterandia anisophylla*	4	0.55
Sapindaceae	*Paranephelium macrophyllum*	4	0.55
Verbenaceae	*Teijsmanniodendron coriaceum*	4	0.55
Dipterocarpaceae	*Hopea odorata*	4	0.55
Anacardiaceae	*Swintonia floribunda*	3	0.42
Ebenaceae	*Diospyros areolata*	3	0.42
Euphorbiaceae	*Elateriospermum tapos*	3	0.42
Euphorbiaceae	*Aporusa blumei*	3	0.42
Euphorbiaceae	*Mallotus oblongifolius*	3	0.42
Fagaceae	*Lithocarpus lucidus*	3	0.42
Meliaceae	*Chisocheton patens*	3	0.42
Meliaceae	*Aglaia tomentosa*	3	0.42
Moraceae	*Artocarpus lanceifolius*	3	0.42
Moraceae	*Cyathocalyx sumatranus*	3	0.42
Moraceae	*Ficus laevis*	3	0.42
Myristicaceae	*Gymnacranthera forbesii*	3	0.42
Rubiaceae	*Diplospora kunstleri*	3	0.42
Apocynaceae	*Kibatalia maingayi*	3	0.42
Anacardiaceae	*Bouea macrophylla*	2	0.28
Dilleniaceae	*Dillenia reticulata*	2	0.28
Fagaceae	*Castanopsis curtisii*	2	0.28

(continue)

Continued (TABLE 3)

Family	Species name	Stand density (no. stem/ha)	Percentage (%)
Fagaceae	*Lithocarpus maingayi*	2	0.28
Lauraceae	*Dehaasia pauciflora*	2	0.28
Lecythidaceae	*Parkia speciosa*	2	0.28
Lecythidaceae	*Barringtonia acutagula*	2	0.28
Leguminosae	*Intsia palembanica*	2	0.28
Melastomataceae	*Memecylon oligoneurum*	2	0.28
Myristicaceae	*Knema intermedia*	2	0.28
Rhizophoraceae	*Gynotroches axillaris*	2	0.28
Rubiaceae	*Aidia wallichiana*	2	0.28
Sapindaceae	*Nephelium humulatum*	2	0.28
Sapindaceae	*Lepisanthes rubiginosa*	2	0.28
Sapotaceae	*Payena maingayi*	2	0.28
Sterculiaceae	*Scaphium macropodum*	2	0.28
Apocynaceae	*Kibatalia maingayi*	1	0.14
Aquifoliaceae	*Ilex sclerophlloides*	1	0.14
Araliaceae	*Arthrophyllum diversifolium*	1	0.14
Bombacaceae	*Durio zibethinus*	1	0.14
Burseraceae	*Santiria rubiginosa*	1	0.14
Celastraceae	*Kokoona littoralis*	1	0.14
Dilleniaceae	*Dillenia ovata*	1	0.14
Dipterocarpaceae	*Shorea curtisii*	1	0.14
Euphorbiaceae	*Aporusa benthamiana*	1	0.14
Fabaceae	*Archidendron contortum*	1	0.14
Lauracea	*Cryptocarya tomentosa*	1	0.14
Lauracea	*Cinnamomum rhyncophyllum*	1	0.14
Leguminosae	*Koompassia malaccensis*	1	0.14
Leguminosae	*Cynometra malaccensis*	1	0.14
Fabaceae	*Dialium kingii*	1	0.14
Linaceae	*Ixonanthes icosandra*	1	0.14
Loganiaceae	*Fagraea fragrans*	1	0.14
Meliaceae	*Sandoricum koetjape*	1	0.14
Moraceae	*Artocarpus scortechinii*	1	0.14
Moraceae	*Artocarpus anisophyllus*	1	0.14
Moraceae	*Ficus seyet*	1	0.14
Myristicaceae	*Horsefieldia macrocoma*	1	0.14
Myrsinaceae	*Ardisia lanceolata*	1	0.14
Myrtaceae	*Syzygium griffithii*	1	0.14
Opiliaceae	*Champereia manillana*	1	0.14
Polygalaceae	*Xanthophyllum rufum*	1	0.14
Rhizophoraceae	*Pellacalyx axillaris*	1	0.14
Salicaceae	*Salix tetrasperma*	1	0.14
Styracaceae	*Styrax benzoin*	1	0.14
Symplocaceae	*Symplocos adenophylla*	1	0.14
Thymelaeaceae	*Gonystylus confusus*	1	0.14

(continue)

Continued (TABLE 3)

Family	Species name	Stand density (no. stem/ha)	Percentage (%)
Tiliaceae	*Pentace strychnoidea*	1	0.14
Tiliaceae	*Microcos tomentosa*	1	0.14
Tiliaceae	*Microcos* sp.	1	0.14
Ulmaceae	*Gironniera nervosa*	1	0.14
Verbenaceae	*Vitex siamica*	1	0.14
Violaceae	*Rinorea anguifera*	1	0.14
		722	100.00

TABLE 4. Summary of IVI in 1 ha plot at Ulu Muda Forest Reserve

Family	Species name	IVI
Euphorbiaceae	*Macaranga hosei*	42.40
Annonaceae	*Polyalthia cauliflora*	39.26
Euphorbiaceae	*Mallotus griffithianus*	34.21
Euphorbiaceae	*Macaranga gigantea*	32.42
Annonaceae	*Monocarpia marginalis*	31.60
Olacaceae	*Ochanostachys amentacea*	31.39
Fabaceae	*Archidendron ellipticum*	28.23
Euphorbiaceae	*Mallotus kingii*	26.17
Meliaceae	*Aglaia forbesii*	25.22
Dipterocarpaceae	*Shorea macroptera*	23.14
Euphorbiaceae	*Antidesma orthogyne*	23.05
Myrtaceae	*Syzygium kunstleri*	22.48
Fabaceae	*Acidendron splendens*	21.18
Polygalaceae	*Xanthophyllum kunstleri*	21.11
Euphorbiaceae	*Macaranga hypoleuca*	20.22
Euphorbiaceae	*Aporusa aurea*	18.05
Sapotaceae	*Payena lanceolata*	17.24
Myristicaceae	*Knema hookeriana*	16.16
Thymelaeaceae	*Gonystylus affinis*	16.14
Euphorbiaceae	*Sapium baccatum*	15.54
Burseraceae	*Canarium littorale*	15.29
Verbenaceae	*Vitex vestita*	15.06
Euphorbiaceae	*Epiprinus malayanus*	15.03
Euphorbiaceae	*Vitex pinnata*	15.01
Burseraceae	*Dacryodes rubiginosa*	14.10
Sapotaceae	*Pouteria malaccensis*	14.10
Sapotaceae	*Pouteria paucinervia*	13.46
Annonaceae	*Polyalthia cinnamomea*	13.05
Meliaceae	*Aphanamixis sumatrana*	13.05
Fagaceae	*Lithocarpus kunstleri*	11.25
Meliaceae	*Aglaia hernii*	11.01
Euphorbiaceae	*Macaranga recurvata*	10.09
Dipterocarpaceae	*Shorea parvifolia*	9.28
Lauraceae	*Litsea curtisii*	9.20
Dilleniaceae	*Dillenia grandiflora*	9.19
Myristicaceae	*Horsfieldia sucosa*	9.15
Euphorbiaceae	*Baccaurea griffithii*	9.10
Elaeocarpaceae	*Elaeocarpus griffithii*	9.08
Euphorbiaceae	*Croton leavifolius*	9.04
Polygalaceae	*Xanthophyllum affine*	9.02
Dipterocarpaceae	*Hopea odorata*	8.31
Meliaceae	*Chisocheton macrophyllus*	8.18
Ulmaceae	*Gironera subequalis*	8.05
Euphorbiaceae	*Drypetes pendula*	8.04
Rubiaceae	*Diplospora malaccensis*	8.04

(continue)

Continued (TABLE 4)

Family	Spieces name	IVI
Ebenaceae	*Diospyros scortechinii*	8.03
Lecythidaceae	*Barringtonia pendula*	8.01
Elaeocarpaceae	*Elaeocarpus petiolatus*	7.11
Sapindaceae	*Paranephelium macrophyllum*	7.03
Euphorbiaceae	*Macaranga triloba*	7.03
Lauraceae	*Litsea myristicaefolia*	7.02
Fagaceae	*Lithocarpus lucidus*	6.28
Meliaceae	*Aglaia rubiginosa*	6.13
Meliaceae	*Aglaia elliptica*	6.07
Annonaceae	*Popowia pisocarpa*	6.07
Verbenaceae	*Teijsmanniodendron coriaceum*	6.06
Symplocaceae	*Symplocos barringtoniifolia*	6.06
Ebenaceae	*Diospyros buxifolia*	6.06
Rubiaceae	*Porterandia anisophylla*	6.06
Myristicaceae	*Gymnacranthera forbesii*	6.03
Burseraceae	*Santiria tomentosa*	6.03
Lecythidaceae	*Barringtonia scortechinii*	6.01
Moraceae	*Artocarpus lanceifolius*	5.65
Anacardiaceae	*Swintonia floribunda*	5.08
Meliaceae	*Chisocheton patens*	5.06
Euphorbiaceae	*Croton caudatus*	5.04
Apocynaceae	*Kibatalia maingayi*	5.04
Moraceae	*Cyathocalyx sumatranus*	5.03
Euphorbiaceae	*Elateriospermum tapos*	5.03
Euphorbiaceae	*Aporusa blumei*	5.03
Meliaceae	*Aglaia tomentosa*	4.09
Sterculiaceae	*Scaphium macropodum*	4.08
Myristicaceae	*Knema intermedia*	4.07
Sapotaceae	*Pouteria malaccensis*	4.04
Ebenaceae	*Diospyros areolata*	4.03
Rubiaceae	*Diplospora kunstleri*	4.03
Moraceae	*Ficus laevis*	4.02
Dilleniaceae	*Dillenia reticulata*	4.02
Lecythidaceae	*Parkia speciosa*	4.02
Euphorbiaceae	*Mallotus oblongifolius*	4.02
Rubiaceae	*Aidia wallichiana*	4.01
Rhizophoraceae	*Gynotroches axillaris*	4.01
Fagaceae	*Castanopsis curtisii*	3.11
Sapindaceae	*Nephelium humulatum*	3.11
Leguminosae	*Intsia palembanica*	3.10
Anacardiaceae	*Bouea macrophylla*	3.04
Fagaceae	*Lithocarpus maingayi*	3.03
Lauraceae	*Dehaasia pauciflora*	3.02
Melastomataceae	*Memecylon oligoneurum*	3.02
Sapotaceae	*Payena maingayi*	3.02
Sapindaceae	*Lepisanthes rubiginosa*	3.01
Lecythidaceae	*Barringtonia acutagula*	3.01
Moraceae	*Artocarpus scortechinii*	2.19
Myrtaceae	*Syzgium griffithii*	2.14
Leguminosae	*Koompassia malaccensis*	2.11
Dipterocarpaceae	*Shorea curtisii*	2.10
Fabaceae	*Acidendron contartum*	2.09
Salicaceae	*Salix tetrasperma*	2.09
Polygalaceae	*Xanthophyllum sp.*	2.05
Rhizophoraceae	*Pellacalyx axillaris*	2.05
Tiliaceae	*Pentace strychnoidea*	2.05
Myristicaceae	*Horsfieldia macrocoma*	2.04
Linaceae	*Ixonanthes icosandra*	2.04

(continue)

Continued (TABLE 4)

Family	Species name	IVI
Moraceae	*Artocarpus anisophyllus*	2.03
Violaceae	*Rinorea anguifera*	2.02
Meliaceae	*Sandoricum koetjape*	2.02
Tiliaceae	*Microcos tomentosa*	2.02
Celastraceae	*Kokoona littoralis*	2.02
Dilleniaceae	*Dillenia ovata*	2.02
Aquifoliaceae	*Ilex sclerophlloides*	2.02
Lauracea	*Cryptocarya tomentosa*	2.01
Verbenaceae	*Vitex siamica*	2.01
Euphorbiaceae	*Aporusa benthamiana*	2.01
Loganiaceae	*Fagraea fragrans*	2.01
Tiliaceae	*Microcos sp.*	2.01
Bombacaceae	*Durio zibethinus*	2.01
Symplocaceae	*Symplocos adenophylla*	2.01
Moraceae	*Ficus seyet*	2.01
Lauracea	*Cinnamomum rhyncophyllum*	2.00
Leguminosae	*Cynometra malaccensis*	2.00
Burseraceae	*Santiria rubiginosa*	2.00
Myrsinaceae	*Ardisia lanceolata*	2.00
Araliaceae	*Arthrophyllum diversifolium*	2.00
Ulmaceae	*Gironniera nervosa*	2.00
Styracaceae	*Styrax benzoin*	2.00
Thymelaeaceae	*Gonystylus confusus*	2.00
Opiliaceae	*Champereia manillana*	2.00
Fabaceae	*Dialium kingii*	2.00

SPECIES ACCUMULATION CURVE

Species accumulation curve for one ha at UMFR showed an increment of individuals, which was highly significant and stops at the sub-plot 12 which is the last plot in this one ha (Figure 1). However, in the sub-plots 7 and 10, the graph was flat, because this area is too much disturbed and no data was collected.

BIOMASS ESTIMATION IN ONE HA

The performance of biomass on family basis was recorded using modified Kato et al. (1978) equation (Figure 2). Total above ground biomass (TAGB) contributed 190.3 t/ha (Table 5). Family Dipterocarpaceae has the highest above-ground biomass (AGB) than other families which contributed 52.2 t/ha. The performance of biomass value

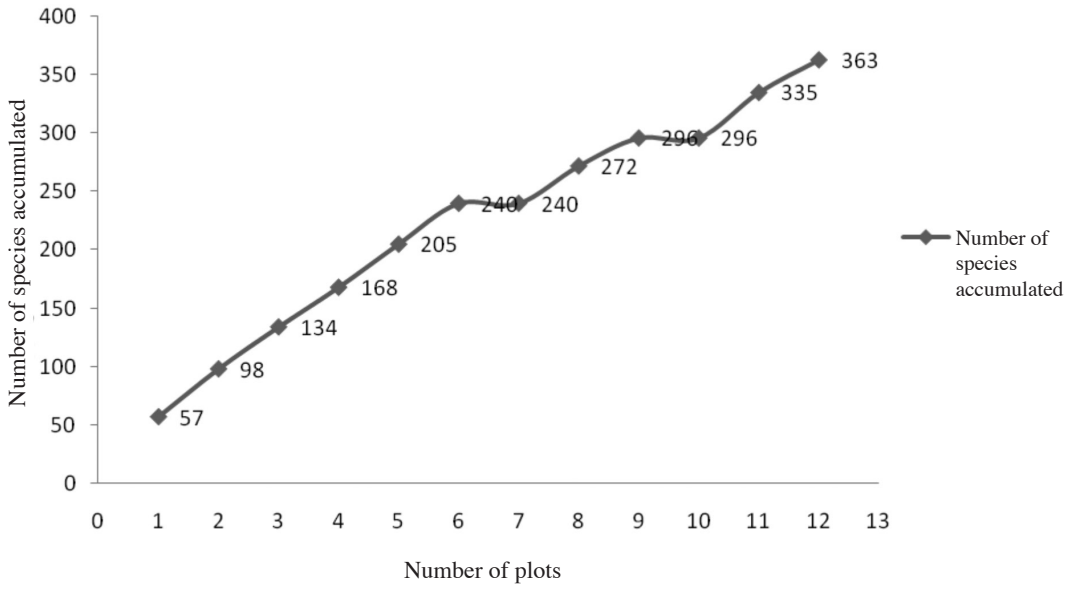

FIGURE 1. Species accumulation curve for 1 ha plot at UMFR

TABLE 5. Biomass for 1 ha plot at UMFR using modified Kato et al. (1978)

Family	No. of individuals	Total biomass/ha	Biomass (t/ha)
Dipterocarpaceae	26	52191.28	52.19
Euphorbiaceae	210	24296.06	24.30
Olacaceae	21	16710.63	16.71
Moraceae	12	13253.06	13.25
Annonaceae	67	9807.84	9.81
Sapotaceae	30	9733.77	9.73
Meliaceae	56	8153.10	8.15
Fagaceae	14	7659.85	7.66
Myrtaceae	17	7508.23	7.51
Fabaceae	37	5406.42	5.41
Myristicaceae	20	4523.80	4.52
Burseraceae	23	4198.44	4.20
Lauraceae	14	2763.05	2.76
Leguminosae	7	2762.37	2.76
Dilleniaceae	8	2495.70	2.50
Sapindaceae	10	2278.39	2.28
Elaeocarpaceae	12	1973.71	1.97
Polygalaceae	20	1670.53	1.67
Thymelaeaceae	11	1522.43	1.52
Anacardiaceae	5	1300.54	1.30
Verbenaceae	24	1201.16	1.20
Rubiaceae	15	1192.24	1.19
Ebenaceae	13	1019.70	1.02
Salicaceae	1	1011.76	1.01
Sterculiaceae	2	868.58	0.87
Tiliaceae	3	792.84	0.79
Lecythidaceae	14	724.73	0.72
Rhizophoraceae	3	605.17	0.61
Symplocaceae	6	595.72	0.60
Ulmaceae	6	489.09	0.49
Linaceae	1	384.51	0.38
Apocynaceae	3	308.61	0.31
Violaceae	1	208.79	0.21
Celastraceae	1	172.94	0.17
Melastomataceae	2	140.12	0.14
Aquifoliaceae	1	131.83	0.13
Loganiaceae	1	91.51	0.09
Bombacaceae	1	72.87	0.07
Myrsinaceae	1	31.02	0.03
Araliaceae	1	29.12	0.03
Styracaceae	1	21.42	0.02
Opiliaceae	1	19.15	0.02
		190322.08	190.32

was implement from modified Roland and Lim (1999) method (Figure 3) and this showed that TAGB was higher than the result from modified Kato equation which is 2522.8 t/ha, but the same result in AGB from family Dipterocarpaceae (473.9 t/ha) was recorded, than other family (Table 6). The performance of biomass using Lim (1986) (Figure 4) showed TAGB contributed 174.7 t/ha and family Dipterocarpaceae has the highest AGB than other family which contributed 74.7 t/ha. The study already covered hill dipterocarp forest which is dominated by the species from this family. We also showed the comparative analysis of biomass using different methods where 10 families has higher AGB (Figures 5 and 6).

DISCUSSION

According to Saiful et al. (2008), about 2421 individuals belonging to 421 species, 187 genera and 57 families cover the total research area of 6.8 ha. The most dominant families were Euphorbiaceae and Dipterocarpaceae. Contribution from Euphorbiaceae was 44 species i.e. 10.5% from total number of species; followed by Lauraceae with 30 species 7.1%, Mytraceae 24 species with 5.7% and Annonaceae 22 species with 5.2% from the total number of species. Euphorbiaceae was mainly confined to the understory with medium-sized trees which did not generally exceed 50 cm dbh and family Dipterocarpaceae was the most abundant family in the overstory canopy (Saiful et al. 2008).

TABLE 6. Biomass for 1 ha plot at UMFR using Roland and Lim (1999)

Family	No of individual	dbh	height	Stem biomass (Ws)	Branch biomass (Wb)	Leaf biomass (1/WL)	Total biomass (WT)	Sum biomass (WT)	t/ha
Dipterocarpaceae	26	16	13	838.9	181.0	1690.4	2710.2	473873.9	473.9
Euphorbiaceae	210	3	2	5.2	0.8	29.9	35.9	340673.6	340.7
Olacaceae	21	31.5	22	5232.8	1282.4	7231.9	13747.1	229102.6	229.1
Moraceae	12	13	9	391.5	80.1	923.0	1394.6	153026.0	153.0
Annonaceae	67	18.5	15	1279.1	284.2	2363.0	3926.3	144475.0	144.5
Meliaceae	56	16.2	15	987.8	215.6	1924.7	3128.0	120923.2	120.9
Sapotaceae	30	16.3	13	869.7	188.1	1739.6	2797.5	116269.7	116.3
Fagaceae	14	15.4	9.5	573.8	120.6	1250.4	1944.9	102154.2	102.2
Myrtaceae	17	20.2	18	1812.6	412.6	3116.5	5341.7	94174.6	94.2
Fabaceae	37	5.6	5	42.9	7.5	159.5	209.9	79447.7	79.4
Celastraceae	20	15.7	16	989.6	216.0	1927.4	3133.0	63574.6	63.6
Burseraceae	23	12.8	15	624.5	132.0	1337.3	2093.8	61262.5	61.3
Myristicaceae	14	15.4	9	544.4	114.0	1199.3	1857.7	57126.8	57.1
Lauraceae	7	37.5	25	8320.9	2106.0	10451.8	20878.7	42833.2	42.8
Loganiaceae	8	12	10	371.2	75.7	884.8	1331.6	41904.1	41.9
Linaceae	10	22	18	2140.2	492.9	3556.0	6189.1	41218.5	41.2
Dilleniaceae	12	14.5	9.5	510.4	106.4	1139.3	1756.0	38533.7	38.5
Leguminosae	20	8.5	8	152.7	29.3	437.0	618.9	37615.5	37.6
Sapindaceae	11	20.9	16	1727.1	391.8	2999.2	5118.1	34677.3	34.7
Elaeocarpaceae	5	9.2	13	285.7	57.2	718.7	1061.5	30551.0	30.6
Polygalaceae	24	3.5	5	17.2	2.8	77.1	97.1	25085.4	25.1
Thymelaeaceae	15	6.5	5	57.3	10.3	200.8	268.3	21396.4	21.4
Anacardiaceae	13	6.5	7	79.5	14.6	260.4	354.5	20352.2	20.4
Rubiaceae	1	24	23	3218.3	762.5	4916.3	8897.1	19875.6	19.9
Verbenaceae	2	2.4	3	5.0	0.8	29.0	34.8	19642.7	19.6
Salicaceae	3	33.1	25.2	6577.0	1637.6	8671.4	16886.0	16886.0	16.9
Sterculiaceae	14	8	10	168.6	32.5	472.8	673.9	14182.0	14.2
Ebenaceae	3	4	3	13.5	2.2	63.9	79.6	13108.7	13.1
Tiliaceae	6	25	18	2744.9	643.2	4332.8	7720.9	11769.1	11.8
Rhizophoraceae	6	25.5	18	2852.8	670.2	4467.5	7990.5	9410.3	9.4
Lecythidaceae	1	7	4.5	59.8	10.7	207.5	278.0	8178.4	8.2
Symplocaceae	3	10.5	11.5	327.9	66.3	801.9	1196.1	7917.4	7.9
Ulmaceae	1	7	8	104.6	19.5	323.7	447.8	7213.8	7.2
Aquifoliaceae	1	14	11	549.8	115.2	1208.6	1873.6	6451.7	6.5
Apocynaceae	2	8.5	8	152.7	29.3	437.0	618.9	4943.4	4.9
Bombacaceae	1	10.9	14	427.1	87.9	989.1	1504.1	3817.2	3.8
Araliaceae	1	7.4	7	102.4	19.1	318.1	439.6	2932.1	2.9
Violaceae	1	17	12.5	908.6	197.1	1801.0	2906.7	2906.7	2.9
Melastomataceae	1	11.7	8	284.3	56.9	716.0	1057.3	2048.2	2.0
Styracaceae	1	6.5	12	134.4	25.5	394.9	554.8	554.8	0.6
Myrsinaceae	1	7.6	6	92.8	17.2	294.3	404.3	404.3	0.4
Opiliaceae	1	6.2	6	62.4	11.2	214.8	288.5	288.5	0.3
	722							2522782.6	2522.8

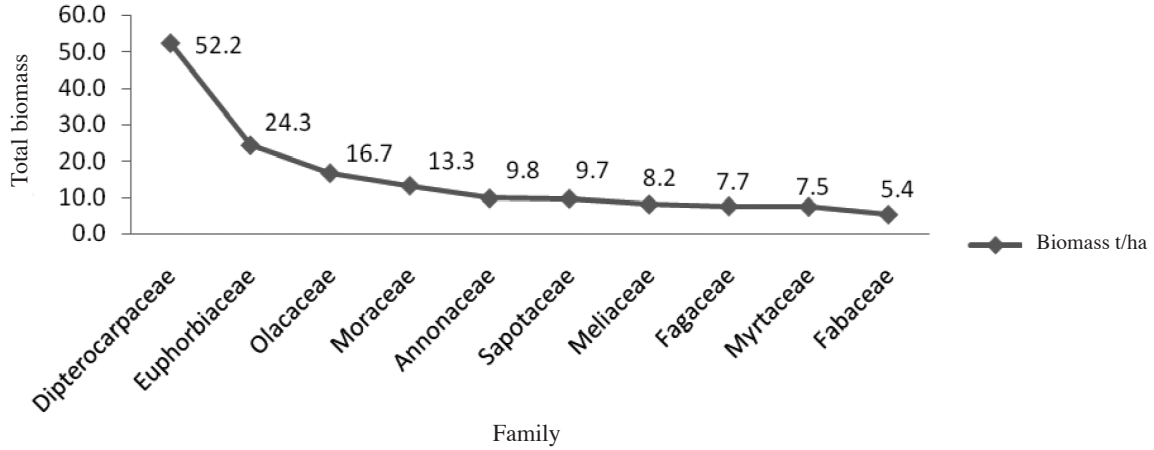

FIGURE 2. Performance by 10 family with higher value biomass using modified Kato et al. (1978)

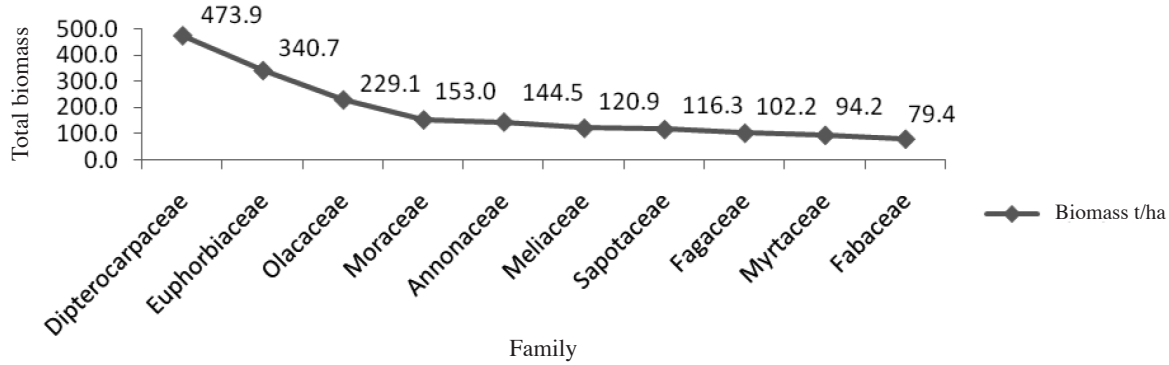

FIGURE 3. Performance by 10 family with higher value biomass using Roland and Lim (1999)

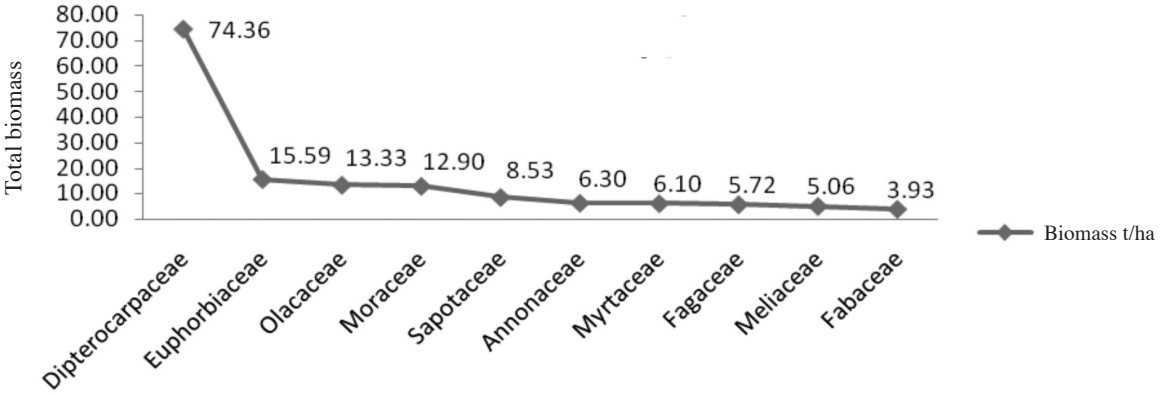

FIGURE 4. Performance by 10 families with higher value biomass using Lim (1988)

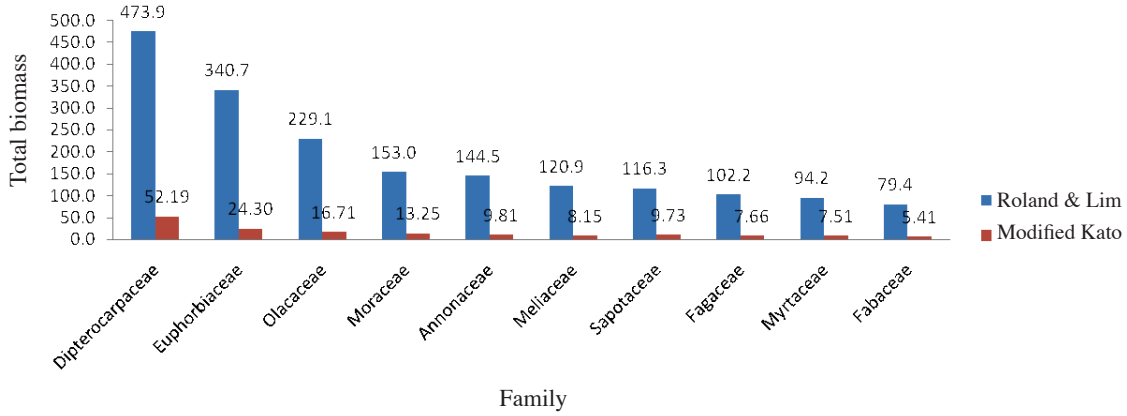

FIGURE 5. Comparative analysis of biomass (Roland & Lim 1999 vs Kato et al. 1978)

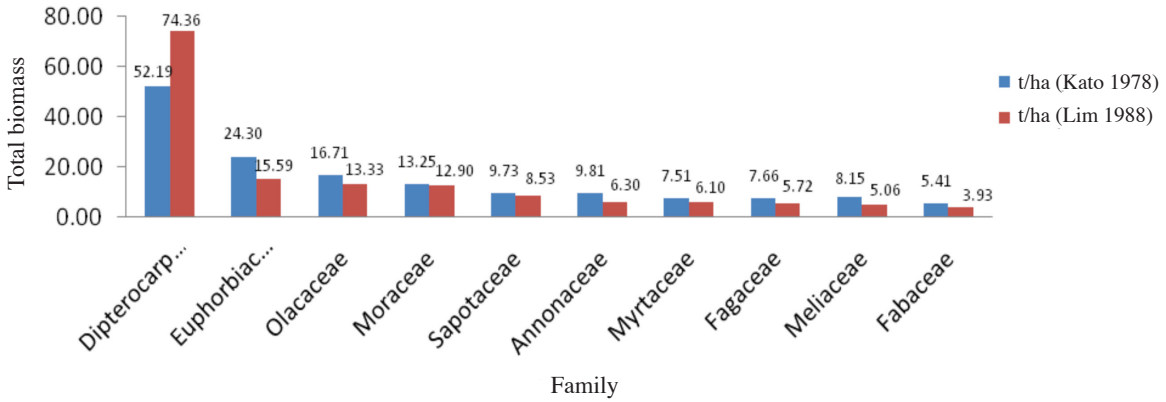

FIGURE 6. Comparative analysis of biomass (Kato et al. 1978 vs Lim 1988)

IVI is the sum of relative density, relative dominance and relative frequency which is significant for each species in data in a study plot. The index is used to determine the overall importance of each species in the community structure (Curtis & McIntosh 1951). Total basal area for every species was calculated from the sum of total dbh by using the formula $\pi d^2/40000$ (m^2/ha). According to Gibbs (1966), the number of plants within the quadrats (abundance), its influence on the other species through its competition, shading or aggressiveness (dominance), and its contribution to the community via its distribution (frequency) is very important.

According to Roberts-Pichette and Gillespie (2001), sampling is sufficient when no or very few species are added with each successive quadrat that is sometimes after the curve starts to flatten. According to Seaby and Henderson (2007), when a species accumulation curve approaches an asymptote, it shows that sampling is adequate to collect most of the species present; the asymptotic value is measure of the total species complement. Species richness in rain forest continue to accumulate even over 4-5 ha survey area particularly of those species, which are determined by habitat conditions or by chance (Poore 1968).

Biomass is a function of density of stems and height of trees in a given location. A contribution of these parameters to the above ground biomass differs with sites, successional stage of the forest and species composition (Brunig 1983; Whitmore 1984). According to Suzuki and Tagawa (1983), TAGB is greatly affected by density, basal area and height.

CONCLUSION

The rainforest at UMFR, Kedah has a higher exchange in the form of composition of species. Many species are light demanding and grow fast in this area, due to too much gap in the forest. This is because of the impact of previous unsupervised logging. The total number of species recorded from this one ha study clearly enlightens the distribution

of hill dipterocarp forest and its base from the elevation. UMFR is still a virgin forest and Forest Department now tries to manage this forest to maintain its vegetation and species richness.

ACKNOWLEDGMENTS

This study has been partly supported by the research grant 'Tree species composition, diversity, structure and physical environment in Ulu Muda Forest Reserve, Kedah 8-years after conventional logging methods' (Research Grant No: 9199757).

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Received: 10 March 2013
Accepted: 12 May 2013