

Diversity of the tree flora in Semenggoh Arboretum, Sarawak, Borneo

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ABSTRACT. A 4-ha sample plot was established at the Arboretum, Semenggoh Forest Reserve to document tree species in this lowland mixed dipterocarp forest. The area assessed contains 2837 trees with diameter at breast height ≥ 10 cm belonging to 60 families, 160 genera and 541 species. Euphorbiaceae and Malvaceae (10 genera each) were the most diverse families at genus level and Dipterocarpaceae (61 species) is most diverse at species level. More than 25% of trees (720 individuals) were dipterocarps and contributed the highest basal area (cross-sectional area over-bark at breast height measured in m²) of 16.7 m²/ha. The most abundant species are *Shorea multiflora* (21 trees/ha) and *Pouteria malaccensis* (31 trees/ha) for dipterocarp and non-dipterocarp species, respectively. Semenggoh Arboretum has a rich and diverse flora and, being a natural primary forest in the middle of an increasingly developed area, Semenggoh is important as a genetic reservoir for threatened species (particularly the dipterocarps) and as an *in-situ* conservation site for Sarawak's lowland mixed dipterocarp forest.

Keywords. Borneo, Dipterocarpaceae, Sarawak, Semenggoh Arboretum, tree diversity

Introduction

Floristic composition studies or floristic analyses are a useful tool to understand the spatial pattern of plant composition and diversity. When combined with ecological, environmental, geological and historical variables, important information on mechanisms maintaining high levels of tree species diversity in tropical forest can be obtained (Slik et al. 2003). For that reason, a floristic composition study is the prerequisite study, in order to determine the species richness and diversity of a selected area. Conducting long-term studies is the only way to understand the dynamics of forest ecosystem due to slow-growing and long-lived trees and numerous long-term study sites were set up in many forests, including in Asia (Condit et al. 2000, Lee et al. 2004, Primack & Hall 1992).

Borneo, of which Sarawak is a part, is renowned for its rich and diverse flora comprising of about 3500–5000 tree species (Soepadmo 1995, Soepadmo & Chung 1997). Semenggoh Forest Reserve is Sarawak's oldest forest reserve constituted in 1920, comprising an area of 653 ha (Forest Department Sarawak 2000). It includes an arboretum, a wildlife rehabilitation centre and a botanical research centre. The Semenggoh Arboretum was established in 1951 to preserve in perpetuity a small

area of easily accessible natural primary lowland forest located at 1°23'50.0"N to 1°24'5.7"N and 110°18'53.1"E to 110°19'13.0"E, and less than 100 m elevation. It covers an area of approximately 14 ha and is one of the few least disturbed lowland mixed dipterocarp forests located about 20 km from Kuching City (Fig. 1A). In April 2000, the Reserve was gazetted as Semenggoh Nature Reserve, which is now legally protected in Sarawak. The arboretum is floristically rich and has attracted a large number of researchers and naturalists (Forest Department Sarawak 2003).

Generally, Semenggoh is more well-known for its orang-utan rehabilitation centre rather than its flora as very little information on the flora of Semenggoh has been published. Based on herbarium records, many local and overseas botanists have collected specimens from the Semenggoh Arboretum from the 1950s to 1970s. To date, about 700 species (from about 2000 herbarium specimens) from Semenggoh are represented at the Sarawak herbarium. Among these collections, about 40 species were described from this locality (e.g., *Shorea pubistyla* P.S.Ashton, Dipterocarpaceae; *Brownlowia ovalis* Kosterm., Malvaceae / Tiliaceae; and *Macaranga kingii* Hook.f., Euphorbiaceae) and nine species are endemic to Semenggoh (e.g., *Chionanthus rugosus* Kiew, Oleaceae; *Xanthophyllum ceraceifolium* Meijden, Polygalaceae; and *Areca ahmadii* J.Dransf., Arecaceae). A census of trees (girth 45 cm and above) carried out by the Sarawak Forest Department in the 1980s recorded 12,778 trees from Semenggoh (unpublished report).

Being one of the reserves located near Kuching City, Semenggoh continues to face pressure from social and economic development; therefore, it is critical to document the flora of the whole Nature Reserve in order to study its diversity. This paper is on the preliminary work carried out in Semenggoh Arboretum to investigate the tree flora diversity, with the long-term aim of fully documenting the flora of Semenggoh Nature Reserve. The objectives of this work are to study the tree flora composition and species richness and to investigate the current conservation value of Semenggoh Nature Reserve.

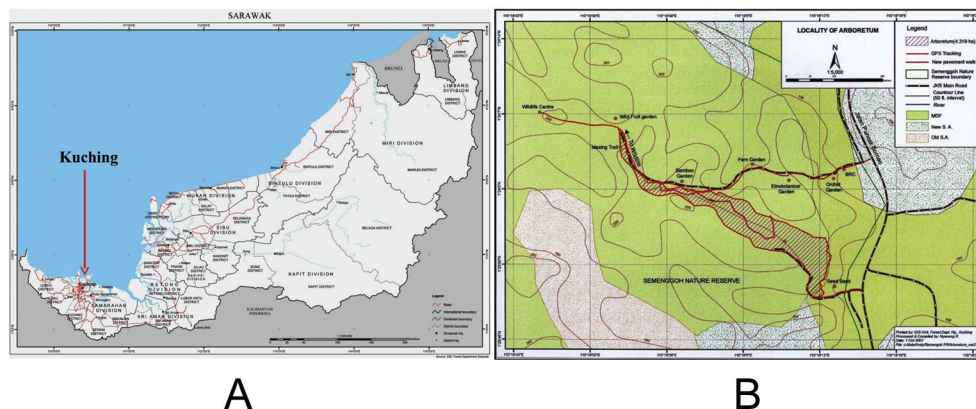


Fig. 1. Location of Kuching city (A) and Semenggoh Nature Reserve (B), showing the 4-ha study area along the eastern side of Masing Trail up to the Arboretum boundary, near the road leading to the Wildlife Rehabilitation Centre. (Courtesy of GIS Unit, Forest Department Sarawak.)

Methodology

Sample plot establishment

Sample plots were established following the method outlined in the “Manual for Establishment and Enumeration of Permanent Sample Plots in Peat Swamp Forest in Sarawak” (Tan 2002) with some modification to meet the objectives of the project at Semenggoh Arboretum. A total of 484 quadrats (each 10 m × 10 m) were established in an area of approximately 4.0 ha (Fig. 1B). All quadrats were numbered consecutively, line by line.

Field assessment

A 100% enumeration was carried out for trees with diameter ≥ 10.0 cm. The diameter of each tree was measured at 1.3 m above the highest ground level for non-buttressed trees, and 30 cm above the highest buttress for buttressed trees. Leaf samples from all trees were collected for botanical identification to species level. The collected leaf samples were identified using the Tree Flora of Sabah and Sarawak volumes I–VI (Soepadmo & Wong 1995; Soepadmo & Saw 2000; Soepadmo et al. 1996, 2002, 2004, 2006, 2007) and other monographs and publications (e.g., Airy Shaw 1975, Chung 2005, Julia 2005, Sugau 2005, Ashton 2006), as well as by comparison to specimens kept in the Sarawak Herbarium.

Data analysis

For data analysis, the number of trees, families, genera and species were transformed into their per ha equivalent. All data analysed were used to determine the floristic composition, species abundance, and diameter and basal area contribution by all tree species. Basal area for each tree was calculated by using the formula: Basal area = $(\text{DBH}/200)^2 \times \pi \text{ m}^2$, where DBH is the diameter at breast height in cm. To determine the stand density and basal area contribution, each tree was then grouped into six different diameter classes (10.0–19.9; 20.0–29.9; 30.0–39.9; 40.0–49.9; 50.0–59.9; ≥ 60.0 cm). Species richness was determined by a relative comparison method, comparing the trees/ha and species/ha of each plot between Semenggoh and four other plots from different sites established in Sarawak. No statistical method was used to calculate species richness, as no duplicates of different plot sites or forest types were taken into consideration in the initial purpose of this study.

Results and discussion

Tree diversity and density

A total of 2837 individuals from 60 families, 160 genera and 541 species were recorded from the sample plot (Appendix A). Euphorbiaceae and Malvaceae were the most diverse families at genus level, with 10 genera each. Relative comparison with four other sites showed that Semenggoh ranked fourth in terms of species richness after Lambir Hills National Park (NP), Batang Ai NP and Bako NP (Table 1). Batang Ai NP

has the highest number of trees recorded, with 813 trees/ha compared with 710 trees/ha in Semenggoh. Twenty eight families (46.7% of total number of families) were represented by a single genus and 13 families (21.7% of the total number of families) were represented by a single species. About 37% of the total species are represented by a single individual. Within the study area, two families (i.e., Icacinaceae and Salicaceae), each represented by a single species, had the lowest number of individuals and also basal area. Both trees are very small in size and may face local extinction from the plot in the future, due to natural disturbances or anthropogenic disturbances, as the mortality of only a few individuals will lead to total loss of representation in the plots. This may result in species turnover in the future. Furthermore, rare species demonstrate higher mortality rates than common species but, at the same time, contribute to high diversity in forests in Borneo (Primack & Hall 1992).

Of the 60 families recorded from the plot, Dipterocarpaceae is the main contributor in terms of total stems (720 individuals), total number of species (61 species), and total stand basal area (16.71 m²/ha) within the study area (Table 2). Myristicaceae is the most diverse family among non-dipterocarps, with 42 species recorded. Sapotaceae is the most dominant family with 66 trees/ha, followed by Myristicaceae (54 trees/ha) and Moraceae (40 trees/ha). In terms of basal area contribution, Sapotaceae, Moraceae, and Malvaceae contributed a total basal area of 3.32 m²/ha, 1.97 m²/ha, and 1.86 m²/ha respectively, while Fabaceae contributed the smallest total number of species, trees and basal area among the ten most abundant families. Dipterocarpaceae is the most dominant family in Semenggoh and other sites in Sarawak (Table 3). The occurrence of Dipterocarpaceae in Semenggoh is relatively high when compared with other similar sites in Sarawak (except the 52-ha plot in Lambir Hills NP) (Table 4).

At the generic level, *Shorea* (Dipterocarpaceae) contributed the highest number of trees with 129 trees/ha, followed by *Artocarpus* (Moraceae) with 38 trees/ha, *Pouteria* (Sapotaceae) with 31 trees/ha, and *Syzygium* (Myrtaceae) with 29 trees/ha (Table 5). *Shorea* also contributed the highest basal area with 44.73 m², followed by *Pouteria* (8.75 m²), *Hopea* (7.51 m²) and *Artocarpus* (7.29 m²). Tree composition in Semenggoh Arboretum is dominated by dipterocarp species with more than 25% of trees belonging to the Dipterocarpaceae. From the total of 2837 trees recorded, dipterocarp species contributed 180 trees/ha, compared with 529 trees/ha by non-dipterocarp species. This is a typical pattern for most evergreen rain forests on the Sunda Shelf region which encompasses the mainland of Peninsular Malaysia, Sumatra, Java and Borneo (Slik et al. 2003).

Among the dipterocarps, *Shorea multiflora* (Burck) Symington (Dipterocarpaceae) is the most abundant species represented by the highest number of individuals with 84 individuals, followed by *Shorea macroptera* Dyer (Dipterocarpaceae) with 74 individuals and *Shorea brunnescens* P.S.Ashton (Dipterocarpaceae) with 62 individuals, while *Pouteria malaccensis* (C.B.Clarke) Baehni (Sapotaceae) is the most abundant species for non-dipterocarps, followed by other species as shown in Table 6. *Pouteria malaccensis* also contributed the highest basal area (2.19 m²/ha) for the non-dipterocarps. Interestingly, although a low number

Table 1. Species diversity of the 4-ha plot in Semenggoh compared with other sites. FDS: Forest Department Sarawak. N: Number of trees. S: Number of species.

Site	N	S	Area (ha)	N/ha	S/ha
Semenggoh	2837	541	4.0	710	135
Lambir Hills NP (FDS 1986)	1672	428	2.4	697	178
Bako NP (FDS 1996)	1901	390	2.4	792	162
Bukit Mersing (FDS 1996)	1584	266	2.4	660	111
Batang Ai NP (Diway et al., 2009)	1831	385	2.25	813	171

Table 2. Ten most abundant families recorded from the 4-ha study area in Semenggoh Arboretum. S: Number of species. N: Number of trees. BA: Basal Area. % Trees: N/Total number of trees \times 100%.

Family	S	N	Trees/ha	% Trees	BA (m ² /ha)
Dipterocarpaceae	61 (11%)	720 (25%)	180	25.38	16.71 (39%)
Sapotaceae	27 (5%)	262 (9%)	66	9.24	3.32 (8%)
Myristicaceae	42 (8%)	216 (8%)	54	7.61	1.65 (4%)
Moraceae	11 (2%)	160 (6%)	40	5.64	1.97 (5%)
Malvaceae	29 (5%)	125 (4%)	31	4.41	1.86 (4.32)
Myrtaceae	29 (5%)	114 (4%)	29	4.02	1.43 (3%)
Burseraceae	28 (5%)	106 (4%)	27	3.74	1.28 (3%)
Anacardiaceae	18 (3%)	94 (3%)	24	3.31	1.69 (4%)
Clusiaceae	38 (7%)	84 (3%)	21	2.96	0.93 (2%)
Fabaceae	15 (3%)	73 (3%)	18	2.57	2.55 (6%)

Table 3. Five most dominant families in Semenggoh and other sites of Sarawak. FDS: Forest Department Sarawak.

Semenggoh	Lambir Hills NP (FDS 1986)	Bako NP (FDS 1996)	Bukit Mersing (FDS 1996)	Batang Ai NP (Diway et al. 2009)
Dipterocarpaceae	Dipterocarpaceae	Dipterocarpaceae	Dipterocarpaceae	Dipterocarpaceae
Sapotaceae	Euphorbiaceae	Myristicaceae	Euphorbiaceae	Euphorbiaceae
Myristicaceae	Burseraceae	Anacardiaceae	Verbenaceae	Myrtaceae
Moraceae	Anacardiaceae	Sapotaceae	Annonaceae	Clusiaceae
Malvaceae	Myristicaceae	Clusiaceae	Myristicaceae	Burseraceae

Table 4. The diversity of Dipterocarpaceae in Semenggoh (4-ha study area) and other sites of Sarawak. FDS: Forest Department Sarawak.

Site	Number of Genera	Number of species	Trees/ha
Semenggoh	7	61	180
Lambir Hills NP (FDS 1986)	7	55	180
Lambir Hills NP -52 ha plot (Lee et al. 2004)	8	78	119
Bako NP (FDS 1996)	7	49	215
Bukit Mersing (FDS 1986)	5	22	140
Batang Ai NP (Diway et al. 2009)	6	45	267

of trees was recorded for *Koompassia malaccensis* Maingay ex Benth. (Fabaceae) and *Dyera costulata* (Miq.) Hook.f. (Apocynaceae), both species contributed relatively high basal areas of 1.56 m²/ha and 1.05 m²/ha, respectively. As for dipterocarps, although *Shorea multiflora* contributed the highest number of individuals, *Shorea beccariana* Burck (Dipterocarpaceae) with only 6 trees/ha, contributed 2.07 m²/ha basal area and was 53.62% higher than *Shorea multiflora*, followed by *Hopea dyeri* F.Heim (Dipterocarpaceae) (1.46 m²/ha), *Shorea elliptica* Burck (Dipterocarpaceae) (1.41 m²/ha) and *Dipterocarpus genticulatus* Vesque (Dipterocarpaceae) (1.07 m²/ha).

Even though Semenggoh Arboretum is dominated by dipterocarp species, non-dipterocarp species (i.e., *Pouteria malaccensis*) contributed the highest number of trees and basal area. This circumstance may relate to the seed dispersal limitations of Dipterocarpaceae and Sapotaceae (Whitmore 1984). Dispersal limitation plays an important role in structuring floristic composition over distance of less than five km (Pyke et al. 2001). Dipterocarp seeds are dispersed by wind, but their heavy weight limits the seed dispersal range, resulting in their germinating closer to the mother tree. Sapotaceae seeds are dispersed by animals, and seedlings of Sapotaceae will eventually establish further from the mother trees, thus reducing competition between mother trees and seedlings for resources such as light, nutrients and space (Tan et al. 1998). Another possible reason is probably due to the mast-fruiting of Bornean species, which occurs at five to ten yearly intervals. In dipterocarp mast-fruiting events, a delay in timing of seedfall after the community fall peak is negatively correlated with seed survival and seedling establishment (Curran & Webb 2000).

Stand density and basal area by diameter classes

Six diameter classes were considered, ranging from 10.0 cm to ≥ 60.0 cm. The distribution of trees in the study area followed a normal reverse-J-shaped curve where the lower diameter classes were dominated by small trees and only few bigger trees dominated the higher diameter classes. Out of 2837 individuals recorded, 57.41% of trees were within the 10.0–19.9 cm diameter range (Fig. 2). Non-dipterocarp species

Table 5. Ten most abundant genera recorded from the 4 ha study area. N: Number of trees. BA: Basal area. % Trees: $N/\text{Total number of trees} \times 100\%$.

Genera	Family	N	Trees/ha	% Trees	BA (m ²)	BA (m ² /ha)
<i>Shorea</i>	Dipterocarpaceae	515	129	18.13	44.73	11.18
<i>Artocarpus</i>	Moraceae	150	38	5.28	7.29	1.82
<i>Pouteria</i>	Sapotaceae	122	31	4.30	8.75	2.19
<i>Syzygium</i>	Myrtaceae	114	29	4.01	5.73	1.43
<i>Gymnacranthera</i>	Myristicaceae	91	23	3.20	2.94	0.74
<i>Hopea</i>	Dipterocarpaceae	86	22	3.03	7.51	1.88
<i>Palaquium</i>	Sapotaceae	80	20	2.82	2.96	0.74
<i>Teijsmanniodendron</i>	Lamiaceae	72	18	2.54	1.24	0.31
<i>Madhuca</i>	Sapotaceae	59	15	2.08	1.57	0.39
<i>Xanthophyllum</i>	Polygalaceae	53	13	1.87	1.92	0.48

Table 6. Ten most abundant species according to number of trees recorded from the study area. N: Number of trees. BA: Basal area. % Trees: $N/\text{Total number of trees} \times 100\%$.

Species	Family	N	Trees/ha	% Trees	BA (m ²)	BA (m ² /ha)
<i>Pouteria malaccensis</i>	Sapotaceae	122	31	4.30	8.76	2.19
<i>Shorea multiflora</i>	Dipterocarpaceae	84	21	2.96	3.86	0.96
<i>Shorea macroptera</i>	Dipterocarpaceae	74	19	2.61	2.50	0.63
<i>Teijsmanniodendron havilandii</i>	Lamiaceae	64	16	2.26	0.74	0.18
<i>Shorea brunnescens</i>	Dipterocarpaceae	62	16	2.19	2.04	0.51
<i>Shorea subcylindrica</i>	Dipterocarpaceae	57	14	2.01	2.72	0.68
<i>Hopea dyeri</i>	Dipterocarpaceae	55	14	1.94	5.84	1.46
<i>Artocarpus integer</i>	Moraceae	49	12	1.73	2.87	0.72
<i>Allantospermum borneense</i>	Ixonanthaceae	44	11	1.55	1.94	0.49
<i>Palaquium leiocarpum</i>	Sapotaceae	41	10	1.45	1.23	0.31

dominated the lowest diameter class (10.0–19.9 cm), with 1315 individuals, compared with only 314 individuals from dipterocarp species in the same diameter class. In the largest diameter class (≥ 60.0 cm), dipterocarp species contributed 15 trees more than non-dipterocarp species (Fig. 3A). The same pattern was observed in basal area contribution of dipterocarps and non-dipterocarps, where dipterocarps dominated the highest diameter class and at the same time contributed the highest basal area (28.21 m²) with c. 30% higher than non-dipterocarps (Fig. 3B). The stand density by diameter

classes in the study area corresponds to the condition in natural forests (Faridah-Hanum & Philip 2006). This is considered as a general characteristic of many uneven-aged stands and has been observed in Semenggoh Arboretum, where smaller trees dominate the small diameter classes, and only fewer bigger trees dominated the higher diameter classes, mostly by Dipterocarpaceae. Only a few non-dipterocarp species will reach diameters over 60 cm, for instance *Dyera costulata* (Apocynaceae), *Koompassia malaccensis* Maingay ex Benth. (Fabaceae), and *Crudia wrayi* Prain (Fabaceae).

As for the non-dipterocarps, basal area distribution decreased while diameter increased, as most non-dipterocarps will not reach diameter ≥ 60.0 cm. The sudden increase of basal area in the highest diameter class is due to the non-dipterocarp species such as *Dyera costulata* (Miq.)Hook.f. (Apocynaceae), *Koompassia malaccensis* (Fabaceae), and *Pouteria malaccensis* (Sapotaceae) that have diameters over 1 m, thus contributing relatively high basal areas, although dipterocarp species dominated the highest diameter class. Through observation, most of the emergent trees with diameter over 100 cm are dominated by Dipterocarpaceae, where species such as *Shorea beccariana* (Dipterocarpaceae), *Shorea elliptica* (Dipterocarpaceae), *Shorea pubistyla* P.S.Ashton (Dipterocarpaceae), and *Upuna borneensis* Symington (Dipterocarpaceae) were recorded. However, there are some other species such as *Dyera costulata* (Apocynaceae), *Dialium* spp. (Fabaceae), *Koompassia malacensis* (Fabaceae) and *Pouteria malaccensis* (Sapotaceae) among the non-dipterocarps that contributed to the high basal area in Semenggoh Arboretum. This is a general characteristic of lowland evergreen tropical rain forest, including lowland mixed dipterocarp forest (Whitmore 1984).

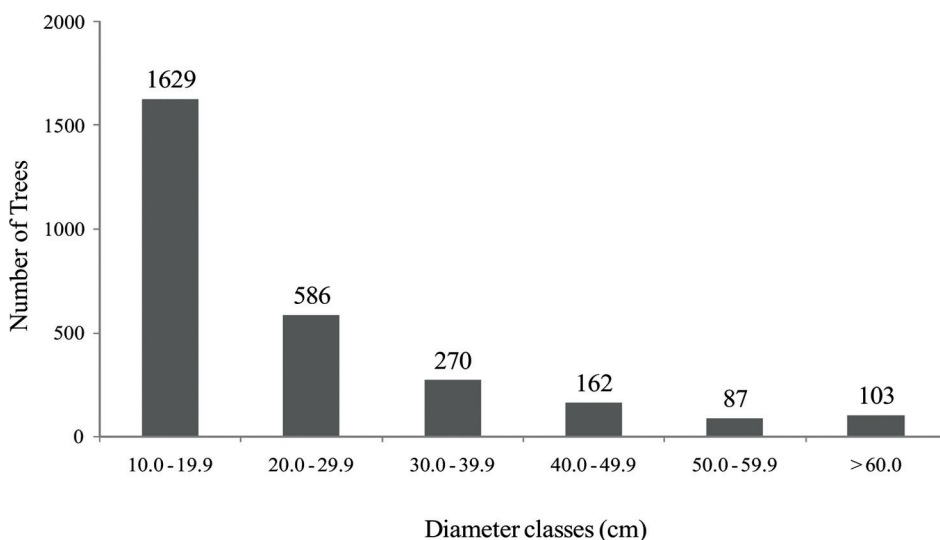


Fig. 2. Stand density by diameter classes of all recorded trees from the 4-ha study area, Semenggoh Arboretum.

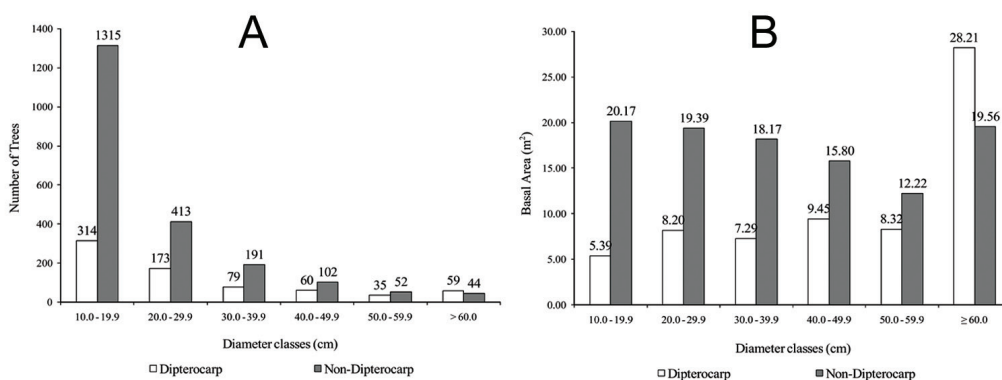


Fig. 3. Stand density (A) and basal area contribution (B) of dipterocarps and non-dipterocarps according to diameter classes (cm).

Furthermore, more than 57% of trees in the study area are in the 10.0–19.9 cm diameter class. In tropical forests, the general contribution of trees within this diameter class is about 50% of the total stand (Whitmore 1984). The high percentage of trees in the study area suggests that natural regeneration of trees species in Semenggoh is active. This may be due to the location of the sample plot which is near the roadside, and is exposed to more or direct overhead light compared to those trees within the Arboretum where relatively little light reaches the understorey seedlings and saplings. Besides, natural disturbances such as lightning and fallen dead trees have also created gaps within the Arboretum and promotes seedling establishment for light-demanding species.

Diversity of dipterocarp species within the study area

In the study area, most of the trees in the bigger diameter classes are dominated by dipterocarps. Within this family, seven genera were recorded, of which *Shorea* is the dominant genus with 515 trees (71.53% from total number of trees in Dipterocarpaceae), followed by *Hopea* with 86 individuals (11.91%). Both *Dipterocarpus* and *Vatica* were represented by almost the same number of trees (i.e., 48 and 47 individuals, respectively). The least abundant genera are *Anisoptera* and *Upuna*, each represented by two individuals (Fig. 4). Among the 9 genera and about 267 species of dipterocarps recorded from Borneo, 7 genera and 61 species were represented in the 4-ha study area, that is, about 70% and 22% of dipterocarps genera and species, respectively. According to Proctor et al. (1983) and Kochummen et al. (1991), the relative contribution of dipterocarps within the Sunda shelf forests is 3–10% of species, 8–18% of stem number and 20–56% for basal area. In the study area, the dipterocarps contributed more than 10% of the total species and more than 18% of the total stem number, but the basal area contribution is within the normal range, which is about 39% (Table 2). Hence, it can be concluded that the occurrence of dipterocarp species in the study area is relatively high and Semenggoh is an important area for research

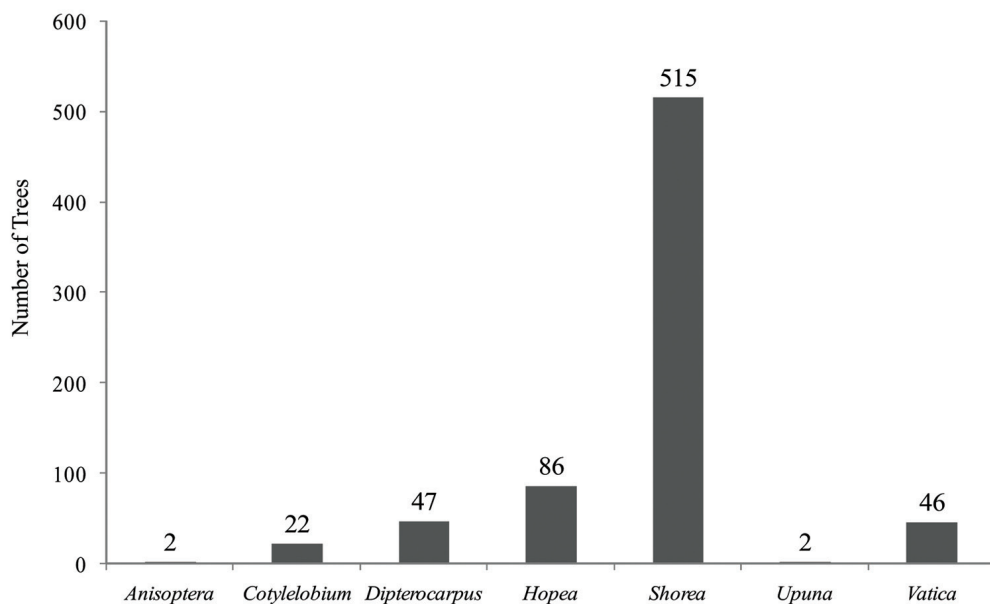


Fig. 4. Relative commonness of Dipterocarpaceae genera in the 4-ha study area.

on this family. Moreover, Dipterocarpaceae is the most important family economically in mixed dipterocarp forest, because the most valuable timbers belong to this family (Whitmore 1984).

The reverse-J-shaped distribution could only be observed in *Shorea* species while other genera had rather random distributions among the six diameter classes. *Shorea* species dominated both in the number of trees and basal area in all six diameter classes (Fig. 5A and 5B). The highest number of trees represented by this genus is in the 10.0–19.9 cm diameter range. However, for basal area distribution, *Shorea* species contributed the highest basal area in the diameter class ≥ 60.0 cm. Overall, the basal area of dipterocarp species increased with diameter class. This may be due to the different growth rates and shade tolerance among the species in other genera in the Dipterocarpaceae (Loewenstein et al. 2000). The distribution of *Shorea* species within the study area indicated that regeneration and recruitment of *Shorea* species into larger diameter classes were satisfactory (Maliondo et al. 2005). The diversity of dipterocarp species in the study area is also important to serve as a seed source for reforestation in the future. The Seedbank at Semenggoh is responsible for collecting seeds from the Seed Production Area established in the Arboretum. The seeds collected are important for supporting plantation, restoration, enrichment planting, urban forestry and greenery projects.

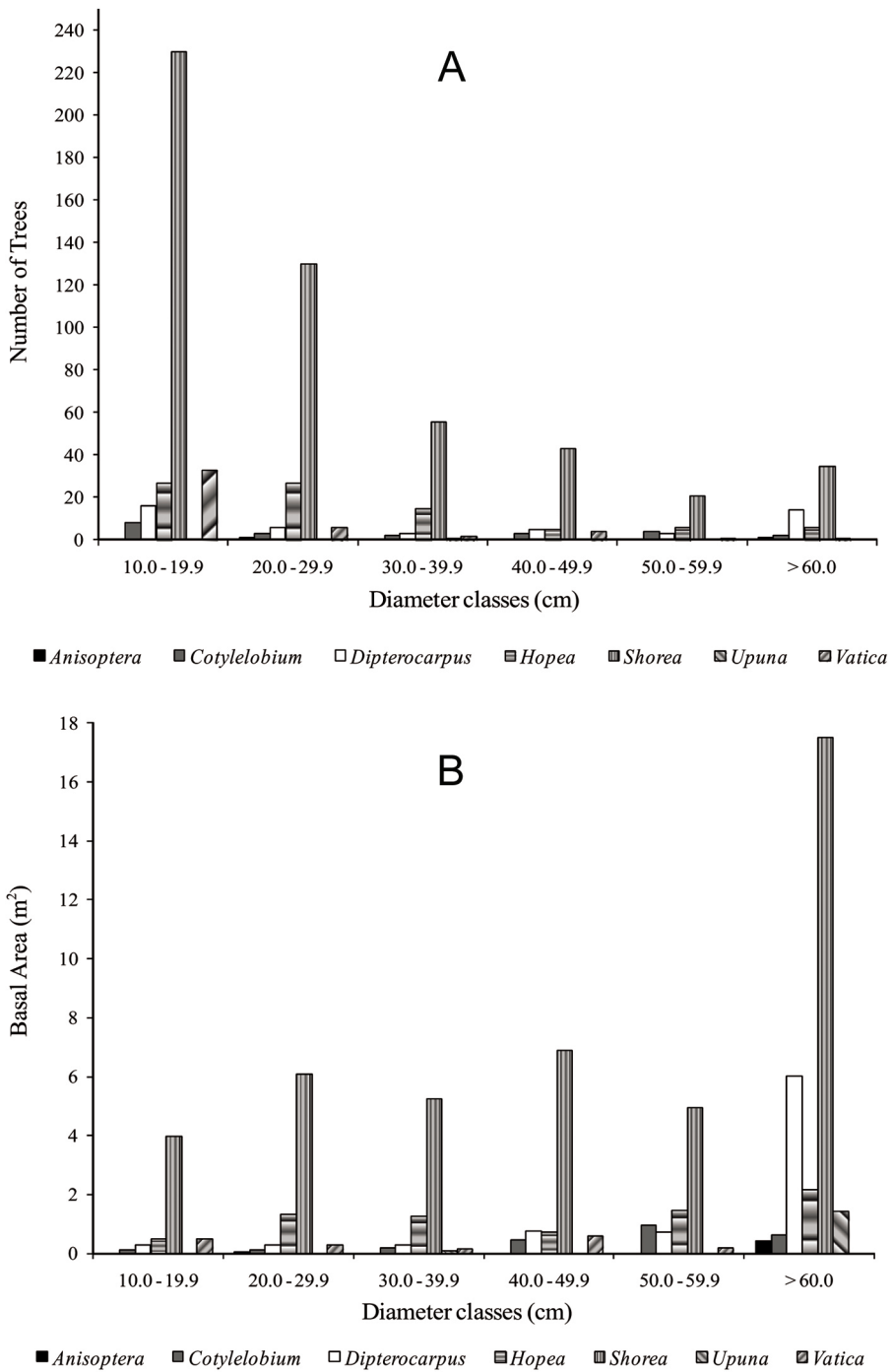


Fig. 5. Stand distribution (A) and basal area contribution (B) of dipterocarp species according to diameter classes in the study area.

Conservation value of Semenggoh

Semenggoh is an important habitat for many threatened, rare and endemic species. The conservation status of all tree species recorded from the study area was determined by using the *IUCN Red List of Threatened Species 2010* (IUCN 2010). Out of 541 species recorded from the study area, about 11% of the species are considered threatened, with 20 species listed as vulnerable (VU), 14 species endangered (EN), 24 species critically endangered (CR) and 1 species extinct. In addition, one species (*Shorea cuspidata* P.S.Ashton), which is considered extinct in the IUCN Red List, was recorded in the plot. Within the 4-ha study area, two individual trees of *Shorea cuspidata* with a basal area of 0.067 m² were documented.

In terms of endemism, 24 species out of the total species recorded are endemic to Sarawak, with 13 species considered rare and three species endemic to Semenggoh. These include species such as *Melanochyla borneensis* (Ridl.) Ding Hou (Anacardiaceae), *Actinodaphne semenggohensis* S. Julia (Lauraceae) and *Xanthophyllum ceraceifolium* Meijden (Polygalaceae) which are restricted to Semenggoh. Approximately 20% of the species recorded are endemic to Borneo, where 19 species are considered rare and only occurs in less than five localities in Sarawak; for instance, the Bornean monotypic species, *Upuna borneensis* (locally known as *penyau*) is the largest tree documented, with only two trees recorded in the study site. Other interesting findings include the presence of 10 species that are uncommon in Sarawak, for example, *Kibatalia maingayi* (Hook.f.) Woodson (Apocynaceae), *Sindora velutina* Baker (Annonaceae), *Pouteria malaccensis*, *Madhuca sericea* (Miq.) H.J.Lam (Sapotaceae), *Crudia wrayi* Prain, and *Madhuca pallida* (Burck) Baehni (Sapotaceae).

Besides the high endemicity of tree species in the study plot, the primary lowland mixed dipterocarp forest of Semenggoh is in the vicinity of Kuching city, so this area is easily accessible by land transport and numerous herbarium collections have been made during earlier years by many taxonomists. In addition, more than 40 species with their type localities at Semenggoh have been described. During this study, 19 species with type specimens collected from Semenggoh were recorded. These include *Swintonia minutalata* Ding Hou (Anacardiaceae), *Hopea kerangasensis* P.S.Ashton (Dipterocarpaceae), *Shorea cuspidata* P.S.Ashton, *Shorea subcylindrica* P.S.Ashton (Dipterocarpaceae), *Actinodaphne semenggohensis*, and *Gonystylus micranthus* Airy Shaw (Thymelaeaceae).

Due to the uniqueness and richness of the tree species in the Semenggoh Arboretum, more detailed studies (e.g., phenology, plant development, flowering and fruiting onset) should be carried out in order to better understand its flora and to propose a proper conservation management of species and habitats.

Conclusion

With 541 species and 710 trees/ha contributing to a 43.04 m²/ha basal area, the 4-ha plot in Semenggoh can be considered a floristically rich area. As the only remaining primary lowland mixed dipterocarp forest in the vicinity of Kuching city, this area is

an important site for threatened, endemic and rare species; therefore, it is critical to protect and maintain the Arboretum in order to conserve this diverse primary mixed dipterocarp forest into the future. At the same time, due to its high level of endemism, the Arboretum can be an important site for future research into forest demographics and dynamics of endangered species, which will further enhance the conservation value of the area.

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Appendix A. Composition, stand density and basal area (BA) contribution of tree families from the 4-ha study site, Semenggoh.

No.	Family	Genus	Species	Total	BA (m ²)
1	Achariaceae	3	11	44	1.98
2	Anacardiaceae	9	18	94	6.74
3	Anisophylleaceae	1	3	15	0.54
4	Annonaceae	5	11	49	1.31
5	Apocynaceae	3	4	28	4.85
6	Araliaceae	1	1	2	0.04
7	Burseraceae	3	28	106	5.12
8	Cardiopteridaceae	1	1	18	0.39
9	Celastraceae	3	3	11	0.24
10	Chrysobalanaceae	3	4	6	0.10
11	Clusiaceae	4	38	84	3.74
12	Combretaceae	1	1	2	0.16
13	Cornaceae	1	2	2	0.05
14	Crypteroniaceae	1	1	1	0.04
15	Ctenolophonaceae	1	1	3	0.32
16	Dilleniaceae	1	5	21	0.65
17	Dipterocarpaceae	7	61	720	66.86
18	Ebenaceae	1	16	39	1.84
19	Elaeocarpaceae	1	6	7	0.20
20	Euphorbiaceae	10	16	61	1.41
21	Fabaceae	7	15	73	10.20
22	Fagaceae	3	8	14	1.79

No.	Family	Genus	Species	Total	BA (m ²)
23	Icacinaceae	1	1	1	0.01
24	Ixonanthaceae	2	2	50	2.75
25	Lamiaceae	2	6	73	1.26
26	Lauraceae	7	18	49	2.30
27	Lecythidaceae	1	2	7	0.41
28	Loganiaceae	1	1	37	3.28
29	Magnoliaceae	2	3	9	0.35
30	Malvaceae	10	29	125	7.46
31	Melastomataceae	2	2	11	0.16
32	Meliaceae	7	23	55	1.62
33	Memecylaceae	1	6	9	0.22
34	Moraceae	3	11	160	7.88
35	Myristicaceae	4	42	216	6.58
36	Myrtaceae	1	29	114	5.73
37	Ochnaceae	1	1	1	0.04
38	Olacaceae	2	3	11	0.55
39	Oleaceae	1	2	4	0.06
40	Oxalidaceae	1	1	4	1.45
41	Peraceae	2	2	13	0.37
42	Phyllanthaceae	3	16	42	0.64
43	Polygalaceae	1	12	53	1.92
44	Proteaceae	1	1	2	0.05
45	Putranjivaceae	1	4	10	0.30
46	Rhizophoraceae	2	2	3	0.07
47	Rosaceae	1	3	4	0.07
48	Rubiaceae	6	6	17	0.25
49	Rutaceae	3	3	10	0.22
50	Salicaceae	1	1	1	0.03
51	Sapindaceae	4	7	14	1.00
52	Sapotaceae	4	27	262	13.29
53	Simaroubaceae	1	1	3	0.39
54	Staphyleaceae	1	2	2	0.02
55	Stemonuraceae	2	3	3	0.21
56	Symplocaceae	1	3	4	0.04
57	Theaceae	3	4	8	0.32
58	Thymelaeaceae	2	5	14	0.43
59	Ulmaceae	1	2	35	1.79
60	Unidentified	1	1	1	0.04
	Total	160	541	2837	172.16

Appendix B. Checklist of trees from the 4-ha study site in Semenggoh Arboretum. (Only species that were listed in *The IUCN Red List of Threatened Species 2010* are specially indicated with conservation status in the notes.)

Achariaceae

- Hydnocarpus anomala* (Merr.) Sleumer
Hydnocarpus borneensis Sleumer
Hydnocarpus kunstleri (King) Warb. var. *tomentosa* (King) Sleumer
Hydnocarpus pinguis Sleumer
Hydnocarpus polypetala (Sloot.) Merr.
Hydnocarpus subfalcata Merr.
Hydnocarpus tenuipetala Sleumer
Hydnocarpus woodii Merr.
Ryparosa hirsuta J.J.Sm.
Ryparosa hullettii King
Trichadenia philippinensis Merr.

Anacardiaceae

- Androtium astylum* Stapf
Buchanania arborescens (Blume) Blume
Camptosperma squamatum Ridl.
Drimycarpus luridus (Hook.f.) Ding Hou *Notes:* Rare in Sarawak (only from two other localities in Tatau & Belaga districts).
Gluta beccarii (Engl.) Ding Hou
Gluta oba (Merr.) Hou. *Notes:* Endemic to Borneo.
Gluta wallichii (Hook.f.) Ding Hou
Mangifera griffithii Hook.f. *Notes:* Uncommon in Sarawak.
Mangifera parvifolia Boerl. & Koord. *Notes:* Uncommon in Sarawak, usually from peat swamp forest.
Melanochyla angustifolia Hook.f. *Notes:* Uncommon in Sarawak.
Melanochyla beccariana Oliv. *Notes:* Endemic to Borneo but uncommon in Sarawak.
Melanochyla borneensis (Ridl.) Ding Hou *Notes:* Endemic to Sarawak and so far only known from Kuching districts.
Melanochyla elmeri Merr. *Notes:* Endemic to Borneo but uncommon in Sarawak.
Melanochyla fulvinervis (Blume) Ding Hou *Notes:* Uncommon in Sarawak.
Parishia insignis Hook.f. *Notes:* Not endemic but uncommon in Sarawak.
Parishia maingayi Hook.f.
Swintonia glauca Engl.
Swintonia minutalata Ding Hou *Notes:* Endemic to Borneo and uncommon in Sarawak (Semenggoh & Bako only); type specimen from Semenggoh.

Anisophylleaceae

- Anisophyllea beccariana* Baill *Notes:* Not endemic but in Sarawak, only found in Kuching & Bintulu district.
Anisophyllea corneri Ding Hou
Anisophyllea ferruginea Ding Hou *Notes:* Uncommon in Sarawak (only known from 4 districts in Sarawak).

Annonaceae

- Alphonsea javanica* Blume
Alphonsea johorensis J. Sinclair
Cyathocalyx biovulatus Boerlage
Cyathocalyx carinatus (Ridl.) J. Sinclair
Mezzettia parviflora Becc.
Polyalthia hookeriana King
Polyalthia lateriflora King
Xylopia caudata Hook.f. & Thomson
Xylopia elliptica Maingay ex Hook.f.
Xylopia ferruginea Baill.
Xylopia malayana Hook.f. & Thomson

Apocynaceae

- Alstonia angustifolia* Wall. ex A. DC.
Alstonia angustiloba Miq. *Notes:* Not endemite but only found in western part of Sarawak.
Dyera costulata (Miq.) Hook.f.
Kibatalia maingayi (Hook.f.) Woodson *Notes:* Not endemic but very localised in Sarawak (Semenggoh & Bau only).

Araliaceae

- Arthrophyllum diversifolium* Blume

Burseraceae

- Canarium apertum* H.J.Lam
Canarium dichotomum (Blume) Miq.
Canarium littorale Blume forma *littorale*
Canarium littorale Blume forma *rufum* (A.W.Benn.) Leenh. *Notes:* Less common in Sarawak.
Canarium megalanthum Merr.
Canarium merrillii H.J.Lam *Notes:* Endemic to Borneo.
Canarium odontophyllum Miq.
Canarium pilosum A. W. Benn. subsp. *pilosum*
Dacryodes costata (A. W. Benn.) H.J.Lam
Dacryodes incurvata (Engl.) H.J.Lam *Notes:* From 4 districts in Sarawak.
Dacryodes longifolia (King) H.J.Lam *Notes:* Less common in Sarawak.
Dacryodes macrocarpa H.J.Lam var. *patentinervia* Leenh
Dacryodes nervosa (H.J.Lam) Leenhouts *Notes:* Not endemic but in Sarawak, only found in Tubau, Bako, Bintulu & Sadong.
Dacryodes rostrata (Blume) H.J.Lam forma *cuspidata* (Blume) H.J.Lam
Dacryodes rugosa (Blume) H.J.Lam var. *rugosa*
Dacryodes rugosa (Blume) H.J.Lam var. *virgata* (Blume) H.J.Lam
Dacryodes sp. 1
Santiria apiculata A.W. Benn. var. *apiculata*
Santiria apiculata Benn. var. *pilosa* (Engl.) Kalkman
Santiria griffithii (Hook.f.) Engl.
Santiria laevigata Blume forma *glabrifolia* (Engl.) H.J.Lam
Santiria megaphylla Kalkman *Notes:* Endemic to Borneo but uncommon in Sarawak (Semenggoh & Dulit).

Santiria mollis Engl. *Notes*: Endemic to Borneo but uncommon in Sarawak (Semenggoh & Lambir, Niah, Bukit Raya).

Santiria oblongifolia Blume

Santiria sarawakana Kochummen *Notes*: Endemic to Sarawak and only from Miri & Sabal.

Santiria tomentosa Blume

Santiria sp. 1

Santiria sp. 2

Cardiopteridaceae

Gonocaryum minus Sleumer

Celastraceae

Bhesa paniculata Arn.

Kokoona littoralis Laws. var. *longifolia* Kochummen

Lophopetalum glabrum Ding Hou *Notes*: Endemic to Borneo.

Chrysobalanaceae

Atuna nannodes (Kosterm.) Kosterm. *Notes*: Not Endemic but uncommon in Sarawak (Bau & Kuching only).

Atuna sp. 1

Kostermantus heteropetalus *Notes*: Sarawak only recorded from 4 districts.

Licania splendens (Korth.) Prance

Clusiaceae

Calophyllum biflorum M.R.Hend. & Wyatt-Smith.

Calophyllum castaneum P.F.Stevens

Calophyllum elegans Ridley

Calophyllum lanigerum Miq. var. *austrororiaceum* (Whitmore) P.F.Stevens

Calophyllum molle King

Calophyllum pulcherrimum Wall. ex Choisy

Calophyllum roseocostatum P.F.Stevens *Notes*: Type specimen from Semenggoh.

Calophyllum soulattri Burm.f. *Notes*: LR/lc ver 2.3

Calophyllum tetrapterum Miq. *Notes*: LR/lc ver 2.3

Calophyllum teysmannii Zoll. ex Planch. & Tiana

Calophyllum woodii P.F.Stevens

Calophyllum sp. 1

Cratoxylum arborescens (Vahl) Blume *Notes*: LR/lc ver 2.3

Cratoxylum formosum (Jack) Dyer *Notes*: LR/lc ver 2.3

Cratoxylum maingayi Dyer *Notes*: LR/lc ver 2.3

Garcinia beccarii Pierre

Garcinia blumei Pierre

Garcinia calophyllifolia Ridl.

Garcinia caudiculata Ridl.

Garcinia celebica L.

Garcinia cuspidata King

Garcinia dryobalanoides Pierre

Garcinia maingayi Hook.f. *Notes*: LR/lc ver 2.3

Garcinia mangostana L.

Garcinia myristicaefolia Pierre
Garcinia nervosa Miq.
Garcinia nitida Pierre
Garcinia parvifolia (Miq.) Miq.
Garcinia vidua Ridl.
Garcinia sp. '39'
Garcinia sp. 'AZ'
Mesua beccariana (Baill.) Kosterm.
Mesua borneensis P.F.Stevens
Mesua congestiflora P.F.Stevens
Mesua elmeri (Merr.) Kosterm.
Mesua macrantha (Baill.) Kosterm.
Mesua myrtifolia (Baill.) Kosterm.
Mesua variabilis P.F.Stevens

Combretaceae

Terminalia foetidissima Griff.

Cornaceae

Alangium javanicum (Blume) Wangerin var. *javanicum*
Alangium javanicum var. *meyeri* (Merr.) Berhaman

Crypteroniaceae

Crypteronia griffithii C.B.Clarke

Ctenolophonaceae

Ctenolophon parvifolius Oliv.

Dilleniaceae

Dillenia beccariana Martelli
Dillenia excelsa (Jack) Gilg
Dillenia excelsa (Jack) Gilg. var. *tomentella* (Martelli) Masamune
Dillenia reticulata King
Dillenia sumatrana Miq.

Dipterocarpaceae

Anisoptera grossivenia Slooten *Notes*: EN A1cd+2cd ver 2.3; endemic to Borneo.
Cotylelobium melanoxyton (Hook.f.) Pierre *Notes*: EN A1cd+2cd ver 2.3
Dipterocarpus confertus Slooten *Notes*: Endemic to Borneo.
Dipterocarpus geniculatus Vesque subsp. *geniculatus* *Notes*: Endemic to Borneo.
Dipterocarpus globosus Vesque *Notes*: CR A1cd+2cd, B1+2c ver 2.3; endemic to Borneo.
Dipterocarpus lowii Hook.f. *Notes*: CR A1cd+2cd, B1+2c ver 2.3
Dipterocarpus sarawakensis F.G.Browne ex Slooten *Notes*: Type specimen from Semenggoh.
Hopea beccariana Burck *Notes*: CR A1cd+2cd, B1+2c ver 2.3
Hopea bracteata Burck
Hopea dyeri F.Heim
Hopea griffithii Kurz *Notes*: VU A1c+2c ver 2.3
Hopea kerangasensis P.S.Ashton *Notes*: CR A1cd+2cd, B1+2c ver 2.3; type specimen from Semenggoh.

- Hopea latifolia* Symington Notes: CR A1c, B1+2c ver 2.3
- Hopea longirostrata* P.S.Ashton Notes: CR A1cd, B1+2c, C1, D ver 2.3; endemic to Sarawak.
- Hopea pachycarpa* (F.Heim) Symington Notes: VU A1cd+2cd, B1+2c ver 2.3
- Hopea sphaerocarpa* (F.Heim) P.S.Ashton Notes: CR A1c, B1+2c ver 2.3; endemic to Sarawak, first and second Division only.
- Hopea tenuinervula* P.S.Ashton Notes: CR A1c, B1+2c ver 2.3; endemic to Borneo.
- Shorea atrinervosa* Symington
- Shorea beccariana* Burck Notes: Endemic to Borneo.
- Shorea bracteolata* Dyer Notes: EN A1cd+2cd ver 2.3
- Shorea brunnescens* P.S.Ashton Notes: EN A1cd+2cd, C2a ver 2.3; endemic to Borneo.
- Shorea crassa* P.S.Ashton Notes: Endemic to Borneo; type specimen from Semenggoh.
- Shorea cuspidata* P.S. Ashton Notes: EX ver 2.3; endemic to Borneo, type specimen from Semenggoh.
- Shorea dasyphylla* Foxw. Notes: EN A1cd ver 2.3
- Shorea elliptica* Burck Notes: CR A1cd, C2a ver 2.3; endemic to Borneo, uncommon in Sarawak (Kuching & Lundu only).
- Shorea falcifera* Dyer ex Brandis Notes: EN A1cd ver 2.3
- Shorea flemmichii* Symington Notes: CR A1cd, C2a ver 2.3; endemic to Sarawak.
- Shorea isoptera* P.S.Ashton Notes: CR A1cd, C2a ver 2.3; endemic to Borneo.
- Shorea kunstleri* King Notes: CR A1cd ver 2.3
- Shorea ladiana* P.S.Ashton Notes: CR A1cd, C2a ver 2.3; endemic to Borneo, type specimen from Semenggoh.
- Shorea leprosula* Miq. Notes: EN A1cd ver 2.3
- Shorea lunduensis* P.S.Ashton Notes: CR A1cd, C2a ver 2.3; endemic to Borneo; uncommon in Sarawak (only from Lundu, Bau & Kuching Marudi districts).
- Shorea macrobalanos* P.S.Ashton Notes: CR A1cd, C2a ver 2.3; endemic to Borneo, uncommon in Sarawak (only from Kapit, Bintulu & Lundu districts).
- Shorea macrophylla* (de Vries) P.S.Ashton Notes: VU A1cd ver 2.3; endemic to Borneo.
- Shorea macroptera* Dyer
- Shorea maxwelliana* King Notes: EN A1c ver 2.3
- Shorea multiflora* (Burck) Symington Notes: LR/lc ver 2.3
- Shorea myrionerva* Sym. ex P.S.Ashton Notes: CR A1cd, C2a ver 2.3; endemic to Borneo.
- Shorea obscura* Meijer Notes: EN A1cd ver 2.3; endemic to Borneo.
- Shorea ovalis* (Korth.) Blume subsp. *sarawakensis* P.S.Ashton Notes: Endemic to Borneo.
- Shorea parvifolia* Dyer subsp. *velutina* P.S.Ashton
- Shorea pubistyla* P.S.Ashton Notes: CR A1cd, C2a ver 2.3; endemic to Borneo, type specimen from Semenggoh.
- Shorea quadrinervis* Slooten Notes: EN A1cd ver 2.3; endemic to Borneo.
- Shorea richetia* P.S.Ashton Notes: CR A1cd, C2a ver 2.3; endemic to Borneo, uncommon in Sarawak (Kuching & Lundu only).
- Shorea rubra* P.S.Ashton Notes: Endemic to Borneo.
- Shorea scaberrima* Burck Notes: Endemic to Borneo.
- Shorea scabrida* Symington
- Shorea seminis* (de Vriese) Slooten Notes: CR A1cd ver 2.3
- Shorea slootenii* Wood ex P.S.Ashton Notes: CR A1cd, C2a ver 2.3; endemic to Borneo.
- Shorea subcylindrica* Slooten Notes: CR A1cd, C2a ver 2.3; endemic to Borneo, type specimen from Semenggoh.
- Upuna borneensis* Symington Notes: EN A1cd, C2a ver 2.3; endemic to Borneo.

- Vatica badiifolia* P.S.Ashton *Notes*: EN A1cd ver 2.3; endemic to Borneo.
Vatica coriacea P.S.Ashton *Notes*: CR A1c, C2a ver 2.3; endemic to Borneo, uncommon (in Sarawak known from Lundu & Kuching districts).
Vatica dulitensis Symington *Notes*: Endemic to Borneo.
Vatica granulata Slooten subsp. *granulata* *Notes*: Endemic to Borneo.
Vatica havilandii Brandis *Notes*: CR A1c, C2a ver 2.3
Vatica maingayi Dyer *Notes*: CR A1cd, C2a ver 2.3
Vatica micrantha Slooten *Notes*: Endemic to Borneo.
Vatica nitens (King) Kosterm.
Vatica oblongifolia Hook.f. subsp. *oblongifolius* *Notes*: Endemic to Borneo.
Vatica pedicellata Brandis *Notes*: EN A1c ver 2.3; endemic to Sarawak, in Kuching, Lundu, Simunjan only.

Ebenaceae

- Diospyros borneensis* Hiern
Diospyros curranii Merr.
Diospyros dictyoneura Hiern
Diospyros ferruginescens Bakh. var. *ferruginescens* *Notes*: Endemic to Borneo.
Diospyros lunduensis Ng *Notes*: Endemic to Borneo, uncommon in Sarawak (Lundu & Semenggoh only).
Diospyros maingayi (Hiern) Bakh.
Diospyros mindanaensis Merr.
Diospyros neurosepala Bakh. *Notes*: Endemic to Borneo.
Diospyros pendula Hasselt ex Hassk.
Diospyros pilosanthera Blanco var. *pilosanthera*
Diospyros puncticulosa Bakh. *Notes*: Endemic to Borneo.
Diospyros ridleyi Bakh.
Diospyros styraciformis King & Gamble
Diospyros venosa Wall. ex A. DC. var. *venosa*
Diospyros sp. 1
Diospyros sp. 2

Elaeocarpaceae

- Elaeocarpus beccarii* DC.
Elaeocarpus clementis Merr.
Elaeocarpus cristatus Coode
Elaeocarpus dolichobotrys Merr.
Elaeocarpus griffithii (Wight) A.Gray
Elaeocarpus petiolatus (Jack) Wall.

Euphorbiaceae

- Blumeodendron calophyllum* Airy Shaw
Blumeodendron tokbrai (Bl.) Kurz
Cephalomappa beccariana Baill. var. *beccariana* *Notes*: Endemic to Sarawak.
Croton argyratus Blume
Endospermum diadenum (Miq.) Airy Shaw
Macaranga bancana (Miq.) Muell.Arg.
Macaranga conifera Muell.Arg.

Macaranga lowii King ex Hook.f.
Macaranga recurvata Gage
Macaranga triloba (Thunb.) Muell.Arg.
Mallotus griffithianus (Muell.Arg.) Hook.f.
Mallotus penangensis Muell.Arg.
Neoscortechinia kingii (Hook.f.) Pax & Hoffm.
Pimeleodendron griffithianum (Muell.Arg.) Benth.
Ptychopyxis costata Miq. var. *oblanceolata* Airy Shaw
Sebastiania borneensis Pax & Hoffm.

Fabaceae

Archidendron borneense (Benth.) I.C. Nielsen
Archidendron microcarpum (Benth.) I.C. Nielsen
Crudia wrayi Prain *Notes*: Not endemic but uncommon in Sarawak (Kuching only).
Dialium indum L. var. *bursa* (de Wit) Rojo
Dialium indum L. var. *indum*
Dialium kunstleri Prain var. *kunstleri*
Dialium platysepalum Baker
Dialium sp. 1
Dialium sp. 2
Koompassia malaccensis Maing. ex Benth.
Parkia sumatrana Miq.
Pithecellobium kunstleri Prain
Sindora irpicina de Wit
Sindora leiocarpa Backer ex de Wit
Sindora velutina Baker
Sindora sp. 1

Fagaceae

Castanopsis costata (Blume) A. DC.
Castanopsis hypophoenicea (Seemen) Soepadmo *Notes*: Endemic to Borneo.
Castanopsis motleyana King
Lithocarpus andersonii Soepadmo *Notes*: Endemic to Borneo.
Lithocarpus coopertus (Blanco) Rehder
Lithocarpus gracilis (Korth.) Soepadmo
Lithocarpus pulcher (King) Markgr. *Notes*: Endemic to Borneo.
Quercus kerangasensis Soepadmo *Notes*: Endemic to Borneo; uncommon in Sarawak (in Ulu Baram, Kuching, Simunjan).

Icacinaceae

Platea latifolia Blume *Notes*: Endemic to Sarawak (4 localities only).

Ixonanthaceae

Allantospermum borneense Forman subsp. *borneense* *Notes*: Type specimen from Semenggoh.
Ixonanthes petiolaris Blume

Lamiaceae

Clerodendrum villosum Blume *Notes*: Endemic to Sarawak (6 localities only).

Teijsmanniodendron bintuluensis Moldenke

Teijsmanniodendron havilandii (Ridl.) G.Rusea *Notes*: Endemic to Sarawak (Sadong & Semenggoh only).

Teijsmanniodendron sarawakanum (H.H.W.Pearson) Kosterm. *Notes*: Endemic to Borneo.

Teijsmanniodendron simplicifolium Merr. *Notes*: Endemic to Borneo.

Teijsmanniodendron subspicatum (H.Hallier) Kosterm.

Lauraceae

Actinodaphne macrophylla (Blume) Nees

Actinodaphne semenggohensis S.Julia *Notes*: Endemic to Sarawak; only from Semenggoh, type specimen from Semenggoh.

Beilschmiedia kunstleri Gamble

Beilschmiedia maingayi Hk.f.

Cryptocarya ferrea Blume var. *ferrea*

Cryptocarya ferrea Blume var. *scortechinii* (Gamble) Ng

Cryptocarya griffithiana Wight var. *crassinervia* (Miq.) Ng

Endiandra clavigera Kosterm. *Notes*: Endemic to Sarawak.

Endiandra coriacea Merr.

Endiandra rubescens (Blume) Miq.

Lindera lucida (Blume) Boerl.

Litsea accedens (Blume) Boerl. var. *oblanceolata* (Gamble) Ng

Litsea gracilipes Hook.f.

Litsea grandis Hook.f.

Litsea lancifolia (Roxb. ex Wall.) Hook.f.

Litsea resinosa Blume

Notaphoebe sp. 1

Notaphoebe sp. 2

Lecythidaceae

Barringtonia lanceolata (Ridl.) Payens *Notes*: Endemic to Borneo.

Barringtonia sarcostachys (Blume) Miq.

Loganiaceae

Norrisia maior Soler.

Magnoliaceae

Magnolia ashtonii Dandy ex Noot.

Magnolia borneensis Noot.

Talauma beccarii Ridl.

Malvaceae

Brownlowia ovalis Kosterm. *Notes*: Type specimen from Semenggoh.

Durio grandiflorus (Most.) Kosterm. *Notes*: VU A1c ver 2.3

Durio graveolens Becc.

Durio kutejensis (Hassk.) Becc. *Notes*: VU A1c ver 2.3

Durio lanceolatus Mast.

Durio malaccensis Planch ex Ma

Durio oblongus Mast.

Durio testudinarius Becc. *Notes*: VU A1c ver 2.3
Grewia gracilis (Stapf ex Ridl.) P.S. Ashton
Heritiera albiflora Kosterm.
Heritiera aurea (Miq.) Kosterm.
Heritiera javanica (Blume) Kosterm.
Heritiera simplicifolia (Mast.) Kosterm.
Heritiera sumatrana (Miq.) Kosterm.
Microcos cinnamomifolia Burret *Notes*: Endemic to Borneo.
Microcos triflora (Blanco) R.C.K.Chung var. *triflora*
Neesia piluliflora Becc.
Pentace borneensis Pierre
Pentace curtisii King
Pentace polyantha Hassk.
Pentace rigida Kosterm.
Scaphium affine (Mast.) Pierre
Scaphium macropodum (Miq.) Beumée ex Heyne
Schoutenia accrescens (Mast.) C.H.Curtis
Schoutenia accrescens (Mast.) C.H.Curtis subsp. *stellata* Roekmowati-Hartono
Sterculia oblongata R.Br.
Sterculia parvifolia Wall. ex R.Br.
Sterculia scortechinii King
Sterculia sp. 1

Melastomataceae

Lijndenia laurina Zoll. & Moritzi
Pternandra hirtella (Cogn.) Nayar

Meliaceae

Aglaia argentea Blume
Aglaia extipulata (Griff.) W.Theob. subsp. *brunneostellata* Pannell
Aglaia forbesii King
Aglaia hiernii King
Aglaia leucophylla King
Aglaia malaccensis (Ridl.) J.A.R.Anderson
Aglaia meliosmoides Craib
Aglaia odoratissima Blume
Aglaia ramotricha Pannell *Notes*: Endemic to Borneo.
Aglaia rubiginosa (Hiern) Pannell
Aglaia sexipetala Griff.
Aglaia speciosa Blume
Aglaia squamulosa King
Aglaia sp. 1
Chisocheton pentandrus (Blanco) Merr. subsp. *paucijugus* (Miq.) Mabb.
Dysoxylum densiflorum (Blume) Miq.
Dysoxylum magnificum Mabb.
Dysoxylum pachyrhache Merr. *Notes*: Endemic to Borneo.
Pseudoclausena chrysogyne (Miq.) T.P.Clark
Reinwardtiodendron humile (Hassk.) Mabb.

Sandoricum borneense Miq. *Notes*: Endemic to Borneo.
Sandoricum dasyneuron Baill. *Notes*: Endemic to Borneo.
Walsura sp. A

Memecylaceae

Memecylon amplexicaule Roxb.
Memecylon argenteum K.Bremer
Memecylon campanulatum C.B.Clarke
Memecylon durum Cogn.
Memecylon garcinioides Blume
Memecylon scolopacinum Ridl.

Moraceae

Artocarpus anisophyllus Miq.
Artocarpus integer (Thunb.) Merr.
Artocarpus kemando Miq.
Artocarpus longifolius Becc. *Notes*: Endemic to Borneo and rare.
Artocarpus nitidus Tréc.
Artocarpus obtusus Jarrett *Notes*: Endemic to Borneo and rare; in Sarawak only from 4 locations, type specimen from Semenggoh.
Artocarpus odoratissimus Blanco *Notes*: Endemic to Borneo.
Artocarpus peltatus Merr. *Notes*: Endemic to Borneo.
Artocarpus rigidus Blume
Parartocarpus venenosus (Zoll. & Moritzi) Becc. subsp. *borneensis* (Becc.) Jarrett *Notes*: Endemic to Borneo.
Prainea frutescens Becc. *Notes*: Endemic to Borneo and uncommon, Sarawak only from west & northern parts (4 localities only).

Myristicaceae

Gymnacranthera bancana (Miq.) J. Sinclair
Gymnacranthera contracta Warb. *Notes*: Endemic to Borneo.
Gymnacranthera farquhariana (Hook.f. & Thomson) Warb. var. *eugeniifolia* (A.DC.) R.T.A.Schouten
Gymnacranthera farquhariana (Hook.f. & Thomson) Warb. var. *farquhariana*
Gymnacranthera forbesii (King) Warb. var. *crassinervis* (Warb.) J. Sinclair *Notes*: Endemic to Borneo.
Gymnacranthera ocellata Schouten *Notes*: Endemic to Borneo.
Horsfieldia androphora W.J. de Wilde *Notes*: Endemic to Borneo.
Horsfieldia borneensis W.J. de Wilde *Notes*: Endemic to Borneo; type specimen from Semenggoh.
Horsfieldia brachiata (King) Warb.
Horsfieldia grandis (Hook.f.) Warb.
Horsfieldia laticostata (J.Sinclair) W.J.de Wilde *Notes*: Endemic to Borneo.
Horsfieldia nervosa W.J.de Wilde *Notes*: Endemic to Sarawak and rare.
Horsfieldia pallidicaula W.J.de Wilde var. *pallidicaula* *Notes*: Endemic to Borneo.
Horsfieldia polyspherula (Hook.f. emend. King) J. Sinclair var. *maxima* W.J.de Wilde *Notes*: Endemic to Borneo.
Horsfieldia punctatifolia J.Sinclair

- Horsfieldia tenuifolia* (J.Sinclair) W.J.de Wilde *Notes*: Endemic to Borneo.
Horsfieldia wallichii (Hook.f. & Thomson) Warb.
Knema curtisii (King) Warb. var. *arenosa*
Knema curtisii (King) Warb. var. *curtisii*
Knema galeata J.Sinclair *Notes*: Endemic to Borneo.
Knema glaucescens Jack
Knema latericia Elmer subsp. *albifolia* (Sinclair) W.J.de Wilde *Notes*: Endemic to Borneo.
Knema latericia Elmer subsp. *ridleyi* (Gand.) W.J.de Wilde
Knema latifolia Warb.
Knema lunduensis (Sinclair) W.J.de Wilde *Notes*: Endemic to Borneo.
Knema membranifolia H.J.P.Winkler *Notes*: Endemic to Borneo.
Knema pedicellata W.J.de Wilde *Notes*: Endemic to Borneo.
Knema pericoriacea Sinclair forma *sarawakensis* *Notes*: Endemic to Borneo.
Knema rufa Warb. *Notes*: Endemic to Borneo.
Knema stenophylla (Warb.) J.Sinclair subsp. *longipedicellata* (Sinclair) W.J.de Wilde *Notes*:
 Endemic to Borneo.
Knema viridis W.J.de Wilde *Notes*: Endemic to Sarawak.
Knema sp. 1
Knema sp. 2
Knema sp. 3
Myristica beccarii Warb.
Myristica borneensis Warb. *Notes*: Endemic to Borneo.
Myristica cinnamomea King
Myristica crassa King
Myristica gigantea King
Myristica iners Blume
Myristica malaccensis Hook.f. subsp. *papillosa* W.J.de Wilde *Notes*: Endemic to Borneo.
Myristica villosa Warb. *Notes*: Endemic to Borneo.

Myrtaceae

- Syzygium acuminatissimum* A. de Camdolle
Syzygium adenophyllum Merrill & Perry *Notes*: Endemic to Borneo.
Syzygium borneense (Miq.) Miq.
Syzygium brachyrachis Merr. & Perry *Notes*: Endemic to Borneo.
Syzygium chloranthum (Duthie) Merrill & Perry
Syzygium durifolium Merrill & Perry *Notes*: Endemic to Borneo and rare, in Sarawak from
 Semenggoh only.
Syzygium glabratum Veldkamp
Syzygium gladiatum (Ridl.) Merrill & Perry *Notes*: Endemic to Borneo and rare; in Sarawak
 from Sabal & Semenggoh.
Syzygium glanduligerum (Ridl.) Merrill & Perry *Notes*: Endemic to Borneo.
Syzygium grande (Wight) Walpers
Syzygium hoseanum (King) Merrill & Perry
Syzygium incarnatum (Elmer) Merrill & Perry
Syzygium inophyllum A. de Candolle
Syzygium kunstleri (King) Bahadur & R.C. Gaur
Syzygium leptostemon (Korth.) Merrill & Perry
Syzygium longiflorum Presl.

- Syzygium napiforme* (Koord. & Valetton) Merrill & Perry
Syzygium nemestrinum (Henderson) I.M. Turner
Syzygium oligomyrum Diels *Notes*: Endemic to Borneo.
Syzygium pendens (Duthie) I.M. Turner
Syzygium polyanthum (Wight) Walpers
Syzygium pyrifolium (Blume) A.de Candolle
Syzygium remotifolium (Ridl.) Merrill & Perry *Notes*: Endemic to Borneo.
Syzygium ridleyi (King) P. Chantaranothai & J. Parn
Syzygium rostratum (Blume) A.de Candolle
Syzygium rugosum Korth.
Syzygium urceolatum Merrill & Perry ssp. *kuchingense* (Merrill) P.S.Ashton *Notes*: Endemic to Borneo.
Syzygium urceolatum Merrill & Perry ssp. *palembanicum* P.S.Ashton
Syzygium sp. 1
Syzygium sp. 2

Ochnaceae

- Gomphia serrata* (Gaertn.) Kanis

Olacaceae

- Anacolosa frutescens* (Blume) Blume
Strombosia ceylanica Gardner

Oleaceae

- Chionanthus havilandii* Kiew *Notes*: Endemic to Sarawak (from 6 localities only).
Chionanthus lucens Kiew

Oxalidaceae

- Sarcotheca diversifolia* (Miq.) Hallier f.

Peraceae

- Chaetocarpus castanocarpus* (Roxb.) Thw.
Trigonopleura malayana Hook.f.

Phyllanthaceae

- Aporosa bullatissima* Airy Shaw *Notes*: Endemic to Borneo; type specimen from Semenggoh.
Aporosa elmeri Merr. *Notes*: Endemic to Borneo.
Aporosa illustris Airy Shaw *Notes*: Endemic to Sarawak.
Aporosa lucida (Miq.) Airy Shaw var. *lucida*
Aporosa nitida Merr. *Notes*: Endemic to Borneo.
Aporosa subcaudata Merr.
Baccaurea macrophylla (Muell.Arg.) Muell.Arg.
Baccaurea maingayi Hook.f.
Baccaurea minor Hook.f.
Baccaurea pyriformis Gage
Baccaurea racemosa (Reinw. ex Blume) Muell.Arg.
Baccaurea reticulata Hook.f.
Baccaurea sarawakensis Pax & Hoffm.

Baccaurea sumatrana (Miq.) Muell.Arg.

Cleistanthus coriaceus Airy Shaw *Notes*: Endemic to Sarawak, type specimen from Semenggoh

Cleistanthus pseudopodocarpus Jabl.

Polygalaceae

Xanthophyllum brevipes Meijden *Notes*: Endemic to Borneo; from 6 localities in Sarawak
(Type specimen from Semenggoh)

Xanthophyllum ceraceifolium Meijden *Notes*: Endemic to Sarawak; from Semenggoh only
(Type specimen from Semenggoh)

Xanthophyllum ecarinatum Chodat *Notes*: Endemic to Borneo.

Xanthophyllum ellipticum Miq.

Xanthophyllum ferrugineum Meijden *Notes*: Endemic to Borneo.

Xanthophyllum flavescens Roxb.

Xanthophyllum griffithii A.W.Benn. var. *angustifolium* Ng

Xanthophyllum parvifolium Meijden *Notes*: Endemic to Borneo.

Xanthophyllum rufum A.W.Benn.

Xanthophyllum stipitatum A.W.Benn.

Xanthophyllum trichocladum Chodat *Notes*: Endemic to Borneo; uncommon in Sarawak
(Kapit & Kuching only).

Xanthophyllum velutinum Chodat *Notes*: Endemic to Borneo.

Proteaceae

Helicia petiolaris Benn.

Putranjivaceae

Drypetes crassipes Pax & Hoffm.

Drypetes eriocarpa Airy Shaw *Notes*: Endemic to Sarawak, from Bukit Raya, Lambir, Sabal
& Semenggoh.

Drypetes longifolia Pax & Hoffm.

Drypetes macrostigma J.J.Sm. *Notes*: Endemic to Borneo.

Rhizophoraceae

Carallia brachiata (Lour.) Merr.

Pellacalyx lobii (Hook.f.) Schimp.

Rosaceae

Prunus arborea (Blume) Kalkman

Prunus arborea (Blume) Kalkman var. *stipulacea* (Blume) Kalkman

Prunus lamponga (Miq.) Kalkman

Rubiaceae

Canthium didymum Ridl.

Diplospora singularis Korth.

Pleiocarpidia capituligera (Ridl.) Bremek.

Porterandia anisophylla (Jack ex Roxb.) Ridl.

Tarenna winkleri Valetton

Timonius eskerianus W.W.Sm.

Rutaceae

- Acronychia pendunculata* (L.) Miq.
Maclurodendron porteri (Hook.f.) T.G.Hartley
Melicope incana T.G.Hartley

Salicaceae

- Flacourtia rukam* Zoll. & Mor.
Guioa diplopetala (Hassk.) Radlk.

Sapindaceae

- Nephelium cuspidatum* Blume var. *ophioides* (Radlk.) Leenh. subvar. *beccarianum* (Radlk.)
 Leenh. *Notes*: Endemic to Borneo.
Nephelium lappaceum L. var. *pallens* (Hiern) Leenh
Nephelium macrophyllum Radlk. *Notes*: Endemic to Borneo.
Pometia pinnata J.R.Forst & G.Forst.
Xerospermum laevigatum Radlk. subsp. *laevigatum*

Sapotaceae

- Madhuca barbata* T.D.Penn. *Notes*: Endemic to Sarawak.
Madhuca engleri (Merr.) Vink *Notes*: Endemic to Borneo and uncommon in Sarawak (only from Semenggoh).
Madhuca erythrophylla (King & Gamble) H.J.Lam *Notes*: Not endemic but uncommon in Sarawak (Semenggoh & Segan only).
Madhuca kingiana (Brace ex King & Gamble) H.J.Lam
Madhuca korthalsii (Pierre ex Burck) H.J.Lam
Madhuca kuchingensis Yii & P.Chai *Notes*: Endemic to Sarawak and confined to the western and central parts of Sarawak.
Madhuca lancifolia H.J.Lam *Notes*: Endemic to Borneo but uncommon; in Sarawak from Semenggoh only.
Madhuca oblongifolia (Merr.) Merr. *Notes*: Not endemic but in Sarawak only from Semenggoh & Bintulu.
Madhuca pallida (Burck) Baehni *Notes*: Not endemic but uncommon in Sarawak.
Madhuca proxila (Pierre ex Dubard) Yii & P.Chai
Madhuca sarawakensis (Pierre ex Dubard) H.J.Lam *Notes*: Endemic to Sarawak; Restricted to Kuching Division.
Madhuca sericea (Miq.) H.J.Lam
Madhuca sp. 1
Palaquium beccarianum (Pierre) P.Royen *Notes*: Endemic to Borneo, uncommon in Sarawak (Kuching Division only).
Palaquium calophyllum (Teijsm. & Binn.) Pierre
Palaquium cryptocariifolium P.Royen *Notes*: Endemic to Borneo; type specimen from Semenggoh.
Palaquium decurrens H.J.Lam *Notes*: Endemic to Borneo.
Palaquium gutta (Hook.f.) Baill.
Palaquium herveyi King & Gamble *Notes*: Endemic to Borneo; in Sarawak from Semenggoh only.
Palaquium leiocarpum Boerlage
Palaquium pseudostratum H.J.Lam

Palaquium ridleyi King & Gamble

Palaquium rigidum Pierre ex Dubard *Notes*: Endemic to Sarawak and confined to Matang, Semenggoh & Baram only.

Palaquium rufolanigerum P.Royen *Notes*: Endemic to Borneo, type specimen from Semenggoh.

Palaquium walsurifolium Pierre ex Dubard

Payena obscura Burck subsp. *havilandii* (King & Gamble) J.T.Pereira *Notes*: Endemic to Borneo; from first and second Division only.

Pouteria malaccensis (C.B.Clarke) Baehni *Notes*: Not endemic but uncommon in Sarawak (Semenggoh & Kelabit Highland only).

Simaroubaceae

Quassia borneensis Noot.

Staphyleaceae

Turpinia sphaerocarpa Hassk. var. *sphaerocarpa* Hassk.

Turpinia sp. 1

Stemonuraceae

Cantleya corniculata (Becc.) R.A.Howard

Stemonurus grandifolius Becc. *Notes*: Endemic to Sarawak.

Stemonurus secundiflorus Blume var. *lanceolatus* (Becc.) Sleum *Notes*: Endemic to Sarawak.

Symplocaceae

Symplocos goodeniacea Noot. *Notes*: Endemic to Borneo and uncommon in Sarawak. (Semenggoh & Usun Apau only)

Symplocos henschelii (Moritz) Benth. ex C.B.Clarke var. *maingayi* (Benth. ex C.B. Clarke) Noot.

Symplocos rubiginosa Wall. ex DC.

Theaceae

Adinandra sarosanthera Miq.

Gordonia havilandii Burkill

Gordonia sarawakensis Keng

Ploiarium alternifolium (Vahl) Melchior

Thymelaeaceae

Aetoxylon sympetalum (Steenis & Domke) Airy Shaw *Notes*: Endemic to Borneo.

Gonystylus affinis Radlk. var. *elegans* Airy Shaw *Notes*: Endemic to Borneo, from Kuching, Lundu and Marudi District in Sarawak.

Gonystylus maingayi Hook.f.

Gonystylus micranthus Airy Shaw *Notes*: Type specimen from Semenggoh

Gonystylus stenosepalus Airy Shaw *Notes*: VU A1c+2c ver 2.3

Ulmaceae

Gironniera nervosa Planch.

Gironniera subaequalis Planch.

