Diversity of Trees at Gunung Serambu, Bau District, Sarawak, Malaysia

Ik Wadell Ik Pahon, Alexander Kiew Sayok, and Jugah Tagi

Abstract An inventory on trees was undertaken in 12 plots of 20 × 20 m at Gunung Serambu, Bau District as part of a multidisciplinary study in 2012. Six plots were established at the upper elevation (≥500 m) of the mountain and another six along the lower elevation from the foothill (≤500 m). A total of 487 trees were enumerated consisting of 112 species from 80 genera and 43 families. Among them are three species of figs namely *Ficus schwarzii*, *F. fistulosa*, *F. grossulariodes* and a legume, *Koompassia excelsa,* which are categorized as protected in Sarawak based on Sarawak Protection Ordinance 1998. Another eight species (*Vatica micrantha*, *Artocarpus primackii*, *Knema pallens*, *Chionanthus pubicalyx*, *Mangifera pajang*, *Diospyros piscicarpa*, *Lithocarpus hallieri* and *Xanthophyllum ecarinatum*) are listed as Borneo endemic. Euphorbiaceae with 13 species and 10 genera was considered the most dominant family. The families that follow in order of decreasing dominance are Moraceae, Clusiaceae, Lauraceae and Anacardiaceae. Based on important value index (IVI), *Durio zibethinus* represents the most dominant species with IVI = 259.24 followed by *Lansium domesticum* with IVI = 242.84, while *Blumeodendron tokbrai,* a distant third, with IVI = 157.23. There were nine species, with IVI less than 5.0. Higher number of individuals and species were recorded at higher elevation than at the lower elevation, as shown by the Shannon index (H') = 3.69 (≥500 m) and H' = (400–500 m), respectively. Simpson index (Ds) also recorded the highest value, with Ds = 0.97 at elevation of ≥500 m. The distribution of individuals among species was more or less even in all plots with E > 0.9.

I.W.I. Pahon • J. Tagi
Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

A.K. Sayok (✉)
Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia
e-mail: ksalexender@ibec.unimas.my

I. Das, A.A. Tuen (eds.), *Naturalists, Explorers and Field Scientists in South-East Asia and Australasia*, Topics in Biodiversity and Conservation 15,
DOI 10.1007/978-3-319-26161-4_12

1 Introduction

The Bidayuhs form the fourth largest ethnic group in Sarawak, and were traditionally settled on mountains, for protection from marauding enemies for centuries until 1841, when the Brooke's took the authority from the Brunei Malay Sultanate to illegalized headhunting and tribal warfare (Chang 2001). Being abandoned for almost a century, the old village sites are today quasi-pristine forming islands of tropical rainforest compared to the developed surroundings. In her journey towards development, Malaysia had rapidly transformed her forests. In general, agricultural estates, which are mainly rural, took most of the land area. City and town development and expansion took place where population concentrate and congregate. The forest fragments in the old village sites, though small in size, are increasingly important as wildlife refuge, apart from being a gene pool for the biodiversity they harbor, warranting conservation and protection.

Peninjau Hill at Gunung Serambu, located near Kuching City, Sarawak, is an old Bidayuh settlement site. Historically, faunal studies have been conducted on insects by Wallace (1876) and one specifically on butterflies by Moulton (1912). Despite its place in history and close proximity to Kuching and its institutes of higher learning and research centers, and that Odoardo Beccari, an Italian botanist, who described many plant species too visited Peninjau Hill in 1902, no structured research has been carried out on the vegetation of the site. Several floristic studies had been reported in the adjacent Bau region, such as those of Adam and Mamat (2005), Pahon (2011), and Migas (2012). This paper presents an inventory of trees, undertaken in 2012 as part of multidisciplinary assessment organized by the Institute of Biodiversity and Environmental Conservation of Universiti Malaysia Sarawak. The objective of this study is to describe the composition, distribution and diversity of trees at Gunung Serambu.

2 Methodology

2.1 Study Area

Gunung Serambu is a lowland secondary forested hill, located in Bau District in the western part of Sarawak, at 1.422°N, 110.225°E, about 35 km from Kuching, the capital city of Sarawak State (Fig. 1).

Alfred Russel Wallace spent about 4 weeks (December 1855 to January 1856) in Peninjau Hill of Gunung Serambu, collecting butterflies, moths, land shells, ferns and orchids. Bukit Peninjau is also the site of the cottage built by Rajah Brooke between the years 1848–1850. The Italian botanist, Odoardo Beccari, who made important contributions to science of the region, also visited Peninjau in 1902. Today, this fragmented habitat of old secondary forest stands intermixed with old farmlands and fruit orchards.

The hill was formerly covered with mixed dipterocarp forest with small patches of heath forest on the exposed rocky peak. The summit is at 555 m above sea level.

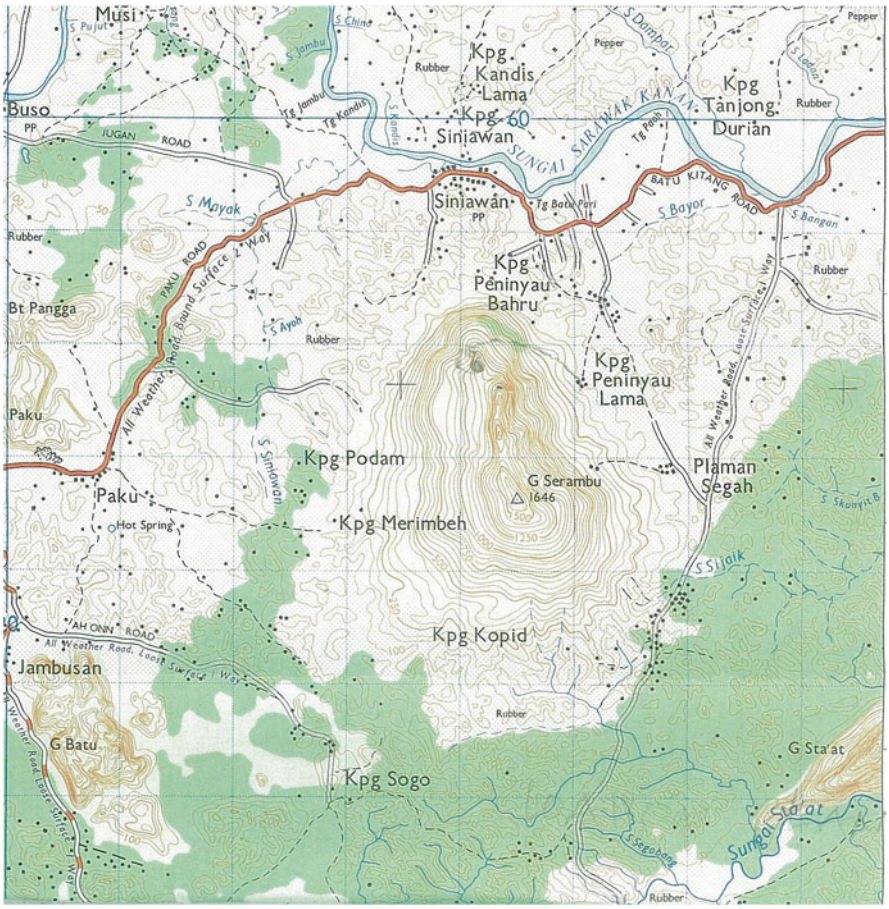

Fig. 1 Map showing the location of Gunung Serambu in Bau District, Sarawak

Much of the timber have been extracted by the local inhabitants for building houses and for other uses. Subsistence farming for hill rice was undertaken along the hill slope by the settlers but had stopped for more than 50 years. Burning of clearings for hill rice planting in the 1960s had engulfed the entire southwestern part of the hill so that smaller and younger trees dominated. At the old village site and foothill, local fruit trees dominated such as *Durio zibethinus*, *Lansium domesticum*, *Baccaurea brecteata*, *Baccaurea motleyana*, and *Mangostana,* with *Koompassia excelsa* trees and bamboo as well as various palms found scattered throughout. A majority of the old fruit trees had been planted during the first resettlement of the Serambu Bidayuh people (known as the Biroih), nearly a century ago. Most of the surrounding lowland areas are owned by the local community and are planted with various fruit trees and rubber (*Hevea basiliensis*). Further uphill, the landscape is steep and strewn with huge boulders. In between, various bamboo and palms, as well as dense understory plants, flourish. At the summit and its immediate surround-

ings, no records of clearing activities were observed so that the original vegetation was maintained.

The study was conducted in lowland mixed dipterocarp of old regrowth forest somewhat resembling a tropical lowland evergreen rainforest.

2.2 Sampling Method and Analyses

Twelve plots of 20 × 20 m were established along the trail at Gunung Serambu with first plot (Plot 1) just above Old Peninjau village and last plot (Plot 12) on the summit. Brief descriptions of the plots are shown in Table 1. At the steeper terrain and big boulders along the trail, some of the plots were adjusted to suit. For each tree with diameter 5 cm and above, both local and botanical name of the plants was recorded. Diameter at breast height was measured using a dbh tape and total height of trees was measured using a clinometer. Voucher specimens of twigs, leaves, flowers and fruits wherever possible, were collected and identified at Sarawak Forest Department Herbarium. Specimens were identified to the lowest taxonomic level possible. The relative frequency (Rf), relative dominance (RD), relative density (Rd), and important value (IV) were determined based on Soepadmo (1987). Three species diversity indices, including the Shannon (H'), Simpson (Ds) and Evenness (E) indices were used to compare different elevation (Magurran 1988).

3 Results and Discussions

3.1 Relative Abundance

A total of 487 individual trees were enumerated comprising of 112 species 80 genera and 43 families of trees. Four species of trees (*Ficus schwarzii*, *F. fistulosa*, *F. grossulariodes* and *Koompassia excelsa*) are categorised as protected plants species in Sarawak, according to the Sarawak Protection Ordinance 1998. Another eight species of trees recorded at Gunung Serambu were listed as Bornean endemic namely *Vatica micrantha*, *Artocarpus primackii*, *Knema pallens*, *Chionanthus pubicalyx*, *Mangifera pajang*, *Diospyros piscicarpa*, *Lithocarpus hallieri* and *Xanthophyllum ecarinatum*. A comparison was made with study conducted at Gunung Santubong as reported by Ipor et al. (2006), where 1421 trees ha^{-1} was enumerated. Gunung Santubong is generally classified as tropical lowland and submontane evergreen rainforest. However, this study did not describe in detail the composition and distribution of trees, containing nonetheless, the dominant trees at different elevations. Migas (2012) reported a total of 83 species from 325 trees at an undisturbed mixed dipterocarp forest at Gunung Jagoi, also in the Bau region, while Sayok et al. (2013; in prep) describes the understory and tree flora at Gunung Singgai, Bau, that includes 23 genera and 17 families for 131 tree species.

Table 1 Plot description for established plots in Gunung Serambu

Plot no	Coordinates		Plot description
	Latitude	Longitude	
1	1.431029°	110.228555°	Foothill of Gunung Serambu, in old orchard, mostly dominated by fruit trees (*Durio zibethinus*, *Lansium domesticum*, *Baccaurea angulata*, *Mangifera* spp.). Terrain condition: flat area, high decomposed leaf litter, litter depth of 5 cm, high moisture on forest floor. High number of understory plants such as common grass and weeds, tapioca, chilies, *Piper* sp., aroid plants, ferns, wild gingers and small clumps of *Bambusa* spp
2	1.431302°	110.227651°	Foothill of mountain. About 50 m from plot 1. Few large fruit trees observed. Mostly dominated by fruit trees (*Durio zibethinus*, *Lansium domesticum*, *Baccaurea angulata*, *Mangifera* spp.). Terrain condition: The slope was 10 %, as trail starts to ascend to the old traditional village (to Biroih village). Low decomposed leaf litter, litter depth of 3.5 cm, high moisture on forest floor, small boulders of rock also recorded outside plot. Understory plants such as seedlings of fruit trees, ferns and fern allies, grass, aroid plants, *Amorphophallus* sp
3	1.431557°	110.226366°	On ridge of mountain. Trees tall with large buttresses. Both *Durio zibethinus* and *Lansium domesticum* dominate plot area. Terrain condition: 15 % slope. Low decomposed leaf litter, litter depth of 2 cm, relatively moist forest floor. Few understory plants, such as seedlings of fruit trees, climbing ferns, palm species, *Caryota mitis* and aroids
4	1.431823°	110.225358°	Area steeper than plots 2 and 3. Mostly dominated by *Lansium domesticum* and *Hevea brasiliensis*. Terrain condition: 30 % slope. Low decomposed leaf litter, litter depth of 2.5 cm, relatively wet and moist forest floor. High number of understory plants observed, such as seedlings of *Hevea brasiliensis*, climbers, aroid plants and few clumps of bamboo. High number of large sized bamboo clumps recorded
5	1.432125°	110.224274°	Site of abandoned ancestral village. Trees high with old buttresses. High number of old fruit trees observed, such as *Durio zibethinus*, *Lansium domesticum* and *Baccaurea spp.* Terrain condition: relatively flat area. High and thick semi decomposed leaf litter on forest floor. Forest floor relatively wet and moist. Some undergrowth cleared with trees intact. High number of fruit tree seedlings observed on forest floor
6	1.432936°	110.223320°	Above site of abandoned village. Steep slope of 15 %. Low semi-decomposed or decomposed leaf litter. Litter depth of 2 cm. Certain part dry due to open canopy

(continued)

Table 1 (continued)

Plot no	Coordinates		Plot description
	Latitude	Longitude	
7	1.431973°	110.221985°	Site of old White Rajah cottage. Old secondary forest. No fruit trees observed within the area. Some patches of openings are seen at plot 8. Extent of farmed land at plot 8. Terrain condition: flat area with pockets of gentle slope. Relative dried and lesser moist forest floor. Low leaf litter with litter depth of 2 cm
8	1.430850°	110.222620°	
9	1.429722°	110.222870°	
10	1.428341°	110.223159°	About 10 m away from the 1st mountain view point. No fruit trees recorded in this plot except few *Artocarpus integer* (Tibodak) trees recorded outside plot. Most probably seedlings dispersed by squirrels. Gentle slope about 5 %. High and thick decomposed leaf litter on forest floor. Forest floor relatively wet and moist. High number of understory plants within and outside plot
11	1.427181°	110.222780°	
12	1.425920°	110.223147°	Second highest summit in Gunung Serambu. Forest floor with thick semi-decomposed/decomposed leaf litter, depth 6 cm. Forest floor with high moisture content. Terrain condition: on ridges, small flat areas. Low number of understory plants, such as seedlings, herbs, *Nepenthes ampullaria,* lichen species and parasitic plants including orchids

The Euphorbiaceae is the most dominant family within the established plots, comprising 10 genera and 13 species (Table 1). The families Lauraceae and Anacardiaceae followed a distant second and third, respectively. The largest family, based on species numbers, was also the Euphorbiaceae, with a total of 13 species or 11.30 % of the total number of species. This was followed by the Moraceae, with ten species (8.70 %) and Clusiaceae, with seven species (6.09 %). The families Lauraceae, Anacardiaceae and Myrtaceae were represented with six species each (5.22 %) within the established plots. These results agree with the studies conducted by Whitmore (1972) and Kochummen et al. (1990), that show that the Euphorbiaceae is one of the largest families of tropical forests. The 12 established plots at Gunung Serambu displayed an extremely low composition of dipterocarp although the vegetation was once classified as lowland dipterocarp forest. However, only two species of dipterocarp were recorded in this study and were found almost on top of the mountain (elevation ≥500 m). Ipor et al. (1998, 2001) also reported low numbers of dipterocarp trees in the highlands of Bario in Sarawak and the Mahua region of the Crocker Range, in Sabah.

A cumulative plot of species (Fig. 2) shows the number of species increased with decreasing rate as the number of plots increases. The species accumulation curve showed no tendency to flatten out, and new species continue to increase slowly as the plot increases within the study area. Poore (1968) mentioned that in the species-rich rainforests, tree species continue to accumulate even over 4–5 ha survey areas, particularly those species whose presence are the result of habitat conditions, or by chance.

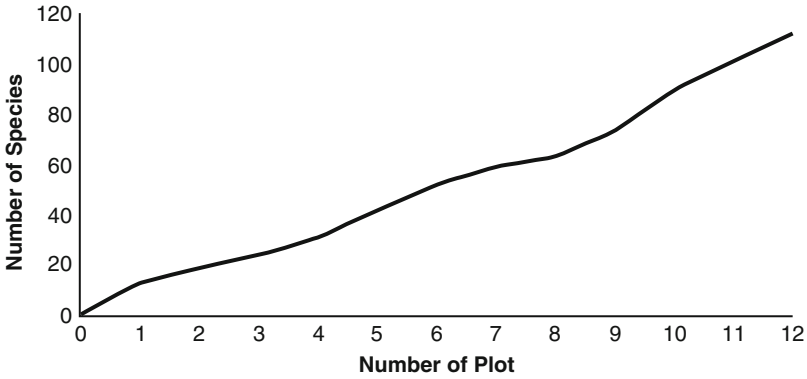

Fig. 2 Species-area curve for trees in Gunung Serambu

Table 2 Six largest families of trees within the established plots (based on species number) at Gunung Serambu

Family	No of genera	No of species
Euphorbiaceae	10	13
Moraceae	2	10
Clusiaceae	3	7
Lauraceae	6	6
Anacardiaceae	4	6
Myrtaceae	2	6

3.2 Important Value Index (IVI)

Based on their important value index (IVI) in Table 2, Durio zibethinus represents the most dominant species, with IVI = 259.24, followed by Lansium domesticum (IVI = 242.84) and Blumeodendron tokbrai (IVI = 157.23). Table 3 shows that some of the co-dominant species recorded included *Artocarpus elasticus* (IVI = 141.24), *Koompassia excelsa* (IVI = 128.04), *Adinandra dumosa* (IVI = 113.32), *Dacryodes rostrata* (IVI = 112.91) and *Symplocos adenophylla* (IVI = 76.88). Some of the least dominant species recorded in the established plots with IVI < 5 are from nine species- *Adenanthera borneense*, *Fagraea crassipes*, *Actinodaphne pruinosa*, *Saurauia heterosepala*, *Swintonia spicifera*, *Diospyros sumatrana*, *Strombosia ceylanica*, *Vitex pubescens* and *Ficus grossulariodes*. According to Ipor et al. (2006), low tree species dominant is due to fewer individual trees as well as their smaller basal area.

3.3 DBH Class Distribution

Figure 3 shows that trees can be classified into five groups based on their dbh (in cm). Class 1 (5.0–≤15.0), class 2 (15.1–≤25.0), class 3 (25.1–≤35.0), class 4 (35.1–≤45.0) and class 5 (≥45.1). The highest number of individual trees were in class 1,

Table 3 Relative frequency (*Rf*), relative dominance (*RD*) and relative density (*Rd*) and importance value index (*IVI*) of tree species with dbh 5 cm and above at Gunung Serambu

Genus	Species	Family	rF	rDom	rd	IVI
Durio	*zibethinus*	Bombacaceae	83.52	92.20	83.52	259.24
Lansium	*domesticum*	Meliaceae	69.05	104.74	69.05	242.84
Blumeodendron	*tokbrai*	Euphorbiaceae	52.79	51.66	52.79	157.23
Artocarpus	*elasticus*	Moraceae	46.07	49.10	46.07	141.24
Koompassia	*excelsa*	Fabaceae	45.85	36.33	45.85	128.04
Adinandra	*dumosa*	Theaceae	34.01	45.31	34.01	113.32
Dacryodes	*rostrata*	Burseraceae	36.38	40.14	36.38	112.91
Cratoxylum	*glaucum*	Clusiaceae	26.57	30.54	26.57	83.67
Symplocos	*adenophylla*	Symplocaceae	24.19	28.50	24.19	76.88
Vatica	*micrantha*	Dipterocarpaceae	19.63	33.66	19.63	72.93
Symplocos	*rubiginosa*	Symplocaceae	24.39	23.22	24.39	71.99
Myristica	*lowiana*	Myristicaceae	19.25	17.86	19.25	56.37
Pimeleodendron	*griffithianum*	Euphobiaceae	14.87	24.06	14.87	53.80
Ixonanthes	*petiolaris*	Ixonanthaceae	17.24	18.01	17.24	52.49
Pometia	*pinnata*	Sapindaceae	17.05	14.05	17.05	48.14
Pangium	*edule*	Flacourtiaceae	17.05	13.90	17.05	47.99
Porterandia	*anisophylla*	Rubiaceae	14.68	15.75	14.68	45.11
Barringtonia	*macrostachya*	Lecythidaceae	12.69	18.38	12.69	43.76
Artocarpus	*kemando*	Moraceae	14.62	13.10	14.62	42.34
Garcinia	*mangostana*	Clusiaceae	15.38	11.22	15.38	41.97
Swintonia	*spicifera*	Anacardiaceae	1.75	1.19	1.75	4.70
Diospyros	*sumatrana*	Ebenaceae	1.75	1.19	1.75	4.70
Strombosia	*ceylanica*	Olacaceae	1.75	1.19	1.75	4.70
Vitex	*pubescens*	Verbenaceae	1.75	1.19	1.75	4.70
Saurauia	*heterosepala*	Actinidiaceae	1.75	1.14	1.75	4.65
Adenanthera	*borneensis*	Fabaceae	1.75	1.14	1.75	4.65
Actinodaphne	*pruinosa*	Lauraceae	1.75	1.14	1.75	4.65
Fagraea	*crassipes*	Loganiaceae	1.75	1.14	1.75	4.65
Ficus	*grossulariodes*	Moraceae	1.75	1.14	1.75	4.65

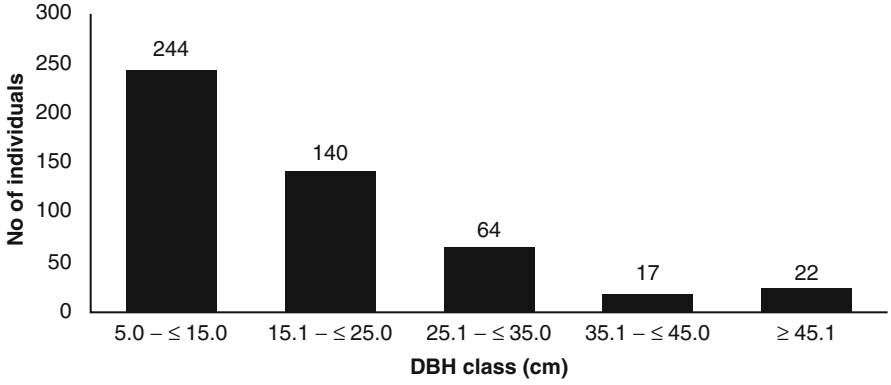

Fig. 3 dbh (cm) class distribution of trees at Gunung Serambu

with 244 individuals, followed by class 2, with 140 individual trees. The least number of individual trees recorded (17) was found in class 4. There is a decreasing trend on number of individual trees as the diameter at breast height (dbh) increases in size. Class 5 (≥45.1) cm included 22 individuals trees. The largest trees recorded in the established plots in Gunung Serambu were Dooh (*Kompassia excelsa*), with dbh 168 cm and Dien (*Durio zibethinus*), with dbh 110 cm.

3.4 Height Class Distribution

Figure 4 shows that trees can be classified in to groups based on their height (in m). Class 1 (0–≤10.0), class 2 (10.1–≤20.0), class 3 (20.1–≤30.0), class 4 (30.1–≤40.0) and class 5 (≥40.1). The highest number of trees with 261 individuals was recorded in class 2 (10.1–≤20.0) m, followed by class 1 (0–≤10.0) m, with 132 individuals and class 3 (20.1–≤30.0) m with 66 individuals. The least number of trees recorded, with 12 individuals, fall in class 5 (≥40.1) m. The tallest tree recorded in Gunung Serambu is Do'oh (*Kompassia excelsa*) with total height range from 45 to 65 m. Notably, there is a major drop in the number of individuals reaching heights of more than 20 m and a gradual decrease in numbers with increasing height class (Fig. 2).

3.5 Species Diversity and Elevations

The highest elevation for Gunung Serambu recorded was 514 m above mean sea level. To compare the species diversity based on different elevational gradients, five different elevation readings were used for this study which are 0–100 m, 100–200 m, 200–300 m, 300–400 m, 400–500 m, and more than 500 m. The highest number of individual trees was 172, recorded at elevation more than 500 m. The second highest was 116 individuals recorded at 400–500 m followed by third ranked

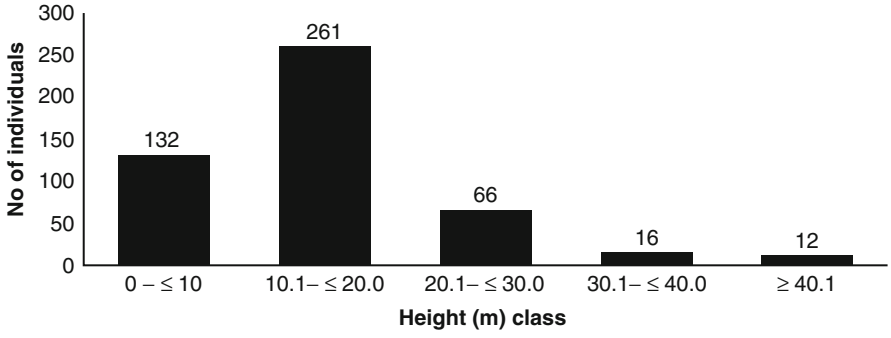

Fig. 4 Height (m) class distribution of trees at Gunung Serambu

Table 4 Tree species diversity indices for different elevations at Gunung Serambu, using the Shannon index (H′), Simpson index (Ds) and Evenness index (E)

Elevational bands (m)	Individuals (n)	Species (s)	Shannon (H′)	Simpson (Ds)	Evenness (E)
0–100	47	19	2.63	0.90	0.73
100–200	40	23	2.89	0.93	0.78
200–300	63	32	3.14	0.94	0.72
300–400	49	27	2.99	0.93	0.74
400–500	116	37	3.15	0.94	0.63
≥500	172	55	3.69	0.97	0.73

highest with 63 individuals at 200–300 m. The lowest number of individuals recorded at two elevations, which are located at the foothill of the mountain with 40 individuals (100–200 m) and 47 individuals (0–100 m).

The highest number of species found was recorded at elevations over 500 m, with 55 species, followed by 37 species at 400–500 m, 32 species at 200–300 m and 27 species at 300–400 m. The lowest number of species found was recorded for 23 species at 100–200 m and 19 species at 0–100 m.

Shannon Index (H′) showed high values at higher elevations. Table 4 shows that H′ = 3.69 at elevations over 500 m, followed by H′ = 3.15 at 400–500 m and H′ = 3.14 at 200–300 m. Low H′ values were recorded at the three lower elevational bands, 0–100 m (H′ = 2.63), 100–200 m (H′ = 2.89) and 300–400 m (H′ = 2.99). Simpson index (Ds) also indicates high values at higher elevations (≥500 m), with Ds = 0.97, while the lowest value (Ds = 0.90) was recorded at the foothills of the mountain (0–100 m). Evenness index (E) shows high value at 100–200 m, with E = 0.78, and the lowest recorded was at 400–500 m, with E = 0.63. The distribution of individuals among the species was even in all established plots (E > 0.9). Figure 4 shows that the highest elevation of Gunung Serambu (≥500 m), recorded high values of selected diversity indices, including high number of individuals, number of species, Shannon index (H′) and Simpson index (Ds).

Based on our observations, no logging or forest extraction activities were evident on the upper reaches of the mountain, as the villagers maintain them for watershed protection, and furthermore, it is difficult to access the steep terrain. The local communities of Gunung Serambu, especially villagers from Kpg. Peninjau Lama and Kpg. Peninjau Baru, live off the forest: they collect wild vegetables, wild fruits, wild honey and meat. Selected tree species provide materials for diverse use, such as housing materials, roofing, firewood, medicine and musical instrument. The forests of Gunung Serambu are also an important water catchment for some of the lowland villages.

4 Conclusions

Gunung Serambu still harbors substantial species of the tropical rainforest despite that it had been settled for a few centuries. These include several protected species under Sarawak Law and Bornean endemic species, as well as the original species of the lowland mixed dipterocarp in tropical rainforest at upper elevations. Fruit trees which dominate in the old village sites and at the lower elevation should be considered as good combination with native species as these trees will provide seasonal fruit and protect the mountain's ecosystem such as habitats for wildlife, source of clean water, and prevention of erosion. They can also be included as one of the ecotourism products. The existing spirit shown the locals to protect the forest and sustainably use it should be supported through gazettement of the area as community forest to discourage individual claims, that can lead to its fragmentation and thus its ecosystem functions.

Acknowledgments We would like to thank the Small Grants Programme of the Global Environmental Facility of the United Nations Development Programme, through the Brooke's Heritage Committee, for providing a grant to conduct the research at Gunung Serambu. We also thanked Veronica Juti, Cecilia Emang and Erdiana Odan of UNIMAS for assisting us during the sampling work, Fendra Robert, Lexter Nuon, Gervin Pinih, Jotom Arit and Jopis Sidup for providing local names of the trees and for various assistance.

References

Adam JH, Mamat J (2005) Floristic composition and structural comparison of limestone forests at three different elevations in Bau, Kuching, Sarawak, Malaysia. J Biol Sci 5:478–485

Chang PF (2001) History of Bidayuh in Kuching Division, Sarawak. Dayak Bidayuh National Association, Kuching

Pahon IW (2011) Diversity and volume of tree species in different forest types. A case study in Kampung Jagoi areas, Bau District, Sarawak, Malaysia. Unpublished B.Sc. Thesis. Faculty of Resources Science and Technology, Universiti Malaysia Sarawak, Kota Samarahan

Ipor IB, Tawan CS, Ismail J, Bojo O (1998) Floristic compositions and structures of forest at Bario Highlands, Sarawak. In: Ismail G, bin Din L (eds) A scientific journey through Borneo. Bario. The Kelabit Highlands of Sarawak. Pelanduk Publications, Kuala Lumpur, pp 113–131

Ipor IB, Sani H, Tawan CS (2001) Floristic composition of forest formation at Mahua, Crocker Range National Park, Sabah, Malaysia. In: Ismail G, Ali L (eds) A scientific journey through Borneo. Crocker Range National Park, Sabah, vol 1, Natural Ecosystem and Species Components. ASEAN Academic Press, London, pp 21–31

Ipor IB, Tawan CS, Mustafa HS (2006) Floristic structure and tree species composition. In: Abang F, Das I (eds) The biodiversity of a peat swamp forest in Sarawak. Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, Kota Samarahan

Kochummen KM, LaFrankie JV Jr, Manokaran N (1990) Floristic composition of Pasoh Forest Reserve, a lowland rain forest in Peninsular Malaysia. J Trop For Sci 3(1):1–13

Magurran AE (1988) Ecological diversity and its measurement. Chapman and Hall Publishers, New York

Migas OK (2012) Species composition of mixed dipterocarp and heath forest: a case study at Jagoi, Bau, Sarawak. Unpublished B.Sc. Thesis. Faculty of Resources Science and Technology, Universiti Malaysia Sarawak, Kota Samarahan

Moulton JC (1912) "Where Wallace trod": being some account of an entomological trip to Gunung Serambu, Sarawak, Borneo (conclusion). Entomology 45:246–251

Poore MED (1968) Studies in Malaysia rain forest. 1: the forest on Triassic sediments in Jengka Forest Reserve. J Ecol 56:143–196

Sayok AK, Tuen AA, Pungga RS, Kerman K, McLellan J, McLellan L (in prep) Plants in Mount Singai. Manuscript

Sayok AK, McLellan J, Noweg GT, McLellan L, Khong HY (2013) Understory plants in Mount Singai, Sarawak, Malaysia. In: Said S, Pawi AAA (eds) Proc. Konferensi Antar Universitas SeBorneo Ke-6 (KABOKA 6). Universitas Palangka Raya, Palangka Raya, pp 610–625

Soepadmo E (1987) Structure, above ground biomass and floristic composition of forest of Gunung Janing Barat, Endau, Johor, Malaysia. Malay Nat J 41:275–290

Wallace AR (1876) The Malay Archipelago: the land of the oran-utan and the bird of paradise, a narrative of travel with studies of man and nature. Macmillan and Co., London

Whitmore TC (1972) Tree flora of Malaya, vol 1. Longman, Kuala Lumpur