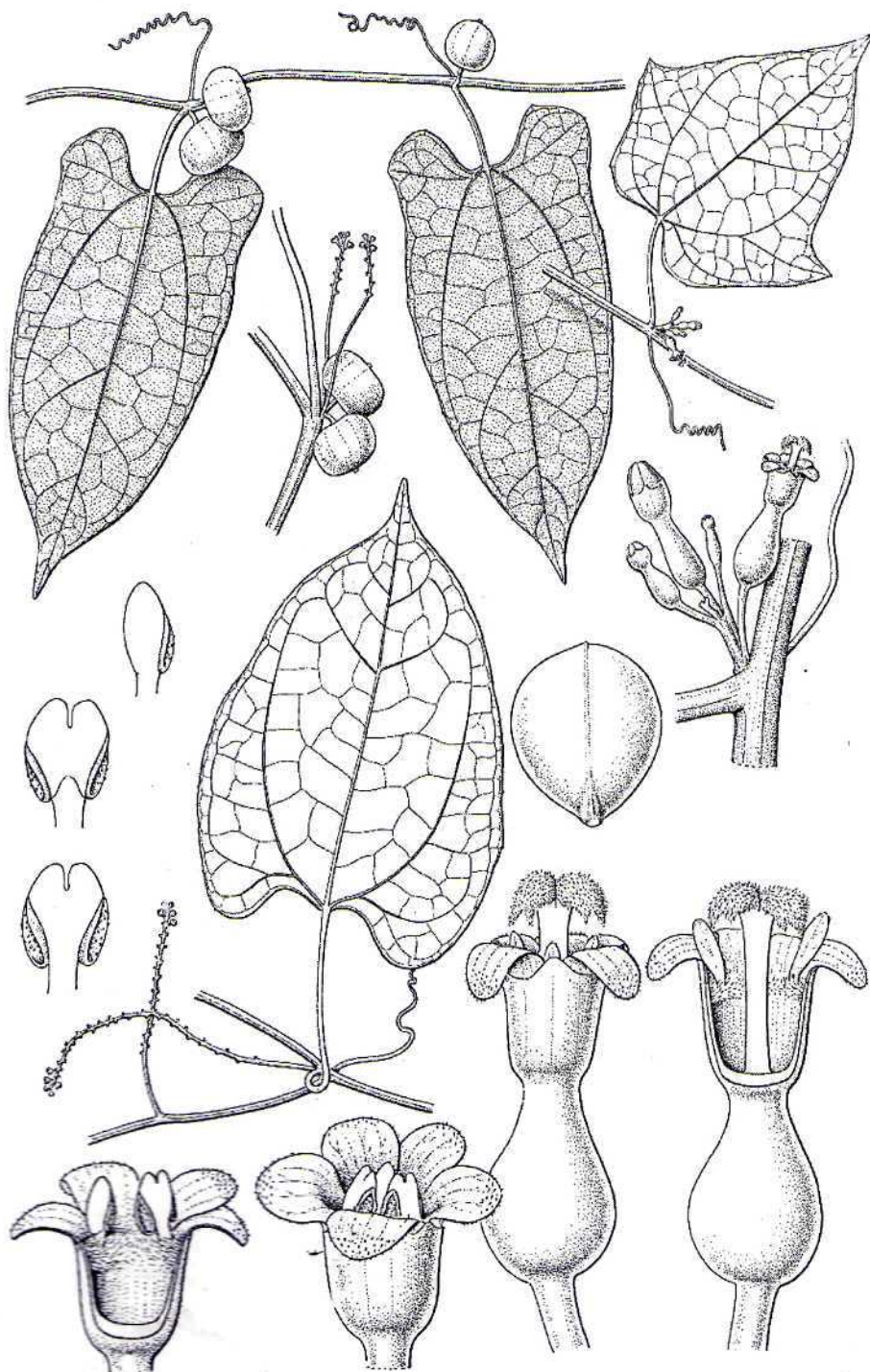




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A TREE SPECIES INVENTORY IN A ONE-HECTARE PLOT AT THE BATANG GADIS NATIONAL PARK, NORTH SUMATRA, INDONESIA

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ABSTRACT

KARTAWINATA, KUSWATA; SAMSOEDIN, ISMAYADI; HERIYANTO, M. AND AFRIASTINI, J. J. 2004. A tree species inventory in a one-hectare plot at the Batang Gadis National Park, North Sumatra, Indonesia. *Reinwardtia* 12 (2): 145 – 157. The results of the inventory of trees with DBH \geq 10 cm shows that 184 species in 41 families, represented by 583 individuals with the total basal areas of 40.56 m² occurred in the one-hectare plot sampled. Together with the saplings and shrubs the number of species was 240 belonging to 47 families. The forest is richer in tree species than other lowland forests in North Sumatra, but poorer than those in Borneo and the Malay Peninsula. Dipterocarps constituted 18.42 % of total species with basal area of 18.99 m² or 46.82 % of the total basal area in the plot. The most prominent species was *Shorea gibbosa*. *Hopea nigra*, reported to be rare in Bangka and Belitung, occurred here as one of the ten leading species. The species-area curve shows that a considerable number of additional species was encountered more or less steadily up to one hectare and there was no indication of levelling off. A *simulated profile diagram* shows the forest may be stratified into five layers: (1) emergent layer, (2) upper canopy, (3) middle canopy, (4) lower canopy and (5) ground canopy. Dipterocarps were leading species in the emergent layer, upper canopy and middle canopy. Only 82 species were regenerating as represented by their presence in the sapling stage ranging from 5 to 50 plants/hectare. *Macaranga lowii* King ex Hook. f. dominated the section which seemed to be previously occupied by gaps.

Key words: Inventory, forest, species richness, dipterocarps, structure, regeneration, North Sumatra.

ABSTRAK

KARTAWINATA, KUSWATA; SAMSOEDIN, ISMAYADI; HERIYANTO, M. AND AFRIASTINI, J.J. 2004. Inventarisasi jenis-jenis pohon pada plot satu hektar di Taman Nasional Batang Gadis, Sumatra Utara, Indonesia. *Reinwardtia* 12 (2): 145 – 157. Hasil inventarisasi pohon dengan diameter setinggi dada \geq 10 cm menunjukkan bahwa 184 jenis dalam 41 suku, yang diwakili oleh 583 pohon dengan luas bidang dasar total 40.56 m² terdapat dalam plot satu hektar yang dicuplik. Bersama-sama dengan belta dan perdu tercatat 240 jenis yang termasuk 47 suku. Jenis-jenis pohon di hutan ini lebih kaya daripada di hutan pamah lain di Sumatera Utara, tetapi lebih miskin daripada di Borneo dan Semenanjung Malaya. Jenis-jenis *Dipterocarpaceae* mencakup 18.42 % dari semua jenis dengan luas bidang dasar 18.99 m² atau 46.82 % dari luas bidang dasar total dalam plot. Jenis yang menonjol adalah *Shorea gibbosa*. *Hopea nigra* yang dilaporkan jarang dan hanya terdapat di Bangka dan Belitung termasuk salah satu dari 10 jenis utama di sini. Kurva jenis-luas menunjukkan bahwa penambahan jenis yang cukup tinggi dapat dilihat sampai luas satu hektar dan tidak menunjukkan tanda-tanda mulai mendatar. Berdasarkan *diagram profil simulasi* dapat dibuat stratifikasi hutan sebagai berikut: (1) lapisan mencuat, (2) kanopi atas, (3) kanopi

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tengah, (4) kanopi bawah dan (5) kanopi dasar. Jenis-jenis Dipterocarpaceae menonjol pada lapisan mencuat, kanopi atas dan kanopi tengah. Regenerasi hanya terdapat pada 82 jenis seperti ditunjukkan oleh kehadirannya dalam fase belta yang berkisar dari 5 sampai 50 tumbuhan/ hektar. *Macaranga lowii* King ex Hook. f. mendominasi bagian plot yang tampaknya sebelumnya berupa rumpang.

Kata kunci: Inventarisasi, hutan, kekayaan jenis, *Dipterocarpaceae*, struktur, regenerasi, Sumatera Utara.

INTRODUCTION

Only a relatively few studies on tree species composition of forests have been undertaken in North Sumatra, Indonesia. Some of them have been published including those of Abdulhadi (1991) and Abdulhadi *et al.* (1984, 1987, 1989a, 1989b, 1991). The present study was conducted in February and March of 2004 as part of biological inventories in the Batang Gadis National Park. The purpose of the present paper is to provide information about tree species richness, frequency, density dominance based on a one-hectare sample in a portion of the park not previously reported in this fashion.

STUDY SITE AND METHOD

The Batang Gadis National Park was established on 29 April 2004 by the decree of the Minister of Forestry No. SK.126/Menhut-II/2004, based on the wish of the local community and the local government. It covers a total area of 108,000 ha in the District of the Mandailing-Natal (Madina), the Province of North Sumatra. It is located between $99^{\circ} 12' 45''$ and $99^{\circ} 47' 45''$ East and between $0^{\circ} 27' 15''$ and $1^{\circ} 01' 57''$ North at the altitude between 300 and 2,145 m a.s.l. (above sea level) with the highest point at the top of the volcanic Mount Sorik Merapi (Sulistiowati & Perbatakusumah 2004). The area is partly mountainous with about 50% are slopes of more than 40% and covers also lowland, swamps, and alluvial fans. Figure 1 shows the map of the National Park and its surrounding area. Geologically the area consists of the pre-tertiary Kuantan formation, which comprised metamorphic rocks and alluvial deposits dominated by sand and gravels (M. N. S Rock cited by Perbatakusumah, unpublished). The nearest rainfall stations (Table 1) showed at Muara Soma the mean annual rainfall of 4004 mm with the highest in November (463 mm) and the lowest in June (178 mm), at Kotanopan 2374 mm with the highest in April (256 mm) and the lowest in July (96 mm) and at Panyabungan (222 m a.s.l.) 1553 mm with the highest in November (191 mm) and the lowest in June (65 mm) and July (65 mm),

which were based on long-term observations ranging from 27 to 60 years (Berlage 1949).

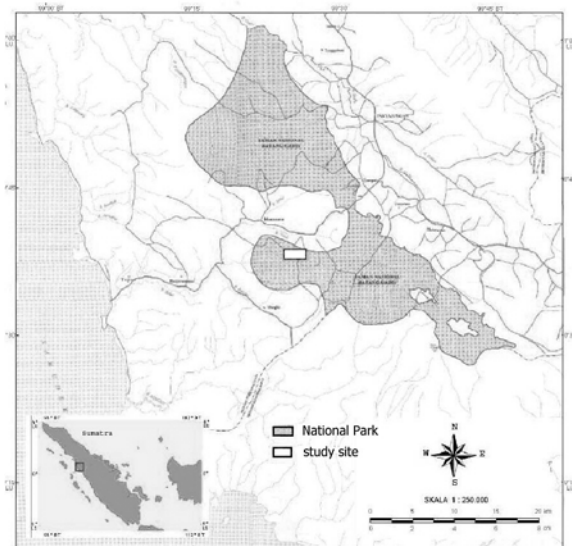


Figure 1. The location of the study site and the Batang Gadis National Park, North Sumatra.

The one-hectare plot sampled was in the form of a 100 x 100 m quadrat and was selected because it was far from any particular settlement so that it is not disturbed by the cutting of trees or collecting of non-timber forest products such as rattans. The plot was established in a primary forest with a canopy cover of about 70-80% at Aek Nangali on a sloping convex ridge at $99^{\circ} 27' 23''$ East and $0^{\circ} 36' 94''$ N and altitude of 660 m a.s.l. The plot was divided into 25 subplots of 20 x 20 m each, where the data on frequency of species were derived, trees with a DBH of 10 cm and greater were marked and enumerated, measured for their diameters and heights and identified. Voucher specimens which were mostly sterile were collected for further identification at the Herbarium Bogoriense at Bogor. Nomenclature followed Whitmore & Tantra (1986) and Steenis *et al.* (1949 – 2004). Plants with diameters of 5 – 9.99 cm were considered saplings or shrubs (those with clumped stems) and were enumerated, measured and identified in five randomly selected subplots.

Table 1. The mean monthly rainfall (January to December) and mean annual rainfall at Muara Soma, Kotanopan and Panyabungan, Mandailing-Natal District.

Locality	Rainfall (mm)												
	Mean Monthly												Mean Annual
	J	F	M	A	M	J	J	A	S	O	N	D	
Muara Soma (500 m a.s.l.)	303	289	347	442	253	178	203	302	363	441	463	414	4004
Kotanopan (433 m a.s.l.)	220	184	218	256	167	114	96	161	190	272	246	250	2374
Panyabungan (222 m a.s.l.)	141	103	150	149	110	65	65	110	138	178	191	153	1553

Source: (Berlage 1949)

RESULTS AND DISCUSSION

Composition

The results of the inventory of trees with DBH of 10 cm and greater shows that 184 species in 41 families, represented by 583 individuals with the total basal areas of 40.56 m² occurred in the one-hectare plot sampled. Of these 184 species, 150 were identified down to specific level, 30 to generic level, three to family level and one was unidentified even to family level. Together with the saplings and shrubs the number of species was 240 belonging to 47 families. Appendix 1 lists all species of trees with DBH \geq 10 cm by family and shows densities, relative densities, frequencies, relative frequencies, basal areas, relative basal areas and Importance Values (IV). They were calculated following the standard procedure as discussed by Mueller-Dombois and Ellenberg (1974). The Total Species Importance Values for a Family (TSIVF) indicate the family importance value, based on the sum of IVs of all species for in a family, which is different from the Family Importance Value of Mori *et al.* (1983) those in Borneo and the Malay Peninsula; while tree densities were higher than those in Ketambe (North Sumatra), Bukit Lagong and Sungai Menyala (the Malay Peninsula), and Ladan and Belalong (Brunei), but lower than those in Malinau and Sebulu (East Kalimantan), Gunung Mulu (Sarawak) and Andulau (Brunei).

Table 2. Compositional and structural characteristics of a one-hectare plot of a lowland forest at the Batang Gadis National Park

Forest characteristics	Dipterocarp	Non Dipterocarp
Number of species	16 (8.70 %)	168 (91.30%)
Density	122 (20.93 %)	461 (79.07)
Basal area (m ²)	18.99 (46.82 %)	21.57 (53.18 %)
Importance Value	84.24 (28.08 %)	215.76 (71.92 %)

Table 3. Comparison of densities and number of species in the present studies with those conducted Sumatra, Malay Peninsula and Borneo.

Locality	Alt (m)	Plot size (ha)	Mean Density (tree/ha)	No of species	Source
East Kalimantan Seturan, Malinau Malinau Sebulu	100	1.0	759	221	Kartawinata (unpublished) Ismayadi (unpublished) Sukardjo <i>et al.</i> (1990)
	100	1.0	640	ca. 211	
	70	1.0	592	276	
Brunei Belalong Ladan Andulau	250	1.0	550	231	Poulsen <i>et al.</i> (1996) Davies & Becker (1996) Davies & Becker (1996)
	70	0.96	480	194	
	60	0.96	596	256	
Sarawak Gunung Mulu	50	1.0	615	223	Proctor <i>et al.</i> (1983)
Malay Peninsula Bukit Lagong Sungei Menyala	460-550	2	494	253	Manokaran & Swaine (1994) Manokaran & Swaine (1994)
	30	2	476.5	232	
North Sumatra Ketambe 1 Ketambe 2 Ketambe 3 Batang Gadis	350-450	1.6	538	116	Abdulhadi <i>et al.</i> (1989) Abdulhadi (1991) Abdulhadi <i>et al.</i> (1991) Present study
	350-450	1.6	420	94	
	350-450	1.6	475	127	
	650	1	583	184	

Table 4. Ten most common families according to the Total Species Importance Values for Families (TSIV) in a one-hectare plot of a lowland forest at the Batang Gadis National Park

No.	Family	TSIV
1	Dipterocarpaceae	84.24
2	Euphorbiaceae	31.97
3	Burseraceae	24.11
4	Myrtaceae	15.89
5	Fagaceae	13.72
6	Lauraceae	11.62
7	Sapotaceae	11.51
8	Myristicaceae	9.73
9	Moraceae	9.09
10	Clusiaceae	7.44
Total		219.32 (73.11 %)

Table 4 indicates ten most common families according to the Total Species Important Values for Families (TSIVF). It can be noted that the *Dipterocarpaceae* was dominant showing TSIVF of 84.24 or 28.08 % of the total and Basal Area of 21.57 m² or 53.18 % of the total (Table 2, Table 4 and Appendix 1). Table 4 reveals ten leading species indicating also the prominence of the dipterocarp species. Altogether 16 species of dipterocarps were recorded in the one hectare plot with the density of 122 and basal area of 18.99 m² (Table 2, Appendix 1). It is interesting to note that *Hopea nigra*, which was reported to occur only Bangka and Belitung (Ashton 1982) was relatively common here with density of 14 trees/ha and frequency of 44 % and was well represented in the sapling stage also (Table 7, 9).

Table 5. Ten leading tree species based on Importance Value (IV) in a one-hectare plot of a lowland forest at the Batang Gadis National Park.

No.	Species	IV
1	<i>Shorea gibbosa</i>	30.29
2	<i>Hopea beccariana</i>	12.84
3	<i>Santiria laevigata</i>	10.84
4	<i>Shorea acuminata</i>	8.44
5	<i>Shorea parvifolia</i>	8.12
6	<i>Artocarpus nitidus</i>	7.20
7	<i>Macaranga lowii</i>	6.70
8	<i>Hopea nigra</i>	5.89
9	<i>Dipterocarpus palembanicus</i>	5.55
10	<i>Santiria tomentosa</i>	5.45
Total		101.38 (33.79 %)

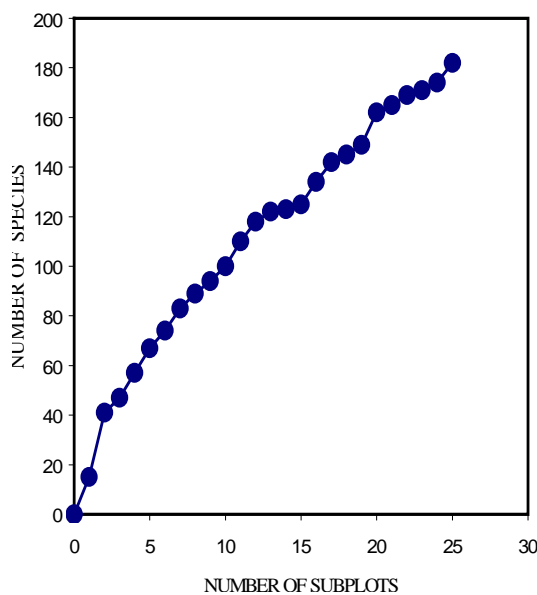


Figure 2. Species-area curve for trees with DBH ≥ 10 cm in a one-hectare plot of a lowland forest at the Batang Gadis National Park, North Sumatra, by plotting the number of species against the number of subplots of 20x20 m each.

In order to determine whether the 184 species recorded in the one-hectare plot represent the total number of species in the area studied, a species-area curve was constructed (Figure 2). The 25 subplots of 20x20 m each were examined to determine the number of additional species recorded each time a subplot was added. It shows that a considerable number of additional species was encountered more or less steadily up to one hectare and there was no indication of levelling off, which may be implied that a one-hectare plot does not represent a minimum area for this forest. This is comparable to situations in the tropical forest elsewhere in Borneo and the Malay Peninsula as reported by various authors (Kartawinata *et al.* 1981, Sist & Saridan 1999, Riswan 1982, Wyatt-Smith 1966, etc.).

Structure

The total basal area (BA) of 40.56 m² (Table 2, Appendix 1) represented that of 583 trees, thus giving a mean basal area/tree of 0.07 m². It should be noted that 18.99 m² or 46.82 % of this total was occupied by dipterocarps. Table 6 shows the basal areas of ten leading species that amounted to 22.22 m² or 54.78 % of the total. It is clear also that six of the species were dipterocarp and *Shorea gibbosa* was the most prominent species with the basal area of 9.36 m². Table 7 shows ten leading species according to the tree density with total of 163 trees /ha or 27.96 % of the total density in the plot (583 trees/ha). Again here dipterocarps are the most prominent species.

Table 6. Ten leading tree species according to the basal area (BA) in a one-hectare plot of a lowland forest at the Batang Gadis National Park

No.	Species	BA (m ²)
1	<i>Shorea gibbosa</i>	9.36
2	<i>Santiria laevigata</i>	2.89
3	<i>Hopea beccariana</i>	2.65
4	<i>Shorea parvifolia</i>	1.83
5	<i>Dipterocarpus palembanicus</i>	1.35
6	<i>Shorea acuminata</i>	1.13
7	<i>Artocarpus nitidus</i>	1.03
8	<i>Santiria tomentosa</i>	0.78
9	<i>Shorea</i> sp.	0.65
10	<i>Litsea</i> sp. 4	0.56
Total		22.22 (54.78 %)

The diameter class distribution of trees in one-hectare plot is presented in Figure 3, which shows more or less a typical size class graph of a tropical undisturbed primary forest. It reveals that

78.6 % of the trees were less than 30 cm DBH (59.2 % in the 10-19.9 cm and 19.4 % in the 20-29.9 cm size class). Only 21.4 % occurred in the diameters greater than 30 cm . It is interesting to note that the trees with large DBH were mainly dipterocarps. Five species were recorded in the 70-80 size class with basal area of 2.53 m², comprising three non-dipterocarps [*Cratoxylon arborescens*, *Mezzetia parvifolia* and *Pouteria malaccensis* and two dipterocarps (*Hopea beccariana* and *Shorea gibbosa*), whose basal area was 1.25 m² or 50 % of the basal in the group. There were no trees with DBH of 80–89.9 cm. In the 90-99.9 cm DBH there were seven trees of five species comprising one non dipterocarp (*Santiria laevigata*) with a basal area of 0.74 m² and three dipterocarps (*Hopea beccariana*, *Shorea gibbosa* and *Shorea* sp.) with the basal area of 4.8 m². The 100-160 cm DBH was entirely occupied by three trees of a single species of dipterocarp (*Shorea gibbosa*) with a basal area of 4.85 m² .

Table 7. Ten leading species according to the density (D) of trees in a one-hectare plot of a lowland forest in the Batang Gadis National Park.

No.	Species	Density
1	<i>Shorea gibbosa</i>	24
2	<i>Shorea acuminata</i>	21
3	<i>Hopea beccariana</i>	20
4	<i>Macaranga lowii</i>	19
5	<i>Shorea parvifolia</i>	15
6	<i>Hopea nigra</i>	14
7	<i>Artocarpus nitidus</i>	14
8	<i>Santiria laevigata</i>	12
9	<i>Lithocarpus lucidus</i>	12
10	<i>Aporusa antennifera</i>	12
Total		163 (27,96 %)

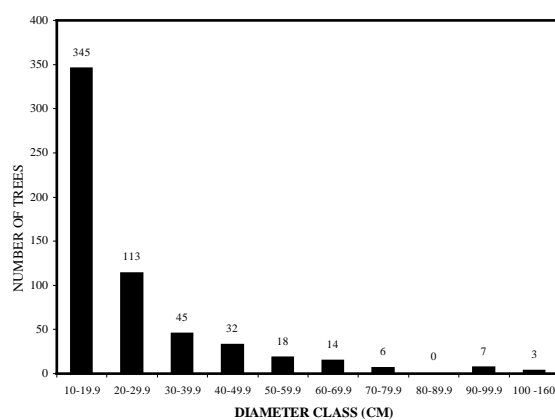


Figure 3. Diameter class distribution of trees with DBH ≥ 10 cm in a one-hectare plot of a lowland forest at the Batang Gadis National Park, North Sumatra

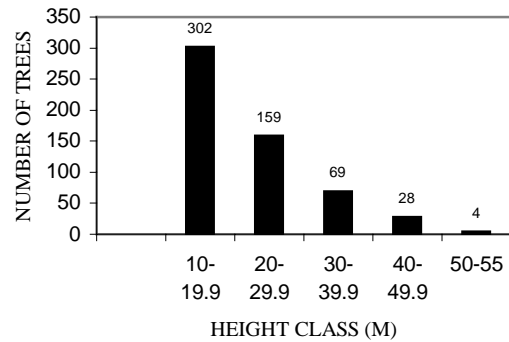


Figure 4. Height class distribution of trees in a one-hectare plot of a lowland forest at the Batang Gadis National Park, North Sumatra

Table 8. Number of trees and species of non-dipterocarps (Non-Dipt.) and dipterocarps (Dipt.) according to the height class distribution in a one-hectare plot of a lowland forest at the Batang Gadis National Park.

Height Class (Cm)	Tree Number		Species	
	Non-Dipt	Dipt	Non-Dipt	Dipt
50.0 - 55	0	4	0	1
40.0 - 49.9	11	17	9	7
30.0 - 39.9	42	27	33	7
20.0 - 29.9	118	41	79	11
10.0 - 19.9	271	31	120	11

Figure 4 and Table 8 show the height class distribution and density of the trees with DBH of 10 cm and greater in the one-hectare plot. It is evident that the majority of the trees were mainly less than 30 m high, totalling 461 trees or 71.9 % of the total number of trees in the plot. Only 101 trees or 17.3 % were in the middle and upper canopy. Trees with height of 50-55 m were only three and all were a dipterocarp, *Shorea gibbosa*, which can be considered as the emergent. In the height class of 40-49.9 m, 28 trees were recorded, of which 17 trees or 60.7 % were dipterocarps. They were 16 species in this group and seven of them were dipterocarps (*Dipterocarpus palembanicus*, *Hopea beccariana*, *Shorea acuminata*, *S. excecliptic*, *S. gibbosa*, *S. parvifolia* and *Vatica micranta*), where again *S. gibbosa* was the most prominent. In the height group of 30-39.9, of 69 trees recorded only 25 trees or 36.2 % were dipterocarps. They consisted of 40 species, including eight species of dipterocarps (*Anisoptera costat*, *D. palembanicus*, *H. beccariana*, *S. acuminata*, *S. gibbosa*, *S. parvifolia* and two *Shorea* spp.). The 10-29.9 cm height class contained 461 trees including 72 trees dipterocarps. Species diversity was high in this height class, where 167 species were recorded,

including 11 dipterocarp species. The prominent species were *Macaranga lowii*, *Santiria laevigata*, *S. tomentosa*, *Shorea acuminata*, *S. gibbosa* and *Swintonia glauca*.

Figure 5 shows a *simulated profile diagram* constructed by plotting the data on tree heights and tree numbers reflecting the sequence of field recording positioned in a linear row. Based on this diagram, the forest canopy (*sensu* Whitmore 1984) may be stratified into five strata: (A) the emergent representing the uppermost layer (50-55 m), (B) upper canopy (30 – 50 m), (C) middle canopy (20-30 m), (D) lower canopy (10-20 m) and (E) ground canopy (0-10 m). The major species composition for strata (A) to (D) were described above. The stratum (E) or the ground canopy consisted mainly of shrubs, small trees and saplings which are described below.

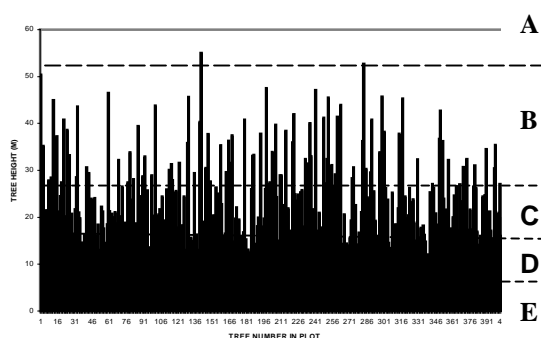


Figure 5. Simulated profile diagram of a one-hectare plot of the lowland forest at the Batang Gadis National Park constructed from data on tree heights and tree numbers reflecting the sequence of field recording positioned in a linear row.

Saplings

Only 82 species were regenerating as represented by their presence in the sapling stage ranging from 5 to 50 plants/hectare. Table 9 shows the species with good regeneration with densities of 25 – 120 saplings/hectare or more than 1 % of the total number of saplings in the plot, which was 2265. *Macaranga lowii* had the highest density of 120 saplings/hectare. It was regenerating well in the disturbed part occurring on one corner of the plot where a gap was at one time formed and now has developed into a building phase of the forest. In the tree stage it was represented by 19 trees/ha which occurred rather widespread as indicated by a frequency of 48 %. Other species of *Macaranga* were *Macaranga gigantea*, *Macaranga hosei* and *Macaranga hypoleuca*. Apparently they

occurred in areas previously occupied by gaps. It should be noted that only five species of dipterocarps had a relatively good regeneration with densities of 25-65 saplings/hectare.

Table 9. Saplings of tree species with density of more than 1 % of the total saplings in the plot

No.	Species	Density (Plants/Ha)	Frequency (%)
1	<i>Macaranga lowii</i>	120	80
2	<i>Syzygium cymosa</i>	80	80
3	<i>Gonyostylus forbesii</i>	80	80
4	<i>Shorea</i> sp. 1	65	80
5	<i>Syzygium racemosum</i>	55	80
6	<i>Hopea beccariana</i>	45	80
7	<i>Syzygium confertum</i>	45	80
8	<i>Chionanthus nitens</i>	45	80
9	<i>Santiria laevigata</i>	45	40
10	<i>Shorea acuminata</i>	45	60
11	<i>Hopea nigra</i>	45	80
12	<i>Beilschmiedia madang</i>	40	40
13	<i>Drypetes longifolia</i> .	35	60
14	<i>Vatica micrantha</i>	35	60
15	<i>Prunus grisea</i>	30	80
16	<i>Mallotus penangensis</i>	30	60
17	<i>Litsea resinosa</i>	30	60
18	<i>Santiria tomentosa</i>	25	60
19	<i>Syzygium</i> sp. 2	25	60
20	<i>Knema laurina</i>	25	60

Ninety nine species of trees had no representation in the sapling stages, 11 dipterocarp species, *i.e.*, *Anisoptera costata*, *Dipterocarpus palembanicus*, *Shorea excelliptica*, *Shorea gibbosa*, *Shorea parvifolia*, *Shorea platyclados*, three *Shorea* spp. *Vatica mangachapoi* and *Vatica perakensis*. There were 55 species were present entirely in the sapling stage (Appendix 2). These were mainly small trees and shrubs and the most common with densities of 25-50 plants/ha were *Ardisia sanguinolenta*, *Cinammomum cuspidatum*, *Ixora pseudo-javanica*, *Saprosma arboreum*, *Sauraruia pendula* and *Urophyllum glabrum*. Some main canopy trees were represented with low densities and frequencies, such as *Dacryodes incurvata*, *Dialium indum*, *Podocarpus neriifolius* and *Lithocarpus* spp.

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Appendix 1. Density (D = trees/ha), Relative Density (RD), Frequency (F=%), Relative Frequency (RF), Basal Area (BA = m²), Relative Basal Area (RBA) and Importance Value (IV) of species and families in a one-hectare plot of lowland forest at the Batang Gadis National Park, North Sumatra.

No.	Family and Species	D	RD	F	RF	BA	RBA	IV
1	2	3	4	5	6	7	8	9
	1. Alangiaceae							
1	<i>Alangium javanicum</i>	1	0.17	4.00	0.21	0.008	0.02	0.40
	Family total	1				0.008		0.40
	2. Anacardiaceae							
2	<i>Buchanania sessilifolia</i>	2	0.34	4.00	0.41	0.066	0.16	0.92
3	<i>Mangifera cf. swintonioides</i>	1	0.17	4.00	0.21	0.029	0.07	0.45
4	<i>Mangifera laurina</i>	4	0.69	16.00	0.82	0.282	0.69	2.21
5	<i>Melanochyla caesia</i>	2	0.34	8.00	0.41	0.036	0.09	0.84
6	<i>Melanochylla bracteata</i>	1	0.17	4.00	0.21	0.034	0.08	0.46
7	<i>Swintonia glauca</i>	8	1.37	28.00	1.44	0.372	0.92	3.73
	Family total	18				0.818		8.61
	3. Annonaceae							
8	<i>Annonaceae</i>	1	0.17	4.00	0.21	0.031	0.08	0.46
9	<i>Annonaceae</i> (t. daun)	1	0.17	4.00	0.21	0.031	0.08	0.46
10	<i>Cyathocalyx biovulatus</i>	13	2.23	48.00	2.47	0.325	0.80	5.50
11	<i>Cyathocalyx</i> sp.1	1	0.17	4.00	0.21	0.040	0.10	0.48
12	<i>Melodorum kentii</i>	1	0.17	4.00	0.21	0.012	0.03	0.41
13	<i>Mezzetia parviflora</i> ec.	1	0.17	4.00	0.21	0.424	1.05	1.42
14	<i>Polyalthia cauliflora</i>	1	0.17	4.00	0.21	0.015	0.04	0.42
15	<i>Polyalthia lateriflora</i>	2	0.34	8.00	0.41	0.050	0.12	0.88
16	<i>Polyalthia sumatrana</i>	1	0.17	4.00	0.21	0.019	0.05	0.42
17	<i>Sageraea lanceolata</i>	1	0.17	4.00	0.21	0.033	0.08	0.46
18	<i>Xylopiya malayana</i>	6	1.03	24.00	1.24	0.321	0.79	3.06
	Family total	28				1.270		13.50
	4. Arecaceae							
19	<i>Oncosperma horridum</i>	1	0.17	4.00	0.21	0.027	0.07	0.44
	Family total	1				0.027		0.44
	5. Asteraceae							
20	<i>Vernonia arborea</i>	1	0.17	4.00	0.21	0.010	0.03	0.40
	Family total	1				0.010		0.40
	6. Bombacaceae							
21	<i>Durio malaccensis</i>	2	0.34	8.00	0.41	0.062	0.15	0.91
22	<i>Durio oxleyanus</i>	1	0.17	4.00	0.21	0.017	0.04	0.42
23	<i>Durio zibethinus</i>	1	0.17	4.00	0.21	0.023	0.06	0.43
24	<i>Neesia altissima</i>	1	0.17	4.00	0.21	0.166	0.41	0.79
	Family total	5				0.268		2.55
	7. Burseraceae							
25	<i>Canarium littorale</i>	1	0.17	4.00	0.21	0.020	0.05	0.43
26	<i>Canarium patentinervium</i>	7	1.20	24.00	1.24	0.130	0.32	2.76
27	<i>Dacryodes laxa</i>	2	0.34	8.00	0.41	0.330	0.81	1.57
28	<i>Dacryodes rostrata</i>	5	0.86	20.00	1.03	0.142	0.35	2.24
29	<i>Dacryodes</i> sp.1	1	0.17	4.00	0.21	0.011	0.03	0.41
30	<i>Santiria apiculata</i>	1	0.17	4.00	0.21	0.020	0.05	0.43
31	<i>Santiria laevigata</i>	12	2.06	32.00	1.65	2.894	7.13	10.84
32	<i>Santiria tomentosa</i>	11	1.89	32.00	1.65	0.775	1.91	5.45
	Family total	40				4.321		24.11

No.	Family and Species	D	RD	F	RF	BA	RBA	IV
1	2	3	4	5	6	7	8	9
	8. Celastraceae							
33	<i>Kokoona littoralis</i>	4	0.69	16.00	0.82	0.157	0.39	1.90
	Family total	4				0.157		1.90
	9. Clusiaceae							
34	<i>Calophyllum rigidum</i>	1	0.17	4.00	0.21	0.024	0.06	0.44
35	<i>Cratoxylon arborescens</i>	4	0.69	16.00	0.82	0.556	1.37	2.88
36	<i>Garcinia gaudichaudii</i>	1	0.17	4.00	0.21	0.011	0.03	0.41
37	<i>Garcinia havilandii</i>	1	0.17	4.00	0.21	0.030	0.07	0.45
38	<i>Garcinia parvifolia</i>	1	0.17	4.00	0.21	0.018	0.04	0.42
39	<i>Garcinia</i> sp. 1	1	0.17	4.00	0.21	0.010	0.02	0.40
40	<i>Mesua coriacea</i>	5	0.86	20.00	1.03	0.152	0.37	2.26
41	<i>Mesua ferrea</i>	1	0.17	4.00	0.21	0.102	0.25	0.63
	Family total	15				0.903		7.89
	10. Cornaceae							
42	<i>Mastixia trichotoma</i>	5	0.86	20.00	1.03	0.178	0.44	2.33
	Family total	5				0.178		2.33
	11. Dipterocarpaceae							
43	<i>Anisoptera costata</i>	1	0.17	4.00	0.21	0.274	0.67	1.05
44	<i>Dipterocarpus palembanicus</i>	7	1.20	20.00	1.03	1.347	3.32	5.55
45	<i>Hopea beccariana</i>	20	3.43	56.00	2.89	2.647	6.53	12.84
46	<i>Hopea nigra</i>	14	2.40	44.00	2.27	0.496	1.22	5.89
47	<i>Shorea acuminata</i>	21	3.60	40.00	2.06	1.126	2.78	8.44
48	<i>Shorea exelliptica</i>	1	0.17	4.00	0.21	0.072	0.18	0.55
49	<i>Shorea gibbosa</i>	24	4.12	60.00	3.09	9.361	23.08	30.29
50	<i>Shorea parvifolia</i>	15	2.57	20.00	1.03	1.832	4.52	8.12
51	<i>Shorea platyclados</i>	1	0.17	4.00	0.21	0.035	0.09	0.46
52	<i>Shorea</i> sp.	1	0.17	4.00	0.21	0.651	1.60	1.98
53	<i>Shorea</i> sp. 1	2	0.34	8.00	0.41	0.243	0.60	1.35
54	<i>Shorea</i> sp. 2	4	0.69	16.00	0.82	0.081	0.20	1.71
55	<i>Shoreasp.3</i>	1	0.17	4.00	0.21	0.246	0.61	0.99
56	<i>Vatica mangachapoi</i>	2	0.34	8.00	0.41	0.028	0.07	0.83
57	<i>Vatica micrantha</i>	6	1.03	20.00	1.03	0.482	1.19	3.25
58	<i>Vatica perakensis</i>	2	0.34	8.00	0.41	0.070	0.17	0.93
	Family total	122				18.991		84.24
	12. Ebenaceae							
59	<i>Diospyros pseudo-malabarica</i>	1	0.17	4.00	0.21	0.009	0.02	0.40
60	<i>Diospyros</i> sp. 1	1	0.17	4.00	0.21	0.010	0.03	0.40
61	<i>Diospyros</i> sp. 2	2	0.34	8.00	0.41	0.017	0.04	0.80
62	<i>Diospyros sumatrana.</i>	1	0.17	4.00	0.21	0.010	0.03	0.40
	Family total	5				0.046		2.00
	13. Elaeocarpaceae							
63	<i>Elaeocarpus mastersii</i>	1	0.17	4.00	0.21	0.086	0.21	0.59
64	<i>Elaeocarpus parvifolius</i>	1	0.17	4.00	0.21	0.043	0.11	0.48
	Family total	2				0.129		1.07
	14. Euphorbiaceae							
65	<i>Aporusa antennifera</i>	12	2.06	40.00	2.06	0.220	0.54	4.66
66	<i>Aporusa falcifera</i>	3	0.51	8.00	0.41	0.111	0.27	1.20
67	<i>Aporusa grandistipula</i>	2	0.34	8.00	0.41	0.023	0.06	0.81

No.	Family and Species	D	RD	F	RF	BA	RBA	IV
1	2	3	4	5	6	7	8	9
68	<i>Aporusa maingayi</i>	1	0.17	4.00	0.21	0.013	0.03	0.41
69	<i>Aporusa symolocoides</i>	1	0.17	4.00	0.21	0.010	0.02	0.40
70	<i>Baccaurea brevipes</i>	1	0.17	4.00	0.21	0.024	0.06	0.44
71	<i>Baccaurea dulcis</i>	1	0.17	4.00	0.21	0.075	0.18	0.56
72	<i>Baccaurea multiflora</i>	3	0.51	8.00	0.41	0.065	0.16	1.09
73	<i>Blumeodendron tokbrai</i>	4	0.69	12.00	0.62	0.184	0.45	1.76
74	<i>Drypetes longifolia</i>	3	0.51	12.00	0.62	0.035	0.09	1.22
75	<i>Macaranga gigantea</i>	3	0.51	8.00	0.41	0.125	0.31	1.24
76	<i>Macaranga hosei</i>	1	0.17	4.00	0.21	0.126	0.31	0.69
77	<i>Macaranga hypoleuca</i>	4	0.69	12.00	0.62	0.232	0.57	1.88
78	<i>Macaranga lowii</i>	19	3.26	48.00	2.47	0.393	0.97	6.70
79	<i>Mallotus penangensis</i>	9	1.54	36.00	1.86	0.222	0.55	3.95
80	<i>Neoscortechinia kingii</i>	2	0.34	8.00	0.41	0.038	0.09	0.85
81	<i>Pimeleodendron griffithianum</i>	5	0.86	20.00	1.03	0.132	0.33	2.21
82	<i>Ptychophyxis kingii</i>	1	0.17	4.00	0.21	0.057	0.14	0.52
83	<i>Sapium baccatum</i>	2	0.34	8.00	0.41	0.260	0.64	1.40
	<i>Family total</i>	77				2.343		31.97
	15. Fabaceae							
84	<i>Archidendon</i> sp. 1	1	0.17	4.00	0.21	0.012	0.03	0.41
85	<i>Archidendron bubalinum</i>	2	0.34	8.00	0.41	0.066	0.16	0.92
86	<i>Fabaceae</i>	2	0.34	4.00	0.21	0.028	0.07	0.62
87	<i>Koompassia malaccensis</i>	9	1.54	28.00	1.44	0.517	1.27	4.26
88	<i>Ormosia sumatrana</i>	1	0.17	4.00	0.21	0.008	0.02	0.40
89	<i>Parkia speciosa</i>	1	0.17	4.00	0.21	0.049	0.12	0.50
	<i>Family total</i>	16				0.680		7.10
	16. Fagaceae							
90	<i>Castanopsis</i> sp. 1	3	0.51	8.00	0.41	0.094	0.23	1.16
91	<i>Castanopsis</i> sp. 2	1	0.17	4.00	0.21	0.045	0.11	0.49
92	<i>Lithocarpus bennetii</i>	1	0.17	4.00	0.21	0.018	0.04	0.42
93	<i>Lithocarpus cyclophorus</i>	1	0.17	4.00	0.21	0.163	0.40	0.78
94	<i>Lithocarpus elegans</i>	1	0.17	4.00	0.21	0.017	0.04	0.42
95	<i>Lithocarpus hystrix</i>	2	0.34	8.00	0.41	0.045	0.11	0.87
96	<i>Lithocarpus lucidus</i>	12	2.06	36.00	1.86	0.268	0.66	4.57
97	<i>Lithocarpus</i> sp. 1	1	0.17	4.00	0.21	0.035	0.09	0.46
98	<i>Quercus argentata</i>	4	0.69	12.00	0.62	0.239	0.59	1.89
99	<i>Quercus gemelliflora</i>	1	0.17	4.00	0.21	0.284	0.70	1.08
100	<i>Quercus subsericea</i>	2	0.34	8.00	0.41	0.333	0.82	1.58
	<i>Family total</i>	29				1.540		13.72
	17. Flacourtiaceae							
101	<i>Ryparosa caesia</i>	4	0.69	16.00	0.82	0.185	0.46	1.97
	<i>Family total</i>	4				0.185		1.97
	18. Icacinaceae							
102	<i>Platea excelsa</i>	1	0.17	4.00	0.21	0.042	0.10	0.48
	<i>Family total</i>	1				0.042		0.48
	19. Lauraceae							
103	<i>Alseodaphne peduncularis</i>	1	0.17	4.00	0.21	0.011	0.03	0.41
104	<i>Beilschmiedia dictyoneura</i>	1	0.17	4.00	0.21	0.027	0.07	0.44

No.	Family and Species	D	RD	F	RF	BA	RBA	IV
1	2	3	4	5	6	7	8	9
105	<i>Beilschmiedia madang</i>	2	0.34	4.00	0.21	0.104	0.26	0.81
106	<i>Cryptocarya ferrea</i>	1	0.17	4.00	0.21	0.010	0.02	0.40
107	<i>Cryptocarya</i> sp. 1	2	0.34	4.00	0.21	0.036	0.09	0.64
108	<i>Litsea firma</i>	1	0.17	4.00	0.21	0.088	0.22	0.60
109	<i>Litsea odorifera</i>	5	0.86	16.00	0.82	0.334	0.82	2.51
110	<i>Litsea resinosa</i>	2	0.34	4.00	0.21	0.021	0.05	0.60
111	<i>Litsea</i> sp.	1	0.17	4.00	0.21	0.008	0.02	0.40
112	<i>Litsea</i> sp. 1	1	0.17	4.00	0.21	0.088	0.22	0.60
113	<i>Litsea</i> sp. 2	1	0.17	4.00	0.21	0.020	0.05	0.43
114	<i>Litsea</i> sp. 3	2	0.34	8.00	0.41	0.216	0.53	1.29
115	<i>Litsea</i> sp. 4	3	0.51	12.00	0.62	0.559	1.38	2.51
	<i>Family total</i>	23				1.523		11.62
	20. Melastomataceae							
116	<i>Memecylon oligoneurum</i>	2	0.34	8.00	0.41	0.093	0.23	0.99
117	<i>Pternandra cordata</i>	1	0.17	4.00	0.21	0.008	0.02	0.40
118	<i>Pternandra rostrata</i>	3	0.51	12.00	0.62	0.034	0.08	1.22
119	<i>Pternandra</i> sp. 1	1	0.17	4.00	0.21	0.009	0.02	0.40
	<i>Family total</i>	7				0.144		3.00
	21 . Meliaceae							
120	<i>Aglaiia ganggo</i>	1	0.17	4.00	0.21	0.038	0.09	0.47
121	<i>Aglaiia odoratissima</i>	1	0.17	4.00	0.21	0.038	0.09	0.47
122	<i>Aglaiia</i> sp. 1	1	0.17	4.00	0.21	0.008	0.02	0.40
123	<i>Chisocheton patens</i>	1	0.17	4.00	0.21	0.017	0.04	0.42
124	<i>Dysoxylum cauliflorum</i>	9	1.54	28.00	1.44	0.178	0.44	3.43
125	<i>Dysoxylum</i> sp.	1	0.17	4.00	0.21	0.011	0.03	0.41
126	<i>Sandoricum koetjape</i>	1	0.17	4.00	0.21	0.035	0.09	0.46
	<i>Family total</i>	15				0.325		6.05
	22. Moraceae							
127	<i>Artocarpus kemando</i>	2	0.34	4.00	0.21	0.067	0.17	0.71
128	<i>Artocarpus nitida</i>	14	2.40	44.00	2.27	1.025	2.53	7.20
129	<i>Ficus drupacea</i>	2	0.34	8.00	0.41	0.172	0.43	1.18
	<i>Family total</i>	18				1.265		9.09
	23. Myristicaceae							
130	<i>Horsfieldia polyspherula</i>	9	1.54	36.00	1.86	0.354	0.87	4.27
131	<i>Knema cinerea</i>	9	1.54	28.00	1.44	0.135	0.33	3.32
132	<i>Knema latericia</i>	2	0.34	8.00	0.41	0.041	0.10	0.86
133	<i>Knema laurina</i>	1	0.17	4.00	0.21	0.010	0.03	0.40
134	<i>Myrtistica iners</i>	2	0.34	8.00	0.41	0.048	0.12	0.87
	<i>Family total</i>	23				0.588		9.73
	24. Myrsinaceae							
135	<i>Embelia</i> sp. 1	1	0.17	4.00	0.21	0.017	0.04	0.42
	<i>Family total</i>	1				0.017		0.42
	25. Myrtaceae							
136	<i>Syzygium acuminatum</i>	3	0.51	12.00	0.62	0.133	0.33	1.46
137	<i>Syzygium antisepticum</i>	5	0.86	16.00	0.82	0.227	0.56	2.24
138	<i>Syzygium chloranthum</i>	3	0.51	8.00	0.41	0.197	0.49	1.41
139	<i>Syzygium confertum</i>	5	0.86	12.00	0.62	0.062	0.15	1.63
140	<i>Syzygium cymosum</i>	2	0.34	8.00	0.41	0.067	0.17	0.92

No.	Family and Species	D	RD	F	RF	BA	RBA	IV
1	2	3	4	5	6	7	8	9
141	<i>Syzygium fastigiatum</i>	2	0.34	8.00	0.41	0.041	0.10	0.86
142	<i>Syzygium flosculifera</i>	3	0.51	12.00	0.62	0.037	0.09	1.22
143	<i>Syzygium griffithii</i>	1	0.17	4.00	0.21	0.036	0.09	0.47
144	<i>Syzygium racemosum</i>	4	0.69	16.00	0.82	0.090	0.22	1.73
145	<i>Syzygium</i> sp. 1	1	0.17	4.00	0.21	0.048	0.12	0.50
146	<i>Syzygium</i> sp. 2	1	0.17	4.00	0.21	0.026	0.06	0.44
147	<i>Syzygium</i> sp. 3	1	0.17	4.00	0.21	0.283	0.70	1.08
148	<i>Syzygium</i> sp. 4	1	0.17	4.00	0.21	0.059	0.15	0.52
149	<i>Syzygium</i> sp. 5	1	0.17	4.00	0.21	0.011	0.03	0.41
150	<i>Tristaniopsis whiteana</i>	1	0.17	4.00	0.21	0.071	0.17	0.55
	<i>Family total</i>	754				58.593		397.09
	26. Olacaceae							
151	<i>Strombosia ceylanica</i>	3	0.51	12.00	0.62	0.031	0.08	1.21
		3				0.031		1.21
	27. Oleaceae							
152	<i>Chionanthus nitens</i>	5	0.86	20.00	1.03	0.058	0.14	2.03
	<i>Family total</i>	5				0.058		2.03
	28. Polygalaceae							
153	<i>Xanthophyllum rufum</i>	7	1.20	24.00	1.24	0.291	0.72	3.15
	<i>Family total</i>	7				0.291		3.15
	29. Proteaceae							
154	<i>Helicia serrata</i>	1	0.17	4.00	0.21	0.012	0.03	0.41
	<i>Family total</i>	1				0.012		0.41
	30. Rosaceae							
155	<i>Atuna racemosa</i>	2	0.34	8.00	0.41	0.077	0.19	0.95
156	<i>Prunus arborea</i>	1	0.17	4.00	0.21	0.064	0.16	0.54
157	<i>Prunus grisea</i>	1	0.17	4.00	0.21	0.013	0.03	0.41
	<i>Family total</i>	4				0.154		1.89
	31. Rubiaceae							
158	<i>Aidia racemosa</i>	1	0.17	4.00	0.21	0.009	0.02	0.40
159	<i>Canthium glabrum</i>	1	0.17	4.00	0.21	0.009	0.02	0.40
160	<i>Tricalysia singularis</i>	2	0.34	8.00	0.41	0.022	0.06	0.81
	<i>Family total</i>	4				0.040		1.61
	32. Santalaceae							
161	<i>Scleropyrum wallichianum</i>	1	0.17	4.00	0.21	0.010	0.02	0.40
	<i>Family total</i>	1				0.010		0.40
	33. Sapindaceae							
162	<i>Nephelium chryseum</i>	6	1.03	24.00	1.24	0.135	0.33	2.60
163	<i>Nephelium cuspidatum</i>	2	0.34	8.00	0.41	0.043	0.11	0.86
164	<i>Nephelium lappaceum</i>	1	0.17	4.00	0.21	0.022	0.05	0.43
165	<i>Xerospermum laevigatum</i>	1	0.17	4.00	0.21	0.011	0.03	0.41
	<i>Family total</i>	10				0.211		4.30
	34. Sapotaceae							
166	<i>Palaquium gutta</i>	2	0.34	8.00	0.41	0.044	0.11	0.86
167	<i>Palaquium hexandrum</i>	7	1.20	24.00	1.24	0.237	0.58	3.02
168	<i>Palaquium quercifolium</i>	1	0.17	4.00	0.21	0.091	0.22	0.60
169	<i>Palaquium rostratum</i>	1	0.17	4.00	0.21	0.302	0.74	1.12

No.	Family and Species	D	RD	F	RF	BA	RBA	IV
1	2	3	4	5	6	7	8	9
170	<i>Payena leerii</i>	8	1.37	24.00	1.24	0.427	1.05	3.66
171	<i>Planchonella nitida</i>	1	0.17	4.00	0.21	0.012	0.03	0.41
172	<i>Pouteria malaccensis</i>	2	0.34	8.00	0.41	0.438	1.08	1.83
	<i>Family total</i>	22				1.550		11.51
	35. Sterculiaceae							
173	<i>Heritiera sumatrana</i>	3	0.51	12.00	0.62	0.081	0.20	1.33
174	<i>Sterculia urceolata</i>	1	0.17	4.00	0.21	0.012	0.03	0.41
	<i>Family total</i>	4				0.093		1.74
	36. Stryracaceae							
175	<i>Stryrax paralleloneurus</i>	6	1.03	16.00	0.82	0.393	0.97	2.82
	<i>Family total</i>	6				0.393		2.82
	37. Symplocaceae							
176	<i>Symplocos</i> sp. 1	1	0.17	4.00	0.21	0.020	0.05	0.43
	<i>Family total</i>	1				0.020		0.43
	38. Theaceae							
177	<i>Gordonia singaporioana</i>	3	0.51	12.00	0.62	0.028	0.07	1.20
178	<i>Pyrenaria serrata</i>	3	0.51	8.00	0.41	0.200	0.49	1.42
179	<i>Thea</i> sp. 1	2	0.34	8.00	0.41	0.032	0.08	0.83
	<i>Family total</i>	8				0.260		3.46
	39. Thymelaeaceae							
180	<i>Aquilaria malaccensis</i>	1	0.17	4.00	0.21	0.013	0.03	0.41
182	<i>Gonystylus forbesii</i>	7	1.20	24.00	1.24	0.102	0.25	2.69
	<i>Family total</i>	8				0.114		3.10
	40. Verbenaceae							
183	<i>Vitex quinata</i>	1	0.17	4.00	0.21	0.013	0.03	0.41
	<i>Family total</i>	1				0.013		0.41
	41. Unidentified family							
184	<i>Unidentified</i>	2	0.34	2.00	0.41	0.093	0.23	0.98
	<i>Family total</i>	2				0.093		0.98
	TOTAL	583	100.0	1,930.00	100.0	40.56	100.0	300.0

Note: The followings are the list of species of shrubs, small trees and saplings which are not listed above.

Actinidiaceae: *Saurauia pendula*; **Anacardiaceae:** *Buchanania sessilifolia*; **Annonaceae:** *Unidentified*; *Polyalthia* sp.1, *Polyalthia* sp. 2; *Polyalthia subcordata*, *Popowia pisocarpa*, *Sageraea elliptica*; **Apocynaceae:** *Alstonia angustiloba*; **Arecaceae:** *Pinanga* sp.; **Burseraceae:** *Dacryodes incurvata*; **Clusiaceae:** *Calophyllum* sp., *Mesua* sp.; **Convolvulaceae:** *Erycibe* sp.; **Crypteroniaceae:** *Crypteronia* sp.; **Ebenaceae:** *Diospyros frutescens*; **Euphorbiaceae:** *Aporusa cf. prainiana*, *Baccaurea javanica*, *Baccaurea minutiflora*, *Glochidion* sp., *Mallotus macrostachyus*, *Sauropus rhamnoides*, *Trigonostemon serratus*; **Fabaceae:** *Dialium indum*; **Fagaceae:** *Lithocarpus* sp. 1, *Lithocarpus* sp. 2; **Lauraceae:** *Actinodaphne* sp., *Cinnamomum cuspidatum*, *Lindera caesia*, *Litsea lanceolata*., *Litsea oppositifolia*, *Litsea pedunculata*; **Melastomataceae:** *Pternandra azurea*; **Meliaceae:** *Aglaiia palembanica*, *Aglaiia* sp., *Lansium domesticum*, *Reinwardtiodendron humile*; **Moraceae:** *Ficus* sp., *Ficus uncinulata*; **Myrsinaceae:** *Ardisia nagelii*, *Ardisia sanguinolenta*; **Myrtaceae:** *Rhodamnia cinerea*, *Syzygium spicatum*; **Podocarpaceae:** *Podocarpus nerifolius*; **Polygalaceae:** *Xanthophyllum affine*; **Rubiaceae:** *Canthium glabrum*, *Ixora pseudojavanica*, *Lasianthus stipularis*, *Saprosma arboreum*, *Unidentified*, *Urophyllum glabrum*; **Rutaceae:** *Euodia glabra*; **Theaceae:** *Ternstroemia* sp., *Adinandra dasyantha*; **Tiliaceae:** *Microcos crassifolia*.

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