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VARIATION IN THE COMPOSITION AND STRUCTURE OF NATURAL LOWLAND FORESTS AT BODOGOL, GUNUNG GEDE PANGRANGO NATIONAL PARK, WEST JAVA, INDONESIA

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ABSTRACT
SADILI, A., SALAMAH, A., MIRMANTO, E. & KARTAWINATA, K. 2023. Variation in the composition and structure of natural lowland forests at Bodogol, Gunung Gede Pangrango National Park, West Java, Indonesia. *Reinwardtia* 22(1): 1–25. — An analysis of the composition and structure of lowland natural forests was carried out in Bodogol, Gunung Gede Pangrango National Park (GGPNP). The two study plots (P1CS and P2CS) were located on Cisuren and one plot (P3CP) on Cipadaranten hill. We recorded 107 species and 48 families with an average basal area of 19.73 m^2/ha, and an average density of 348 trees/ha. The species richness was poorer than those of the typical lowland rainforests of Kalimantan and Sumatra but comparable to those of the montane forests of Java. The IUCN-Red Listed species were *Castanopsis argentea* and *Castanopsis tungurrut* (critical) and *Saurauia bracteosa* (vulnerable). Based on the two dominant species, the forests can be designated as the *Maesopsis eminii-Syzygium acuminatissimum* association and *Syzygium acuminatissimum-Lithocarpus korthalsii* association. *Maesopsis eminii* was dominant in P1CS (IV= 56.46%) and P3CP (IV=55.94%), while *Syzygium acuminatissimum* in P2CS (IV= 43.67%). *Maesopsis eminii* was a strongly aggressive and invasive species, that endangered the purity of the natural forest GGPNP, therefore, it must be eradicated. Vertically, P2CS and P3CP consisted of four strata, while P1CS had three strata. This one-hectare study can be considered as a minimal area to reflect the floristic representation of lowland forest and submontane forest.

Key words: Association, forest structure, Gunung Gede Pangrango National Park, lowland forests, minimal area, species composition, species richness.

ABSTRAK
SADILI, A., SALAMAH, A., MIRMANTO, E. & KARTAWINATA, K. 2023. Variasi komposisi dan struktur hutan pamah alami di Bodogol, Taman Nasional Gunung Gede Pangrango, Jawa Barat, Indonesia. *Reinwardtia* 22(1): 1–25. — Analisis komposisi dan struktur hutan pamah alami dilakukan di Bodogol, Taman Nasional Gunung Gede Pangrango (TNGGP). Kajian dilakukan di dua petak (P1CS dan P2CS) di bukit Cisuren, dan satu petak (P3CP) di bukit Cipadaranten. Dalam tiga petak tersebut tercatat 107 jenis dan 48 suku, dengan luas area dasar rata-rata 19,73 m^2/ha dan kerapatan rata-rata 348 pohon/ha. Kekayaan jenis di lokasi penelitian ini lebih rendah daripada di hutan hujan pamah Kalimantan dan Sumatra, tetapi sebanding dengan di hutan pegunungan Jawa. Berdasarkan IUCN Red List *Castanopsis argentea* dan *Castanopsis tungurrut* tercatat sebagai jenis kritis dan *Saurauia bracteosa* sebagai jenis rentan. Berdasarkan dua jenis dominan hutan di petak penelitian dapat disebut sebagai asosiasi *Maesopsis eminii-Syzygium acuminatissimum* dan asosiasi *Syzygium acuminatissimum-Lithocarpus korthalsii*. *Maesopsis eminii* dominan di P1CS (IV=56,46%) dan P3CP (IV=55,94%), sementara *Syzygium acuminatissimum* dominan di P2CS (IV=43,67%). *Maesopsis eminii* adalah jenis invasif yang sangat agresif sehingga membahayakan kemurnian hutan pegunungan alami TNGGP, oleh karena itu harus diberantas. Secara vertikal, struktur P2CS dan P3CP terdiri dari empat strata, sementara P1CS tiga strata. Hasil penelitian ini menyimpulkan bahwa luas satu hektar dapat dianggap sebagai area minimum yang dapat mencerminkan representasi floristik hutan pamah bagian atas dan hutan pegunungan.

Kata kunci: Asosiasi, area minimum, Bodogol, hutan pamah, kekayaan jenis, komposisi jenis, struktur hutan, Taman Nasional Gunung Gede Pangrango.

INTRODUCTION

Studies of flora, composition, and structure of forests and other vegetation of GGPNP (Gunung Gede Pangrango National Park) have been undertaken since the early 19th century (Steenis *et al.,* 1972, 2006). The GGPNP has been a key for research on flora, vegetation, and fauna (Kartawinata & Sudarmonowati, 2022; Rozak *et al.*, 2016; Steenis *et al.*, 1972, 2006). The first botanical exploration and investigation in Indonesia were carried out in 1777 in the Gede Pangrango twin mountains (now within the GGPNP) by Carl Pehr Thunberg, a Swedish naturalist and student of Carollus Linnaeus, the father of taxonomy. He was the first European naturalist who explored the area. He published the species he collected in Florula Javanica in 1825 (Kartawinata, 2010; Kartawinata & Sudarmonowati, 2022; Steenis *et al.*, 1972, 2006).

The Cibodas Botanical Garden, established on the slopes of Mt. Gede, in 1852 was the research station for studies of mountain flora and fauna in Indonesia. It is part of the GGPNP region stretching from the lower montane forest at 1,400 m asl (above sea level) to subalpine vegetation on the top of Mt. Pangrango at 3,019 m asl. Earlier investigators, who undertook vegetation studies, included Junghuhn (1845, 1853-1854), Seifriz (1923, 1924), and Docters van Leeuwen (1933). Steenis-Kruseman (1953) made a complete bibliography of the studies in Mt. Gede-Pangrango and Bogor Botanical Garden. After the 2nd World War, vegetation studies were carried out by many investigators, including Abdulhadi *et al.* (1998), Arrijani (2008), Arrijani *et al.* (2008), Meijer (1959), Rollet *et al.* (1976), Rozak *et al.* (2016), Sadili & Alhamd (2012), Sadili *et al.* (2009), Sriyanto (1987), Yamada (1975; 1976a, 1976b, 1977), and Zuhri & Mutaqien (2013).

The GGPNP was divided into several resorts (regions), including the Bodogol Resort (BR) for management purposes. BR covers planted forests, natural upper lowland forests with an elevation of < 1,000 m asl, and montane forests with an elevation > 1,000 m asl (Sadili *et al.,* 2008; Sadili & Alhamd, 2012; Sadili, 2014; Junaedi *et al.,* 2020). We know very little about the structure and composition of the lowland forests in GGPNP and to date only Helmi *et al.* (2009), who had investigated a one-hectare plot of the upper lowland forest at Bodogol. Therefore, more studies in the lowland forests are necessary to complement the montane and subalpine forest data for better scientifically based management of the GGPNP (Brearley *et al.,* 2019). Species of *Dipterocarpaceae* can be found in the Bodogol lowland forest, including *Anisoptera costata, Vatica* sp., *Dipetrocarpus hasseltii, D. retusus, D. gracilis* (Ismail *et al*., 2000; Helmi *et al*., 2009; Junaedi *et al*., 2020). These species are listed as vulnerable by the IUCN (IUCN, 2013).

Data on the structural characteristics and species composition of the GGPNP's lowland forest are limited to a one-hectare plot near the Research Station at Bodogol (Helmy *et al.,* 2009). Here we study the composition and structure of the lowland forests at Cisuren and Cipadaranten hill ranges in Bodogol Resort to support data-driven park management, including ecological restoration of disturbed forests and degraded lands within the GGPNP domain.

MATERIALS AND METHODS

Study site

The GGPNP is located in the Bogor, Cianjur, and Sukabumi Regencies (*Kabupaten*), West Java, at 6°10'–6°51' South and 106°51'–107°02' East. The study was carried out in May 2022 in Bodogol Resort, in the administrative region of the Benda Village, Cicurug District, Sukabumi Regency, West Java (Fig. 1). The Bodogol resort covered natural forest areas on the Cisuren and Cipadaranten hill ranges, extending from the lowland area on the western side of the GGPNP towards the top of Mt. Pangrango. It also included tree plantations of rasamala (*Liquidambar excelsa*), damar (*Agathis dammara),* and pinus (*Pinus merkusii*). We selected subjectively the study sites in the lowland natural forest with slight disturbances at the Cisuren and Cipadaranten mountain ridges. Three study plots of one hectare (100 m × 100 m) were established on the partially flat sections of the ridges, with steep to very steep slopes (55%–75%) on the sides, at elevations of < 1,000 m asl. Plot 1 (designated as P1CS) and plot 2 (P2CS) were located in the Cisuren hill range, while plot 3 (P3CP) was in the Cipadaranten hill range.

The terrain on the sides of the three plots was steep slopes leading to river valleys. The Cisuren river was located in the northern and Tangkil river on the southern sides of the P1CS and P2CS. The upper stream of the Cisuren river lies on the western side of the P3CP and the Cipadaranten river is on the eastern side of the P3CP. Table 1 summarizes the data on the three plots, including Global Positioning System (GPS) position, elevation, the thickness of litter, air humidity, soil acidity (pH), and disturbances in the three plots at Bodogol, GGPNP.

Each one-hectare plot was divided into 10 m × 10 m subplots to measure trees with diameters at breast height (DBH) ≥ 10 cm. The diameters of all trees were measured at 1.3 m above the ground. The total height of each tree was estimated by eye. The position of each tree was mapped out using the X and Y coordinates. Each tree was identified in the field and voucher specimens were collected for identification at the Herbarium Bogoriense, BRIN (National Research and Innovation Agency) in Cibinong Bogor. The measurements of density, dominance (basal area), and frequency followed

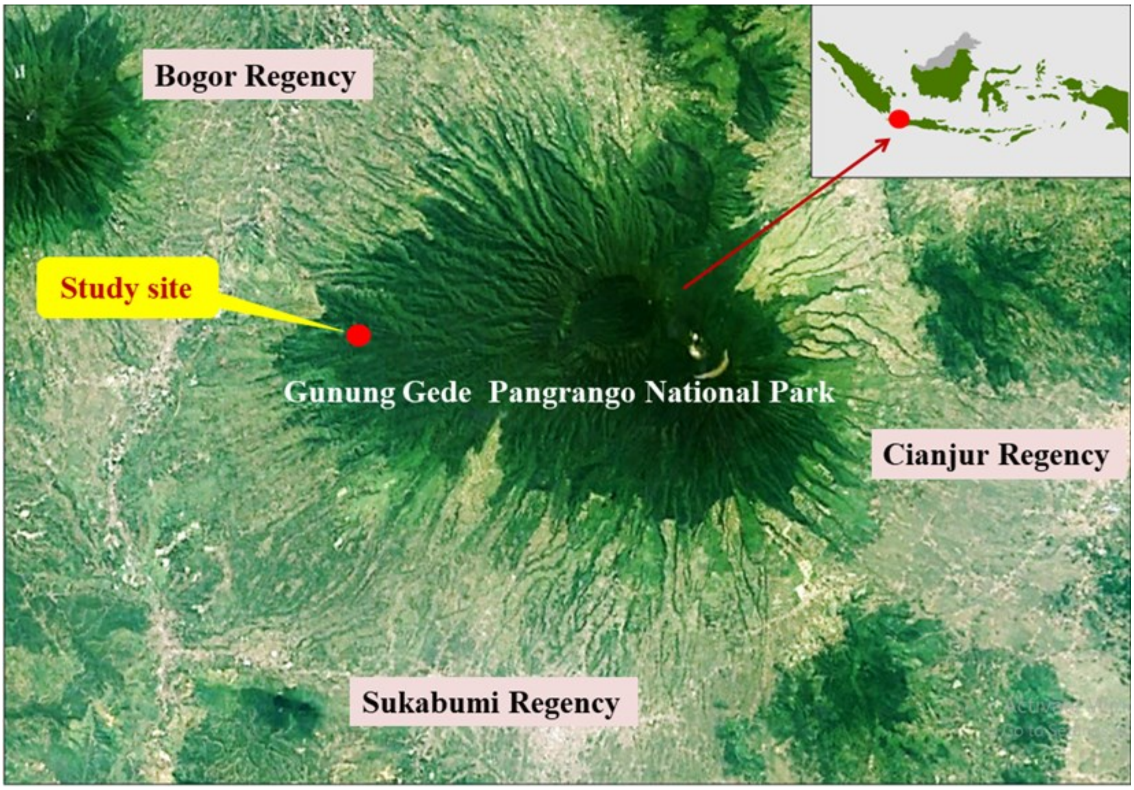

Fig. 1. Map of the Gunung Gede Pangrango National Park showing the study site at Bodogol Resort (Redrawn and modified from the map of BBTNGGP 2020).

Cox (1967) and Mueller-Dombois & Ellenberg (1974, 2016). The construction of the species-area curve followed Sadili *et al.* (2018), which was based on species data from 100 subplots nested within the plot, *i.e.* 100 m^2 (10 m × 10 m), 400 m^2 (20 m × 20 m), 900 m^2 (30 m × 30 m),..... 10,000 m^2 (100 m × 100 m).

RESULTS

General habitat conditions around the study plot

The study plots were located in slightly disturbed natural forests. Natural disturbances, such as landslides were absent in P1CS and P2CS. The canopy cover in P1CS and P2CS varied from 40% to 75%. Many subplots with open canopies were found in P1CS (Fig. 7) and P2CS (Fig. 8). The gaps were filled up with shrubs, climbers, and herbs, including *Bambusa* sp., *Calamus* sp., *Dinochloa scandens, Dendrocnide stimulans, Melicope latifolia, Ficus* sp., *Pinanga* sp., and *Piper aduncum*. In P3CP gaps in the subplots (Fig. 9) and those resulting from fallen trees were present, in which shrubs and herbs grew, including *Cyathea* sp., *Calliandra houstoniana* var. *calothyrsus, Etlingera* sp., *Piper aduncum*, and *Selaginella willdenowii*.

Species composition

A total of 107 tree species with DBH ≥ 10 cm and 37 families (Appendix 1), with an average basal area of 19.73 m^2/ha, and an average density of 348 trees/ha, were recorded in the lowland forests of GGPNP as represented by the three study plots. Table 2 shows the summary of the lowland forest vegetation data as recorded in the three study plots. *Maesopsis eminii* in P1CS and P3CP had the highest density (D= 69 trees/ha), basal area (BA= 2.68 m^2/ha) and absolute frequency (F= 12.61%), while in P2CS *Syzygium acuminatissimum* had the highest density (61 trees/ha), BA (3.81 m^2/ha), and absolute frequency (F= 12.46%). Based on IV analysis, the dominant species in P1CS and P3CP were *Maesopsis eminii* with IV= 56.46% (P1CS) and IV= 55.93% (P3 CP), while in P2CS was *Syzygium acuminatissimum* (IV= 43.67%) (Table 3 and Table 4).

Ten species with the highest density (D) and highest basal area (BA) (Table 3), highest absolute frequency (F), and highest importance value (IV) (Table 4) in each plot varied. Among them, however, three species were always recorded as the highest in three plots, *i.e., Lithocarpus korthalsii, Syzygium acuminatissimum,* and *Lithocarpus pseudomoluccus*. Species present in the P1CS, P2CS, and P3CP but with low values of

Table 1. GPS position, elevation, litter thickness, air humidity, soil acidity (pH), and disturbances in the three plots at Bodogol GGPNP.

Plot	GPS position		Elevation (m)	Litter	Mean air humidity (%)	Mean pH	Disturbance
	Latitude (S)	Longitude (E)					
P1CS	-06° 46'52.6"	106° 51.09.4"	713	Thick	90	7	None
P2CS	-06° 46'53.1"	106° 51.23.1"	767	Thick	89	7	None
P3CP	-06° 46'40.2"	106° 51.41.1"	843	Thin	87	6.8	Slight (human activities along forest trails)

Table 2. Summarized data show the number of species, the number of families, Density (D), Basal Area (BA Index (H'), and Evenness Index (E) in three plots at the lowland natural forest Bodogol, GGPNP.

No	Plot	Species	Family	D (ha)	BA (ha)	Index	
						Diversity (H')	Evennes (E)
1	P1CS	59	25	283	13.79	3.33	0.82
2	P2CS	64	27	385	24.83	3.52	0.85
3	P3CP	74	29	376	20.57	3.61	0.83
	Mean	66	27	348	19.73	3.49	0.83

D, F, BA, and IV were listed in Group 1 in Appendix 1, while other species present in one or two plots were listed in Groups 2–7 in Appendix 1.

The relationship between the number of species and BA varied (Fig. 2). The highest number of species occurred in the BA class of 0.01–0.09 cm^2 and the highest appeared in P1CS (71 species). Species with BA of 0.40–0.49 m^2 appeared only in P3CP (2 species), while BA > 0.50 occurred in P2CS (2 species) and P3CP (4 species). The relationship between the number of trees and stem diameters also varied (Fig. 3). The highest number of trees appeared in the 10–19.99 cm diameter class and the highest was in P2CS (223 trees). Trees with a diameter class of 80–89.9 cm occurred only in P2CS and P3CP (2 trees, respectively).

The species-area curves in the three plots differed as can be seen in Fig. 4. The curves appeared to begin flattening at 6,400 m^2 (0.64 ha) in P1CS, and 10,000 m^2 (1 ha) in P2CS and P3CP. At the points of inflection, the number of species ranged between 50 and 70. Based on density, the species composition of P1CS, P2CS, and P3CP were slightly similar, where the index of similarity between P1CS, and P2CS was 57% and between P3CP and combined P1CS, P2CS was 54%.

Of the total 107 species (Appendix 1), we recorded nine exotic species (8.41%), which were *Maesopsis eminii* and *Cecropia peltata* occurring in all the plots, *Calliandra houstoniana* var. *calothyrsus, Bellucia pentamera,* and *Swietenia mahagoni* in P3CP, and Indonesian species but not native to GGNPP (*Dracaena angustifolia*, *Falcataria falcata, Pinus merkusii,* and *Artocarpus heterophyllus*) were slightly similar, where the index of similarity between P1CS, and P2CS was 57% and between P3CP and combined P1CS, P2CS was 54%.

Table 5 shows that six families contained five or more species in each plot. *Lauraceae, Fagaceae*, and *Euphorbiaceae* occurred in all plots, while *Moraceae* in two plots (P2CS and P3CP), and *Meliaceae* in one plot (P3CP). *Lauraceae* (11 species) in P1CS was the largest family and other families contained less than five species, each (Appendix 1).

Table 3. Ten species with the highest density (D) and basal area (BA) in three plots at the lowland natural forests in Bodogol, GGPNP.

No	Species	Density (trees/ha)			Basal area (m^2/ha)		
		P1CS	P2CS	P3CP	P1CS	P2CS	P3CP
1	*Syzygium acuminatissimum*	19	61	21	1.20	3.81	1.46
2	*Maesopsis eminii*	69	7	51	2.68	0.69	6.54
3	*Lithocarpus pseudomoluccus*	16	22	13	1.41	1.85	0.49
4	*Schima wallichii*	6	11	20	0.64	2.74	1.43
5	*Lithocarpus korthalsii*	11	25	16	1.55	2.32	0.78
6	*Macaranga denticulata*	9	12	12	0.17	0.27	0.23
7	*Castanopsis tungurrut*	12	4	11	0.59	0.26	0.34
8	*Neoscortechinia kingii*	10	17	4	0.27	0.72	0.10
9	*Sandoricum koetjape*	1	12	8	0.36	0.36	0.47
10	*Pometia pinnata*	7	8	7	0.34	0.21	0.41
11	*Nephelium juglandifolium*	6	25	4	0.29	1.53	0.22
12	*Ficus padana*	7	1	1	0.15	0.02	0.10
13	*Aglaia elliptica*	2	2	5	0.09	0.22	0.54
14	*Castanopsis argentea*	1	4	2	0.02	0.15	0.42
15	*Beilschmiedia madang*	7	6		0.31	0.22	
16	*Neonauclea lanceolata*	7			0.32		
17	*Donella lanceolata*	1			0.37		
18	*Syzygium antisepticum*		13	31		0.37	1.24
19	*Didymocheton nutans*		14	7		0.79	0.42
20	*Symplocos acuminata*		8	9		0.18	0.12
21	*Chisocheton ceramicus*		2	3		0.97	0.07
22	*Elaeocarpus angustifolius*		2	2		0.71	0.06
23	*Spondias pinnata*		3			0.98	
24	*Calliandra houstoniana* var. *calothyrsus*			28			0.33

Table 4. Ten species with the highest absolute frequency (AF) and the highest importance value (IV) in three plots at the lowland natural forests in Bodogol, GGPNP.

No	Species	Absolute Frequency (F= %)			Importance Value (IV= %)		
		P1SC	P2CS	P3CP	P1SC	P2CS	P3CP
1	*Maesopsis eminii*	12.61	1.87	10.58	56.46	6.48	55.93
2	*Syzygium acuminatissimum*	7.66	12.46	4.49	23.10	43.67	17.15
3	*Lithocarpus korthalsii*	3.60	6.85	4.81	18.74	22.68	12.84
4	*Lithocarpus pseudomoluccus*	5.41	6.23	3.53	21.32	19.40	9.34
5	*Neoscortechinia kingii*	4.05	4.05	1.28	9.55	11.38	2.81
6	*Schima wallichii*	2.25	2.49	4.49	9.03	16.38	16.77
7	*Castanopsis tungurrut*	4.95	1.25	2.88	13.50	3.33	7.46
8	*Macaranga denticulata*	3.15	2.80	2.56	7.56	7.01	6.88
9	*Nephelium juglandifolium*	2.70	5.92	0.96	6.90	18.58	3.07
10	*Pometia pinnata*	3.15	2.49	2.24	8.09	5.40	6.09
11	*Cecropia peltata*	1.35	0.31	5.13	2.65	1.53	5.44
12	*Sandoricum koetjape*	0.45	3.43	2.24	3.42	8.01	6.68
13	*Syzygium antisepticum*		2.80	5.77		7.67	20.05
14	*Didymocheton nutans*		3.12	1.92		9.94	5.83
15	*Neonauclea lanceolata*	3.15			7.98		
16	*Calliandra houstoniana* var. *calothyrsus*			5.13			14.18

Forest structure

Forest profile diagrams (Fig. 6) for all plots were constructed following the method of Kartawinata *et al*. (2004) as applied by Rahma *et al.* (2016). The profile diagrams show the tree heights that jointly form the vertical stratification (A Stratum to D Stratum), which varied from one plot to another. The ten main tree species with the highest density composing A Stratum to C Stratum are presented in Table 6. Fig. 5 shows the relationship between the diameters and heights of trees within the three plots revealing that most trees were concentrated in the 10–20 cm diameter class with heights of < 20 m (C Stratum). In P1CS no trees were forming the emergent A Stratum (height > 34 m). In P2CS, five trees of five species constituted the A Stratum and in P3CP there was only one tree formed the emergent A stratum (Fig. 5 and Fig. 6).

The distribution of the exotic species, *Maesopsis eminii*, in each plot was scattered (Figs. 7–9, in red). The density of *Maesopsis eminii* in P1CP (69 trees/ha) was higher than that in P2CS (7 trees/ha) and P3CP (51 trees/ha) (Table 3). Observations during the field study revealed that the fruits of *Maesopsis eminii* were consumed daily by Owa Jawa (*Hylobates moloch*), Lutung Jawa *(Trachypithecus auratus)*, Surili (*Presbytis comata*) and Tupai (*Tupaia* sp.).

DISCUSSION

Species Composition

Of the total 107 species recorded in the three plots (Appendix 1), 48 species (44.86%) were not registered in the Gunung Gede Pangrango flora (Sunarno & Rugayah, 1992), and in Helmi *et al.* (2009), whose study site was located in the same forest area. They are here considered as the lowland forest species which were confirmed

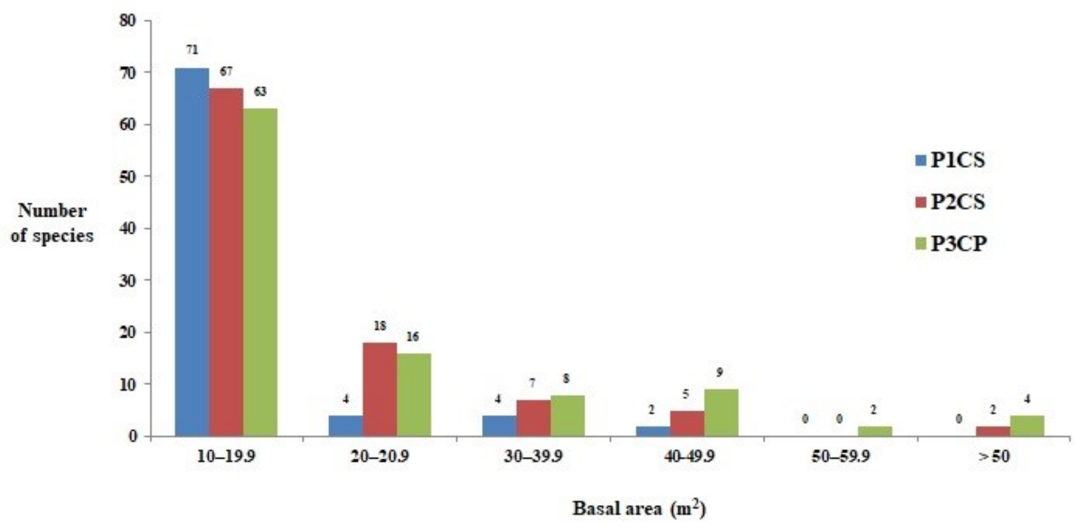

Fig. 2. The relationship between the number of species and BA classes in three plots at the lowland natural forests in Bodogol, GGPNP.

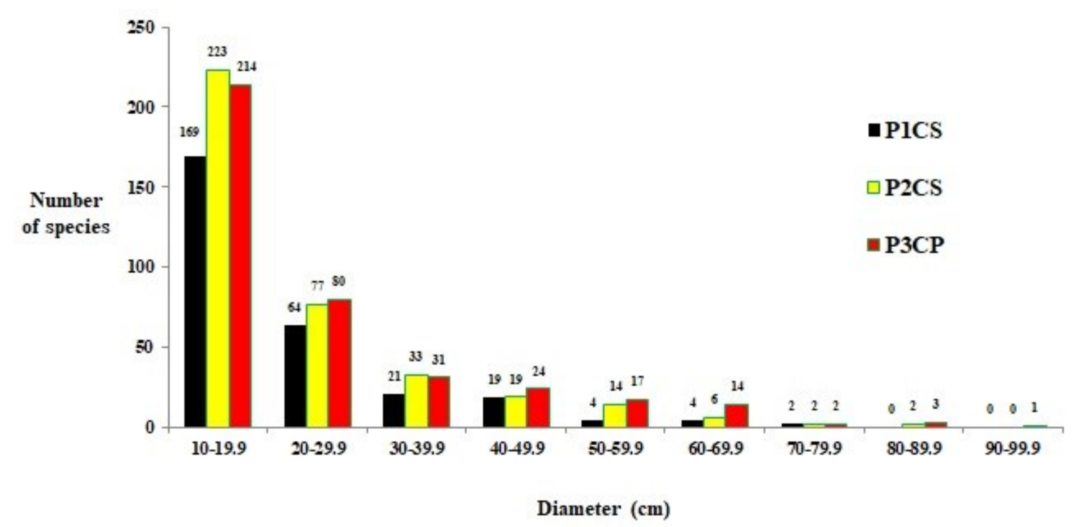

Fig. 3. The relationship between density (D) and diameter class in three plots at the lowland forest in Bodogol, GGPNP.

through comparison with Backer & Bakhuizen van den Brink (1963-1968), Djarwaningsih *et al.* (2010), Ismail *et al.* (2000), Kartawinata (1977), Rozak *et al.* (2016), and Yusuf (2004). They contributed to the increase of the current GGNPP floristic diversity of 1,103 species (Kartawinata & Sudarmonowati, 2022), which should now total 1,151 species.

The present study, along with Helmy *et al.* (2009) and Sadili (2014), has described the transitional forest area between the lowland and montane forests with tree species diversity that was not known when GGPNP was established in 1980. It is interesting to note that species of *Dipterocarpaceae* were reported to occur sparingly in Bodogol (Ismail *et al.,* 2000; Helmi *et al*., 2009; Junaedi *et al.,* 2020) but they were not found in the present study plots, possibly because of unsuitable microclimate and located far away from the seed producing mature trees (Purwaningsih, 2004).

Ten species with the highest density (D), basal area (BA) (Table 3), absolute frequency (F), and important value (IV) (Table 4) varied. Based on the dominance as reflected by the highest IV analysis the forest in P1CS and P3CP, on the one hand, may be called *Maesopsis eminii-Syzygium acuminatissimum* association, with the character species that were confined to the two plots as listed in Group 3 in Appendix 1. The forest in

Table 5. The number of families having five or more species in the three plots at the lowland natural forests Bodogol, GGPNP.

No	Family	Number of species		
		P1CS	P2CS	P3CP
1	Lauraceae	11	6	7
2	Fagaceae	6	7	6
3	Euphorbiaceae	5	6	8
4	Moraceae		6	6
5	Meliaceae			6

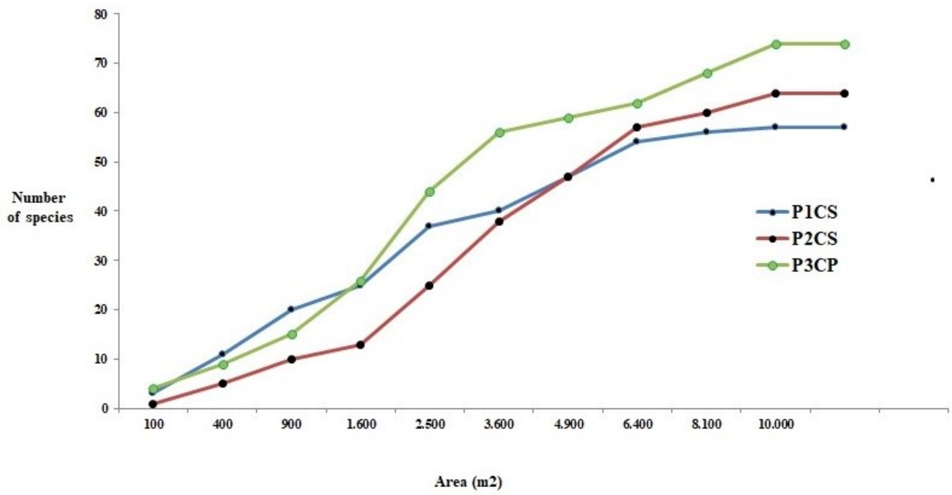

Fig. 4. Species-area curves in three plots of one hectare each in the lowland natural forests in Bodogol, GGPNP.

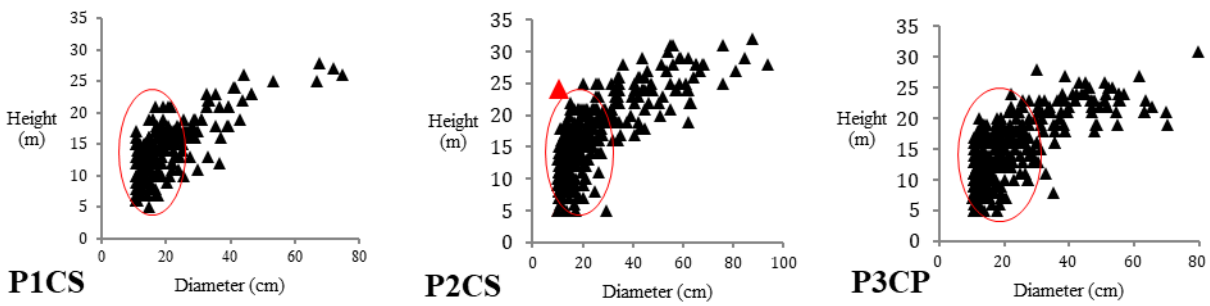

Fig. 5. Scattered diagram of diameter classes and tree heights in the three plots at the lowland natural forests at Bodogol, GGPNP.

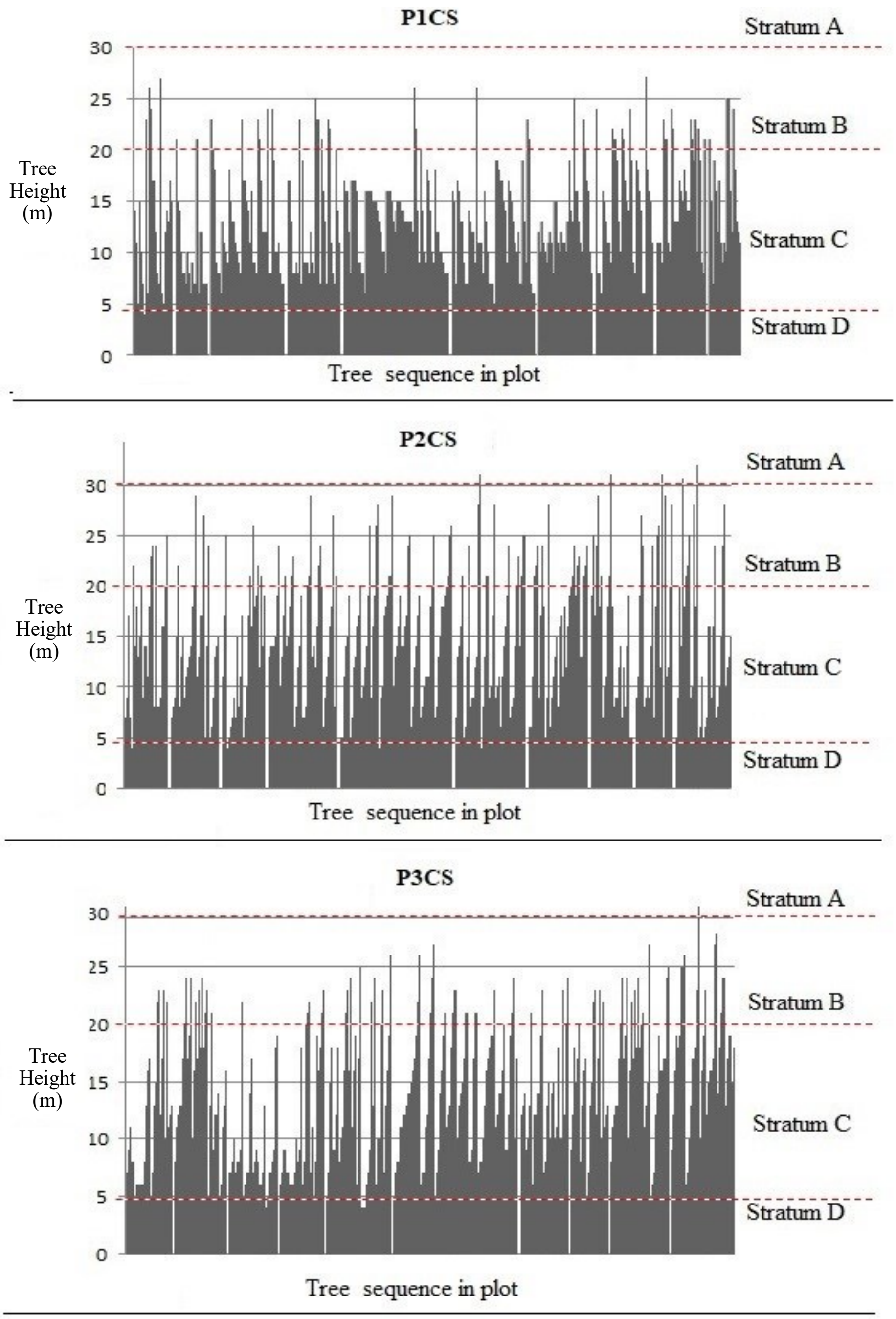

Fig. 6. Profile diagrams of the forest on the plots constructed by plotting the height of each tree and sequential tree position from tree no. 1 in the 1st subplot up to the last tree in the 100th subplot in all plots in the lowland natural forests at Bodogol, GGPNP, using the method of Kartawinata *et al.* (2004).

Table 6. The number of species, number of trees, and ten species with the highest density in the A, B, and C strata in the three plots in the lowland natural forests at Bodogol, as graphically presented in Fig. 9.

Plot	Stratum	Number		Ten species with the highest density (trees/ha)
		Species	Tree	
P1CS	A (Height > 30 m)	-	-	-
	B (Height: 20–30 m)	23	50	*Maesopsis eminii* (8), *Syzygium acuminatissimum* (7), *Lithocarpus korthalsii* (7), *Lithocarpus pseudomoluccus* (5), *Schima wallichii* (2), *Neoscortechinia kingii* (2), *Castanopsis tungurrut* (2), *Neonauclea lanceolata* (2), *Adina trichotoma* (1), *Liquidambar excelsa* (1)
	C (Height: 4–19.9 m)	55	233	*Maesopsis eminii* (61), *Syzygium acuminatissimum* (2), *Lithocarpus pseudomoluccus* (12), *Castanopsis tungurrut* (10), *Neoscortechinia kingii* (10), *Macaranga deltoidea* (8), *Beilschmiedia madang* (7), *Ficus padana* (7), *Nephelium junglandifolium* (6), *Pometia pinnata* (6)
P2CS	A (Height: > 30 m)	5	5	*Chisocheton ceramicus* (1), *Lithocarpus korthalsii* (1), *Lithocarpus pallidus* (1), *Schima wallichii* (1), *Dalrympelea sphaerocarpa* (1)
	B (Height: 20–30 m)	33	107	*Maesopsis eminii* (8), *Syzygium acuminatissimum* (7), *Lithocarpus korthalsii* (7), *Lithocarpus pseudomoluccus* (5), *Schima wallichii* (2), *Neoscortechinia kingii* (2), *Castanopsis tungurrut* (2), *Neonauclea lanceolata* (2), *Adina trichotoma* (1), *Liquidambar excelsa* (1)
	C (Height: 4–19.9 m)	55	273	*Calliandra houstoniana* var. *calothyrsus* (31), *Syzygium antisepticum* (27), *Maesopsis eminii* (22), *Syzygium acuminatissimum* (13), *Schima wallichii* (13), *Lithocarpus korthalsii* (12), *Macaranga deltoidea* (12), *Castanopsis tungurrut* (11), *Symplocos acuminata* (10), *Lithocarpus pseudomoluccus* (9)
P3CP	A (Height: > 30 m)	1	1	*Maesopsis eminii* (1)
	B (Height: 20–30 m)	24	76	*Syzygium acuminatissimum* (25), *Lithocarpus korthalsii* (14), *Nephelium junglandifolium* (9), *Lithocarpus pseudomoluccus* (8) *Schima wallichii* (7), *Neoscortechinia kingii* (4), *Beilschmiedia madang* (3), *Didymocheton nutans* (3), *Sandoricum koetjape* (3), *Spondias pinnata* (3)
	C (Height: 4–19.9 m)	69	299	*Syzygium acuminatissimum* (36), *Nephelium juglandifolium* (16) *Lithocarpus pseudomoluccus* (13), *Macaranga deltoidea* (12), *Neoscortechinia kingii* (12), *Didymocheton nutans* (11), *Lithocarpus korthalsii* (11), *Syzygium antisepticum* (10), *Dendrocnide stimulans* (9), *Myristica* sp. (9)

P2CS, on the other hand, may be designated as *Syzygium acuminatissimum-Lithocarpus korthalsii* association, characterized by species that were confined to P2CS, as listed in Group 6 in Appendix 1. Before the *Maesopsis eminii* invasion, the *Syzygium acuminatissimum-Lithocarpus korthalsii* association could have been prevalent in the lowland forests at Bodogol. In these associations, the following species were registered in the IUCN Red List (Effendi *et al.,* 2022; Wihermanto, 2007) as critical (*Castanopsis argentea* and *C. tungurrut*) and vulnerable category (*Saurauia bracteosa*).

The number of species along the basal area classes (Fig. 2) and diameter classes (Fig. 3) showed that the highest number of species occurred in the lowest BA class (0.01–0.09 m^2) and diameter class (10.0–19.9 cm). It follows that the number of species decreased as the BA and diameter increased. The BA is related to the diameter. The above reverse-J pattern is typical for the tropical rainforest and indicated that the forest regenerated well and was in a dynamic state (Ogawa *et al.*, 1965; Richards, 1996; Mirmanto, 2014).

The species richness and tree density in our plots were comparable to those obtained from various studies in the montane forests of Mount Gede-Pangrango and Mount Halimun in West Java, Foja Mountains in the upper montane forest of Papua, but lower than those of the studies in Sumatra (Table 7). From Table 7 it is evident that the montane forests, even the pristine forest untouched by human activities in the Foja Mountains in Papua (Sadili *et al*., 2018), and the transitional lowland-montane forests at Bodogol had a low species diversity of 59–70 species in one hectare, compared to very species-rich undisturbed lowland forests at Kalimantan (Sheil *et al*., 2010), and Sumatra (Kartawinata *et al*., 2004), where the number of species per hectare was 205 and 182, respectively. Studies in Sulawesi by Brambach *et al.* (2017) in several plots with a total area of 3.1 ha in the Lore Lindu National Park at 700–2,400 m asl and by Trethowan *et al.* (2019) in several plots with a total area of 2.5 ha in lowland forest areas at Morowali, Wawonii and Bualemo, show the mean species richness of 9/ha and 113/ha, respectively, which are comparable to the result of the present study. It may be implied that it is a norm for any montane forest to have low species diversity. The richness of a plot may be due to disturbance by facilitating species dependent on disturbance to associate very closely with late-successional species (Connell, 1978; Sheil & Burslem, 2003; Slik *et al*., 2008).

The occurrence of low species richness is reflected also in a species-area curve. The species-area relationship is essential to ecology (Plotkin *et al*., 2000) and it can also be used to approximate species extinction resulting from habitat loss (May *et al*., 1995; Pimm & Raven, 2000) and to assess patterns of species diversity in different forest types (Ashton, 1965; Mueller-Dombois & Ellenberg, 1974, 2016). The curve was constructed to indicate species diversity in relation to the increasing size of the area (Mueller-Dombois & Ellenberg, 1974, 2016) within the plot. Fig. 4 shows the species-area curves in three plots with an area of one hectare each. The species-area curves in the three plots differed. The curves began to flatten at 6,400 m (0.64 ha) in P1CS and at 10,000 m (1 ha) in P2CS and P3CP, which indicated that at the points of inflection, the number of species ranged between 50 and 70. It is in contrast to the species-area curves of undisturbed lowland forests in Kalimantan and Sumatra. In Kalimantan, Kartawinata *et al.* (2008) showed that the curve still steadily rose to indicate no sign of leveling at the area of 10.5 ha with a number of species of 552 and in Sumatra. Kartawinata *et al.* (2004) noted the same pattern with no indication of flattening of the curve at one hectare and 182 species.

Table 2 shows the Diversity Index (DI) with a mean value of H'= 3.49 may be considered high, comparable to H'= 3.39 at higher elevations (1,000 m asl) of the GGNP forest (Zuhri & Mutaqien, 2011) but higher than the diversity index at the montane forest at the Mt. Ceremai National Park with H'= 2.66–2.77 (Purwaningsih & Yusuf, 2008). The diversity index is considered high if H' > 3 and H' in the tropical forests is 1.5–3.5 and rarely H' > 4 (Greig-Smith, 1983). The Evenness Index (E) is used as the indicator of prevalence in the forest community. In the present study plots E values were high (0.82–0.85), which were indicating that all the species were even relatively (Ludwig & Reynold, 1988; Oosting, 1956).

Exotic species, other than *Maesopsis eminii,* (*i.e. Bellucia pentamera, Calliandra houstoniana* var. *calothyrsus, Cecropia peltata,* and *Swietenia mahagoni*) and Malesian species but not native to GGPNP (*i.e*., *Artocarpus heterophyllus, Dracaena angustifolia*, *Falcataria falcata,* and *Pinus merkusii*) were contaminating but not aggressively invading the natural tree communities, as indicated by their very low densities and basal areas (Appendix 1). They should be, however, monitored and prevented from spreading more widely and even eradicated.

Maesopsis eminii, which was introduced to Indonesia for the first time in 1920, should receive special attention because this species aggressively and rapidly invaded submontane rain forests and became the dominant species in Eastern Tanzania (Schabel & Latiff, 1997). In Bodogol it dominated the lowland forest, as indicated in the study plots (Appendix 1, Figs. 7–9, and Table 4), it reached the highest IV in P1CS (56.46%) and P3CP (55.93%), while in P2CS it was one of the 11 main

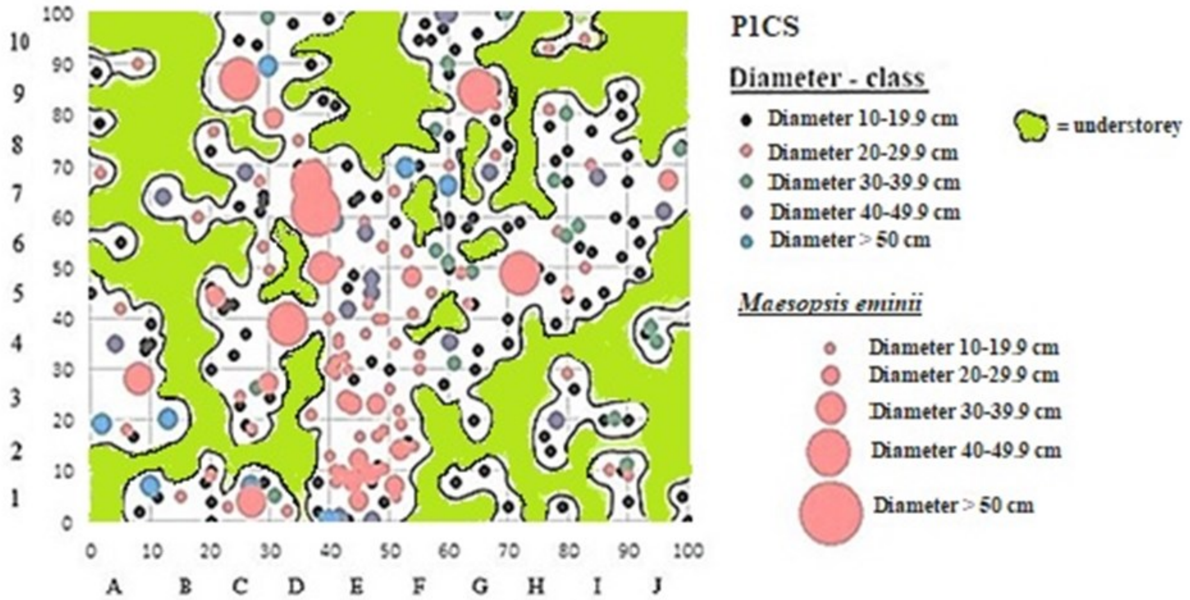

Fig. 7 The scattered and dispersed tree distribution of trees with DBH ≥ 10 in the P1CS at the lowland natural forest Bodogol, GGPNP.

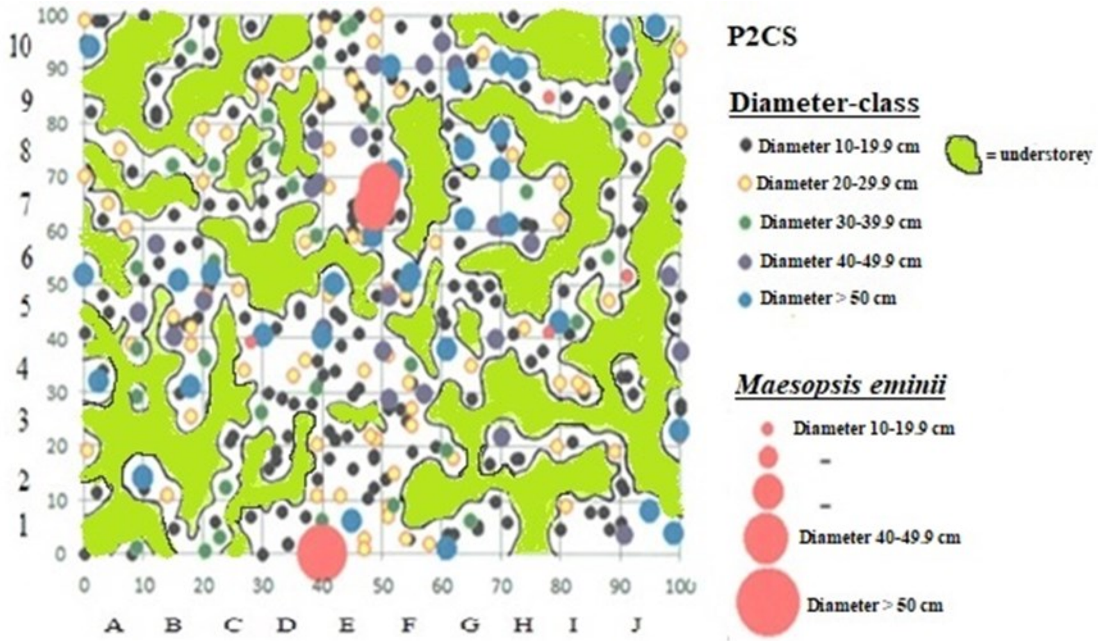

Fig. 8. The scattered and dispersed tree distribution of trees with DBH ≥ 10 in the P2CS at the lowland natural forest Bodogol, GGPNP.

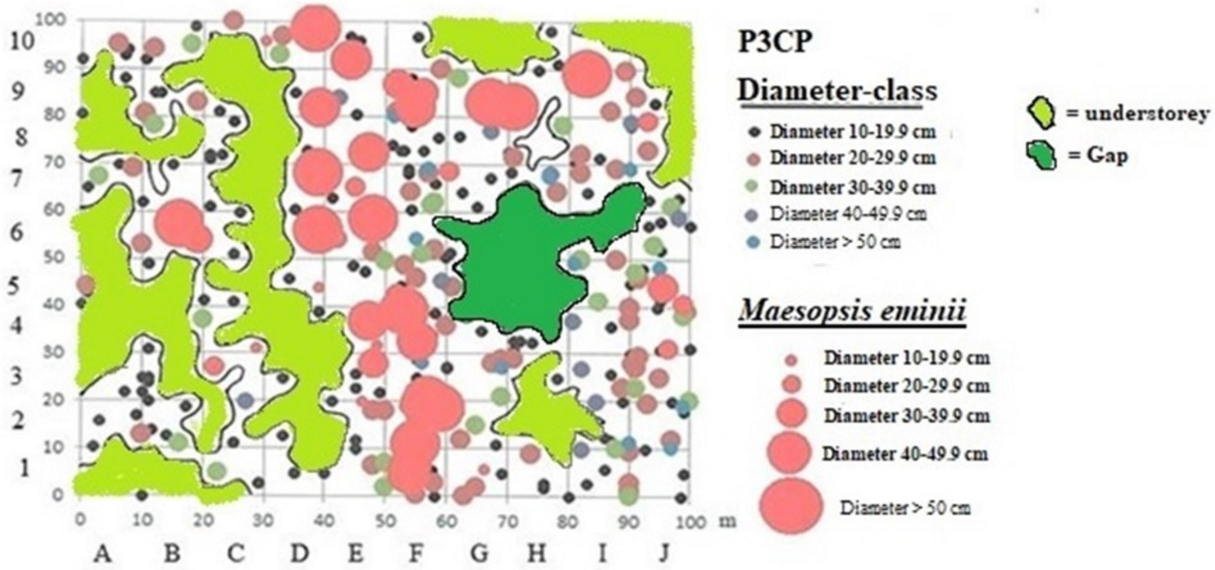

Fig. 9. The scattered and dispersed tree distribution of trees with DBH ≥ 10 in the P3CP at the lowland natural forest Bodogol. A relatively large gap (dark green colour) resulting from fallen trees was present.

species with IV= 6.48%. Naturally, the species occurred in Africa from lowland tropical rain forests to savannas, extending to montane forests at the altitude of 1,800 m asl and dispersed by birds (especially hornbills), rodents, and monkeys (Schabel & Latiff, 1997). It is a fast-growing species with a growth rate of 1.5–5.5 cm per year in diameter and 1–3 m per year in height (Schabel & Latiff, 1997) and could grow well at the altitudes of 100–900 m asl within full sunshine. It was planted in community forests and plantations in West Java in 1960 by the Forestry Department (Samsoedin *et al.*, 2016). Informants (pers. comm., 2022) stated that it was planted in the community forests in Bodogol village in the 1970s.

In Bodogol, many primate species (Owa Jawa-*Hylobates moloch*, Lutung Jawa-*Trachypithecus auratus,* and Surili-*Presbytis comata*) and rodents (*Tupaia* sp.) living in the GGPNP vigorously consumed the fruits of *M. eminii* (Helmi *et al.*, 2009) and later dispersed seeds germinated and developed into large trees elsewhere in the interior of natural forests as indicated in the results of the present study as far as 1,000 m from the natural forest edges. In Africa, it is an amazingly long-lived pioneer species that could live up to 150 years (Schabel & Latiff, 1997). Considering the above growth and behavioral characteristics of the species and the current dominating existence in Bodogol inland natural forests it would be not surprising that *M. eminii* will become a dominant species in the upper montane forests and even in the subalpine forests of GGPNP. A drastic action to eradicate *M. eminii* from the natural forest of GGPNP and the adjacent areas of GGPNP should be seriously undertaken without delay to save the continuing existence of natural forests in GGPNP.

Falcataria falcata and *Pinus merkusii* are native to Indonesia and were present in the study plots but at low density (Appendix 1), hence not aggressive invaders. They were planted by the Forest Department in the vicinity of the GGPNP and those in Bodogol have been incorporated into the GGPNP. The presence of *Artocarpus heterophyllus* and *Dracaena angustifolia* could have been due to human activities that inadvertently carry the propagules into the natural forests (Andila & Warseno, 2019; Samsoedin *et al.,* 2016).

Species having high commercial value is *Liquidambar excelsa* (Sutomo & Sari, 2019). It is native to Bhutan, Assam, Myanmar, Peninsular Malaysia, Sumatra, and Java. Growing at the elevation of 550–1,700 m asl (Vink, 1957). In P1CS it had D= 3/ha, BA= 0.07 m^2 and IV= 2.89% (Appendix 1). In Bodogol, it was recorded by Ismail *et al.* (2000), Helmi *et al.* (2009), Gunawan *et al.* (2011), Sadili & Alhamd (2012), and Sadili (2014). In Cibodas, grew on the submontane to montane forests (Meijer, 1959; Yamada, 1975; Abdulhadi *et al.,* 1998; Arrijani *et al.,* 2006; Rozak *et al.,* 2016). Local people informed us that seedlings and saplings of *A. excelsa* were hard to find in the natural forests at Bodogol. Similarly, the planted forest of *A. excelsa* in Bodogol, which according to informants in the village (pers. comm., 2022) was planted in 1918. Sadili (2014)

Table 7. Comparison of the number of species and number of trees in one-hectare plots in montane forests of Java and Papua and the lowland forests of Sumatra and Kalimantan.

Locality		Elevation (m)	Plot size (ha)	Density (trees/ha)	Number of species	Source
WEST JAVA						
Gunung Gede pangrango National Park						
Bodogol	P1CS	713	1	283	59	Present study
	P2CS	767	1	385	64	Present study
	P3CP	843	1	376	74	Present study
	Mean	713-843	1	348	66	Present study
Bodogol		806	1	352	70	Helmi *et al.* (2009)
Cibodas		1600	1	427	57	Yamada (1975)
Gunung Halimun Salak National Park						
Gunung Kendeng		1000	1	406	64	Suryanti (2006)
Gunung Malang		1000	1	421	69	Suryanti (2006)
Gunung Panenjoan		1000	1	405	69	Suryanti (2006)
Purabakti		900	1	441	69	Yusuf (2004)
KALIMANTAN						
Malinau		200	1	759	205	Sheil *et al*. (2010)
SUMATRA						
Batang Gadis National Park		660	1	583	182	Kartawinata *et al*. (2004)
Bukit Lawang		297	1	453	216	Polosakan (2001)
PAPUA						
Foja Mountains		1710	1	693	59	Sadili *et al.* (2018)

found only two saplings (diameter= 8.62 cm and 9.39 cm), indicating that the species had a poor regenerating capability. An officer of the Halimun-Salak National Park (pers. comm., 2022) informed that seedlings and saplings of *A. excelsa* could be found only in secondary growth on small landslides near mature trees. Qualitative observation revealed that the absence of regeneration in the old *A. excelsa* planted in Bodogol could be related to the unsuitable elevation of less than 1,000 m asl for growth and reproduction. It could be inferred that planted *A. excelsa* had a low ability to sustain itself with the implication that the species may not be a good candidate to be used in ecological restoration but acceptable for rehabilitation of degraded lands.

Native tree species that are potentially good for ecological restoration is *S. wallichii*. It is a variable species, consisting of nine subspecies and five varieties (Bloembergen, 1952), including *S. wallichii* subsp. *noronhae.* In Java, it is spreading from 300 m to 2,600 m asl, which comprised two varieties (Backer & Bakhuizen van den Brink, 1963). Many pioneer species inhabiting the lowland to montane forests are amazingly long-lived (Whitmore, 1986) and *S. wallichii* could be placed in this category, as can be seen, it lived in the primary montane forest of GGPNP (Kartawinata & Sudarmonowati, 2022; Yamada, 1974, 1976). In the present study, it occurred in all plots (Table 3, Table 4, and Appendix 1). Vertically (Table 6) filled up the B stratum (height 20–30 m) and C stratum (height 4–20 m). Gunawan *et al.* (2011) noted that its distribution was clustered and based on high IV it was predicted that *S. wallichii* could become dominant in the *Agathis dammara* plantation. In the Kawah Ratu (Halimun-Salak National Park), Hilwan & Rahman (2021) reported good regenerations of *S. wallichii.* Rozak *et al.* (2016) in GGPNP, *S. wallichii* occurred from the submontane to the subalpine forests.

Lauraceae, Fagaceae, and *Euphorbiaceae* are common families in the submontane forests (Steenis *et al.,* 2006; Purwaningsih & Polosakan, 2016), hence, the forest is often designated as *Lauro-Fagaceous* forest (Steenis & Shippers-Lammertse, 1965; Steenis *et al.,* 2006). In the present study, families in the submontane forest with a high number of species (> 5) were *Lauraceae, Fagaceae*, and *Euphorbiaceae* (Table 5). *Euphorbiaceae* contained the highest number of species (eight species) in P3CP, which was related to high adaptability to the environment (Kartawinata, 1977; Riswan, 1987). Based on the number of species, in Malesia, *Euphorbiaceae* is listed as one of the four big family groups (Whitmore, 1995). The existence of *Euphorbiaceae* in three plots could be implied that the habitat was once disturbed, such as fallen trees creating gaps, which in turn stimulated seeds to germinate.

Structure

Species distribution in each plot varied (Appendix 1). The number recorded in three plots accounted for 29 species (27.10%), in two plots 31 species (28.97%), and only in one plot 47 species (43.93%). It is implied that each species had different characteristics in its regeneration and survival. The species that had the widest distribution were tolerant to the varied environment of different forests (Group 1 in Appendix 1). *Magnolia montana* (IV= 0.62%) and *Neesia altissimo* (IV= 0.62%) were species with the lowest IV and occurred only in P3CP, which could be due to the presence of the highest number of exotic species in the plot. It needs further research to clarify the phenomenon.

Forest profile showing the vertical structures (Figs. 5 and 6), containing ten species with varied highest diversity in each stratum of each plot (Table 6). The A stratum (height > 30 m) occurred in P2CS (5 trees/ha) and P3CP (1 tree/ha). Furthermore, the correlation between diameter class and tree height of < 20 m (C Stratum), and in general diameters are correlated with tree height, implying that the bigger the diameters the taller the trees, hence the forest canopy. Fig. 5, illustrating the profile of the P2CS, revealed the presence of trees with small diameters but with very tall trunks, implying that the trees optimally utilized the light along with the others. This phenomenon could be observed in *Lithocarpus korthalsii*. Figs. 7–9 show the uneven distribution of all trees in the plots. The distribution of *Maesopsis eminii* was concentrated on the more or less flat ridges of the hills and decreased towards the sloping sides. It should be pointed out that in some subplots with open canopies and in such openings, many species of young trees, shrubs and lianas grew profusely, including *Bambusa* sp., *Calamus* sp., *Dendrocnide stimulans, Dinochloa scandens, Melicope latifolia, Ficus* sp., *Pinanga* sp., and *Piper aduncum.* Forest structure in Bodogol is comparable to those at 1,600 m asl (Kartawinata & Sudarmonowati, 2022; Yamada, 1975).

Successional status of the forest

We checked the species listed in Appendix 1 to identify the successional status of species using the following references, Kramer (1926, 1933), Backer & Bakhuizen van den Brink, Jr. (1963–1968), Steenis *et al.* (1972), Riswan (1984), Whitmore (1986), Sriyanto (1987), Sunarno & Rugayah (1992), Keβler *et al.* (2000), and Kartawinata & Sudarmonowati (2022). Appendix 1 recorded the following 32 secondary forest species in the plots *i.e. Liquidambar excelsa, Artocarpus elastica, Bellucia pentamera, Blumeodendron tokbrai, Glochidion rubrum* var. *rubrum, Calliandra houstoniana* var. *calothyrsus, Castanopsis argentea, C. tungurrut, Cecropia pel-*

tata, Decaspermum fruticosum, Dendrocnide stimulans, Melicope latifolia, Ficus tinctoria subsp. *gibbosa, Ficus fistulosa, Ficus padana, Ficus variegata, Polyspora excelsa, Knema laurina, Litsea noronhae, Maesopsis eminii, Mallotus paniculatus, Neonauclea lanceolata, Homalanthus populneus, Falcataria falcata, Pinus merkusii, Podocarpus neriifolius, Pometia pinata, Schima wallichii, Sterculia chrysodasys, Swietenia mahagoni, Strobocalyx arborea* and *Oreocnide rubescens*. The fact that they constituted 29.9% of the total species recorded in the three plots, combined with many open subplots and the presence of gaps in the three plots (Figs. 7–9), pointed to the somewhat secondary nature of the lowland forests of Bodogol. It was resulted from human disturbances and natural disruptions such as landslides and thunderstorms, which occasionally took place in the area. Structural characteristics showing low forest heights (Fig. 5 and Table 6) support this contention. It can be inferred that the forests in the plots were regenerating after disturbances in the past.

CONCLUSION

The forests investigated contained a total of 107 species recorded in three one-hectare plots. Lowland species were prevalent, thus forming the transition between lowland and lower montane forests, with relatively poor species richness. It was much poorer than the typical lowland rain forest of Kalimantan and Sumatra but comparable to those of the montane forests of Java. Based on two dominant species, the forest could be designated as the *Maesopsis eminii-Syzygium acuminatissimum* association and *Syzygium acuminatissimum-Lithocarpus korthalsii* association. Before *M. eminii* invasion the *Syzygium acuminatissimum-Lithocarpus korthalsii* association could have been prevalent in lowland forests at Bodogol. The trees native to Mt. Gede-Pangrango recorded in the present studies are the potential species for ecological restoration undertaken around the GGPNP.

This study strongly confirmed that the one-hectare area could be considered a minimal area to reflect the representativeness of the floristic composition. The dominance of *M. eminii,* pointed to a strong aggressive, and invasive species, which in no time will frighteningly take over the dominance of the lowland to subalpine forests of GGPNP. It, therefore, is very urgent to totally eradicate it at all costs from the natural forests, the plantations, and community forests adjacent to the GGPNP. Structurally and floristically the forest represented a developing and regenerating disturbed forest, and very low frequency and density in the majority of the species reflected species heterogenity. Investigations, similar to the present study, should be extended to other undescribed natural lowland forests of other resorts for better management, including ecological restoration.

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Appendix 1. Species present in the plots of the lowland natural forests at Bodogol GGPNP with their parameters on Density (D=trees/ha), Basal area (BA= m^2), and Importance Value (IV= %) The NSR and NH are considered lowland species following Backer & Bakhuizen van den Brink (1963-1968).
Note; L= lowland; M=Montane; A=Alien; NSR=Non Sunarno & Rugayah (1992); NH=Non Helmi *et al.* (2009):

No	Species	Family	P1CS			P2CS			P3CP			Note
			D (Ha)	BA (m2/ ha)	IV (%)	D (Ha)	BA (m2/ ha)	IV (%)	D (Ha)	BA (m2/ ha)	IV (%)	
1	2	3	4	5	6	7	8	9	10	11	12	13
GROUP 1												
1	*Maesopsis eminii* Engl.	Rham.	69	2.68	56.46	7	0.69	6.48	51	6.54	55.93	L.M.A.NH
2	*Syzygium acuminatissimum* (Blume) DC.	Myrt.	19	1.20	23.10	61	3.81	43.67	21	1.46	17.15	M.NH
3	*Lithocarpus pseudomoluccus* (Blume) Rehder	Fag.	16	1.41	21.32	22	1.85	19.40	13	0.49	9.34	M.NH
4	*Lithocarpus korthalsii* (Endl.) Soepadmo	Fag.	11	1.55	18.74	25	2.32	22.68	16	0.78	1.84	M.NH
5	*Castanopsis tungurut* (Blume) A.DC.	Fag.	12	0.59	13.50	4	0.26	3.33	11	0.34	7.46	M.NH
6	*Neoscortechinia kingii* (Hook.f.) Pax & K.Hoffm	Euph.	10	0.27	9.55	17	0.72	11.38	4	0.10	2.81	M.NSR.NH
7	*Schima wallichii* (DC.) Korth.	Thea.	6	0.64	9.03	11	2.72	16.38	20	1.43	16.77	L.M.NH
8	*Pometia pinnata* J.R.Forst. & G.Forst.	Sapin.	7	0.34	8.09	8	0.22	5.40	7	0.41	6.09	L.M.NSR.NH
9	*Macaranga denticulata* (Blume) Müll.Arg.	Euph.	9	0.17	7.56	12	0.27	7.01	12	0.23	6.88	M.NSR.NH
10	*Nephelium juglandifolium* Blume	Sapin.	6	0.29	6.90	25	1.53	18.58	4	0.22	3.07	M.NSR.NH.
11	*Ficus padana* Burm.f.	Mor.	7	0.15	6.25	1	0.02	0.66	1	0.10	1.07	L.M.NSR.NH
12	*Strobocalyx arborea* (Buch.-Ham.) Sch.Bip.	Astera.	3	0.24	4.17	1	0.01	0.61	2	0.04	1.39	M.NH
13	*Knema cinerea* (Poir.) Warb.	Myrist.	4	0.08	3.80	2	0.21	1.93	6	0.33	5.13	L.M.NSR.NH
14	*Melicope latifolia* (DC.) T.G.Hartley	Rut.	4	0.05	3.60	3	0.18	2.44	4	0.25	3.55	M.NSR

15	*Sandoricum koetjape* (Burm.f.) Merr.	Melia.	1	0.36	3.42	12	0.36	8.01	8	0.47	6.68	L.M.NSR.NH
16	*Gynotroches axillaris* Blume	Rhiz.	3	0.10	3.17	7	0.35	5.08	4	0.09	2.80	M
17	*Persea venosa* Nees & Mart.	Laur.	2	0.15	2.68	1	0.03	0.70	1	0.12	1.16	M.NH
18	*Cecropia pachystachya* Trécul	Urt.	3	0.03	2.65	4	0.04	1.53	1	0.01	5.44	L.A.NH
19	*Dalrympelea sphaerocarpa* (Hassk.) Nor-Ezzaw.	Staph	3	0.08	2.57	8	0.45	6.08	1	0.01	0.64	M
20	*Myristica* sp.	Myrist.	2	0.12	2.48	9	0.16	5.78	1	0.02	0.66	M.NH
21	*Aglaia elliptica* (C.DC.) Blume	Melia.	2	0.09	2.25	2	0.22	2.02	5	0.54	5.56	M.NSR.NH
22	*Litsea resinosa* Blume	Laur.	2	0.04	1.87	7	0.24	4.98	6	0.11	4.05	M.NH
23	*Mallotus paniculatus* (Lam.) Müll.Arg.	Euph.	2	0.03	1.85	1	0.04	0.75	3	0.14	2.45	M.NSR
24	*Symplocos acuminata* (Blume) Miq.	Sympl.	2	0.02	1.77	2	0.12	1.61	6	0.08	3.28	M.NH
25	*Dendrocnide stimulans* (L.f.) Chew	Urt.	2	0.02	1.30	9	0.17	5.82	5	0.05	3.17	M.NH
26	*Quercus gemelliflora* Blume	Fag.	1	0.06	1.25	1	0.03	0.70	1	0.01	0.66	M.NSR.NH
27	*Antidesma velutinosum* Blume	Euph.	1	0.02	0.97	1	0.09	0.93	1	0.01	0.64	L.NGPF
28	*Castanopsis argentea* (Blume) A.DC.	Fag.	1	0.02	0.96	4	0.15	2.27	2	0.42	3.22	M.NH
29	*Oreocnide rubescens* (Blume) Miq.	Urt.	1	0.01	0.88	9	0.13	4.73	7	0.12	4.06	L.M
GROUP 2												
30	*Beilschmiedia madang* (Blume) Blume	Laur.	7	0.31	7.42	6	0.22	4.33				M.NSR
31	*Syzygium koghianum* Petitm. & Bonati	Myrt.	6	0.21	6.35	4	0.13	2.81				M.NH
32	*Astronia macrophylla* Blume	Melast.	3	0.19	3.81	1	0.07	0.87				M.NSR
33	*Lithocarpus pallidus* (Blume) Rehder	Fag.	2	0.10	2.35	5	0.69	5.32				M.NH

34	*Glochidion rubrum* Blume var. *rubrum*	Euph.	2	0.05	1.96	3	0.04	1.89				M.NSR.NH
35	*Unidentified*	Uni-dent.	2	0.04	1.90	2	0.02	0.63				M.NH
36	*Litsea ligustrina* (Nees) Fern.-Vill.	Laur.	1	0.08	1.40	1	0.16	1.20				M.NH
37	*Ficus ribes* Reinw. ex Blume	Mor.	1	0.01	0.87	3	0.03	1.82				L.M
38	*Urophyllum arboreum* (Reinw. ex Blume) Korth.	Rub.	1	0.01	0.87	3	0.03	1.84				M.NSR
GROUP 3												
39	*Prasoxylon alliaceum* (Blume) M. Roem.	Melia.	6	0.25	6.60				1	0.02	0.66	M.NH
40	*Polyspora excelsa* (Blume) Orel, Peter G. Wilson, Curry & Luu	Thea.	3	0.06	2.83				2	0.03	1.30	M
41	*Barringtonia racemosa* (L.) Spreng	Lecyth.	3	0.04	2.27				1	0.03	0.71	M.NSR.NH
42	*Machilus rimosa* Blume	Euph.	2	0.05	1.98				3	0.05	2.01	M.NH
43	*Lannea coromandelica* (Houtt.) Merr.	Anac.	1	0.13	1.75				3	0.12	2.36	M.NSR.NH
44	*Cinnamomum* sp.	Laur.	1	0.11	1.57				2	0.03	1.00	M.NH
45	*Litsea noronhae* Blume	Laur.	1	0.02	0.97				1	0.08	0.97	M.NH
GROUP 4												
46	*Chisocheton ceramicus* Miq.	Melia.				2	0.97	5.05	3	0.07	1.80	M.NSR.NH
47	*Didymocheton nutans* Blume	Melia.				14	0.79	9.94	7	0.42	5.83	M
48	*Syzygium antisepticum* (Blume) Merr. & L.M.Perry	Myrt.				13	0.37	7.67	31	1.24	20.05	M. NH
49	*Symplocos acuminata* (Blume) Miq.	Sympl.				8	0.18	5.29	9	0.12	5.23	M.NSR.NH
50	*Myrsine hasseltii* Blume ex. Scheff.	Myrs.				7	0.11	4.44	1	0.11	1.13	M.NH
51	*Elaeocarpus angustifolius* Blume	Elaeoc.				2	0.71	4.00	2	0.06	1.48	M.NSR.NH

52	*Lithocarpus korthalsii* (Endl.) Soepadmo	Fag.				3	0.52	3.82	1	0.02	0.70	M.NH
53	*Knema laurina* (Blume) Warb.	Myrist.				3	0.23	2.35	1	0.03	0.72	L.NSR.NH
54	*Nauclea subdita* (Korth.) Steud.	Rub.				3	0.14	2.28	3	0.30	3.20	M.NSR.NH
55	*Cinnamomum parthenoxylon* (Jack) Meisn.	Laur.				3	0.11	2.15	2	0.19	2.08	M.NSR.NH
56	*Ostodes paniculata* Blume	Euph.				1	0.08	0.89	1	0.06	0.87	M.NH
57	*Ficus tinctoria* subsp. *gibbosa* (Blume) Corner	Mor.				1	0.04	0.73	3	0.03	1.57	M.NSR.NH
58	*Ficus fistulosa* Reinw. ex Blume	Mor.				1	0.03	0.70	3	0.03	1.93	L.M
59	*Mangifera laurina* Blume	Anac.				1	0.01	0.61	1	0.06	0.90	M.NSR.NH
60	*Mangifera* sp.	Anac.				1	0.01	0.61	1	0.17	1.40	M.NH
GROUP 5												
61	*Neonauclea lanceolata* (Blume) Merr.	Rub.	7	0.32	7.98							M
62	*Myrsine affinis* A.DC.	Myrs.	5	0.11	4.39							M
63	*Donella lanceolata* (Blume) Aubrév	Sapot.	1	0.37	3.50							M.NSR.NH
64	*Litsea brachystachya* (Blumea) Fern.-Vill.	Laur.	3	0.10	3.16							M.NSR.NH
65	*Liquidambar excelsa* (Noronha) Oken	Ham.	3	0.07	2.89							M
66	*Actinodaphne glomerata* (Blume) Nees	Laur.	2	0.07	2.10							M.NSR.NH
67	*Semecarpus heterophylla* Blume	Anac.	2	0.07	1.87							L.NSR.NH
68	*Adina trichotoma* (Zoll. & Moritzi) Benth. & Hook.f. ex B.D.Jacks	Rub.	1	0.04	1.52							L.NSR.NH
69	*Litsea glutinosa* (Lour.) C.B.Rob.	Laur.	1	0.04	1.11							M.NSR.NH
70	*Litsea* sp.	Laur.	1	0.04	0.90							M.NH
71	*Gironniera subaequalis* Planch.	Cann.	1	0.04	0.89							M.NSR.NH

72	*Saurauia bracteosa* DC.	Acthin.	1	0.03	0.89							M.NH
73	*Symplocos fasciculata* Zoll.	Sympl.	1	0.01	0.88							M
74	*Ficus grossularioides* Burm.f.	Mor.	1	0.01	0.87							M.NH
GROUP 6												
75	*Spondias pinnata* (L.f.) Kurz	Anac.				3	0.98	5.65				M.NSR.NH
76	*Flacourtia* sp.	Flacour.				5	0.13	3.38				M.NH
77	*Ficus glandulifera* (Miq.) Wall. ex King	Mor.				2	0.32	2.45				M.NSR.NH
78	*Sterculia chrysodasys* Miq.	Ster.				2	0.03	1.26				M.NSR.NH
79	*Diospyros frutescens* Blume	Ebena.				1	0.09	0.94				L.NGPF
80	*Artocarpus elasticus* Reinw. ex Blume	Mor.				1	0.05	0.94				L.M.NSR.NH
81	*Podocarpus neriifolius* D.Don	Pod.				1	0.05	0.76				M.NH
82	*Magnolia macklottii* (Korth.) Dandy	Mag.				1	0.04	0.73				M.NSR.NH
83	*Litsea sphaerocarpa* Blume	Laur.				1	0.02	0.66				M.NSR
84	*Leptospermum polygalifolium* Salisb.	Laur.				1	0.02	0.64				M.NSR.NH
GROUP 7												
85	*Calliandra houstoniana* var. *calothyrsus* (Meisn.) Barne-by	Leg.							28	0.33	14.18	L.A.NH
86	*Decaspermum fruticosum* J.R.Forst. & G.Forst.	Myrt.							3	0.40	3.72	M.NH
87	*Swietenia mahagoni* (L.) Jacq.	Melia.							4	0.31	3.55	L.A.NH

88	*Falcataria falcata* (L.) Greuter & R.Rankin	Leg.	3	0.35	3.45	L.A.NH
89	*Pinus merkusii* Jungh. & de Vriese	Pin.	4	0.11	2.90	L.A.NH
90	*Ficus variegata* Blume	Mor.	4	0.08	2.39	L.N.H
91	*Cryptocarya ferrea* Blume	Laur.	3	0.08	2.14	L.N.H
92	*Bellucia pentamera* Naudin	Melast.	3	0.05	1.99	M.A.NH
93	*Quercus lineata* Blume	Fag.	2	0.13	1.80	M.NSR.NH
94	*Artocarpus heterophyllus* Lam.	Mor.	2	0.09	1.62	L.A.NH
95	*Garcinia cambogioides* (Murray) Headland var. *cambogioides*	Clusia.	2	0.06	1.45	M.NSR.NH
96	*Syzygium* sp.	Myrt.	1	0.15	1.32	M.NH
97	*Blumeodendron tokbrai* (Blume) Kurz	Euph.	1	0.05	0.82	L.M.NSR.NH
98	*Dracaena angustifolia* (Medik.) Roxb.	Aspar.	1	0.04	0.79	L.A.NH
99	*Ficus virens* Aiton var. *virens*	Mor.	1	0.04	0.78	M.NSR.NH
100	*Magnolia sumatrana* var. *glauca* (Blume) Figlar & Noot.	Mag.	1	0.03	0.72	M.NH
101	*Aporosa spaeridophora* Merr.	Euph.	1	0.02	0.71	M.NSR.NH
102	*Pavetta montana* Reinw. ex Blume	Rub.	1	0.01	0.65	M.NSR.NH
103	*Homalanthus populneus* (Geiseler) Kuntze	Euph.	1	0.01	0.64	L.M.NH
104	*Elaeocarpus angustifolius* Blume	Elaeoc.	1	0.01	0.63	M.NH
105	*Sterculia* sp.	Ster.	1	0.01	0.63	M.NH
106	*Magnolia montana* (Blume) Figlar	Mag.	1	0.01	0.62	L.M.NH
107	*Neesia altissima* (Blume) Blume	Bomb.	1	0.01	0.62	M.NSR