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FLORISTIC COMMUNITY COMPOSITION IN RAFFLESIA'S HABITAT AT KINABALU PARK, SABAH

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ABSTRACT. In the vicinity of Kinabalu Park, Sabah, a study was conducted to determine the plant community and its composition in the habitat of *Rafflesia* sp. and its host, *Tetrastigma* sp. A total of 5 circular-shaped plots each with a fixed radius of 20 meters, were located around Kinabalu Park, namely in Losou Podi, Losou Minunsud, Sayap Substation, Langanan and Gansurai. The *Rafflesia* species detected in Kinabalu Park during the present study were *Rafflesia pricei* and *R. keithii*. Overall, 19 *Rafflesia* individuals were detected, which comprised of 3 flowers and 16 buds. A total of 20 scars from former dead flowers and buds were obtained on the host, where they possessed an average diameter of 2.2-4.8 cm from the five plots. There were 778 individuals recorded for plant community, belonging to 111 genera, 53 families and 250 species. The total tree density was 1238 individuals/ha, where the family Lauraceae (11.05%) had the highest individuals followed by Annonaceae (8.61%). Although the species *Baccaurea lanceolata* were found in all study plots, the species *Xantophyllum macrophyllum* has the most individuals detected (3.60%) in the plant community habitats. The value of the Shannon-Wiener Index was H'=3.23 and the Evenness Index is low, E=0.10. The percentage of family similarity between plots was high (S_{BC}=70.19–48.23%), but the percentage of species similarity between plots was very low (S_J=4.31–1.54%). This study shows that both the species of *Xanthophyllum macrophyllum* and *Baccaurea lanceolata* have a relationship with the habitat of *Rafflesia* in Kinabalu Park, as both species were located nearest to the *Rafflesia*'s host. Moreover, these two species were seen to be well associated with *Tetrastigma* since the *Tetrastigma* was observed to climb several trees of these species in the plot.

KEYWORDS. Ecology, Kinabalu Park, plant community, *Rafflesia*, *Tetrastigma*.

INTRODUCTION

Malaysia is rich in floral and faunal diversity, as it houses an estimated of 20,300 species flowering plants (Middleton *et al.*, 2019). Some of these plants are endemics in certain areas, for example, the *Rafflesia* sp. (Rafflesiaceae), which is only found in some areas of Southeast Asia; ranging from Sumatra, Java Islands, Borneo Island, Southern Thailand, Peninsular Malaysia and in the Philippine Islands (Barcelona *et al.*, 2009; Erlinda *et al.*, 2018; Farah Khaliz *et al.*, 2018; Mat-Salleh *et al.*, 2011; Meijer, 1984; Suwartini *et al.*, 2008; Wiriadinata & Sari, 2011). The *Rafflesia* sp. can be found in several areas in Sabah; namely Crocker Range, Mount Trus Madi, Maliau Basin Conservation Area, Imbak Canyon Conservation Area and Danum Valley Conservation Area. There are three species of *Rafflesia* occurring in Sabah, where two are known to occur in the Kinabalu Park namely *Rafflesia pricei* and *R. keithii*. The other one, *R. tengku-adlinii* has never been recorded in any area in Taman Kinabalu (Nais, 2001).

Vegetation differences found in a plant community can be influenced by various factors, either by biotic or abiotic factors, e.g., soil saprophytic microbes, root-fungal associations and altitude difference (Ghollasimood *et al.*, 2012; Ushio *et al.*, 2017). This will have positive or negative impact on the plant community because they have to compete for a continuous supply of nutrients and water, as the same soil characteristics and natural factors are shared and are limited to all plants within the habitat area (Laksana *et al.*, 2018). All these factors will influence a plant species in its distribution and existence in the habitat (Baltzer *et al.*, 2005).

Although *Rafflesia* and its hosts are protected under the Wildlife Conservation Enactment 1997, Part II (Schedule II) (Sabah Wildlife Department, 1997), they still face the problem of forest clearing for commercial crops agriculture (Meijer & Elliotts, 1990), logging (Latiff & Mat-Salleh, 1991) or natural disasters such as typhoon in the Philippines (Yahya *et al.*, 2010). The deforestation activities in the areas with *Tetrastigma*, a host of the *Rafflesia*, have caused the population to experience a reduction in number, mainly due to the silviculture practices within the logging industry.

This study focused on the vegetation survey to determine the plant communities and floristic composition of the *Rafflesia's* habitat in Kinabalu Park. Therefore, more in-depth understanding on the surrounding plant communities in the habitat of *Rafflesia* will be obtained. By knowing this information, it can aid *in-situ* conservation efforts to *Rafflesia* sp. and *Tetrastigma* sp. (Vitaceae) around Kinabalu Park and in the state of Sabah. Information on the ecology of this plant is particularly crucial as its natural habitats are increasingly threatened every year. This study will help in further improve the understanding of this plant, and it is essential for conservation purposes.

MATERIALS AND METHODS

Study Location

Kinabalu Park is located at an altitude of N 6° 5' and E 160° 33', about 20 km from Ranau town. This area has been classified as a Class IV Forest (Amenity Forest) with an area of approximately 754 km^2 (Jabatan Perhutanan Sabah, 2005). The average elevation of the area range from 550-1000 meters above sea level and consists of a variety of vegetation dependent on the altitude (Rafiqpoor & Nieder, 2006). Figure 1 shows the location of each study plot at Kinabalu Park, Sabah.

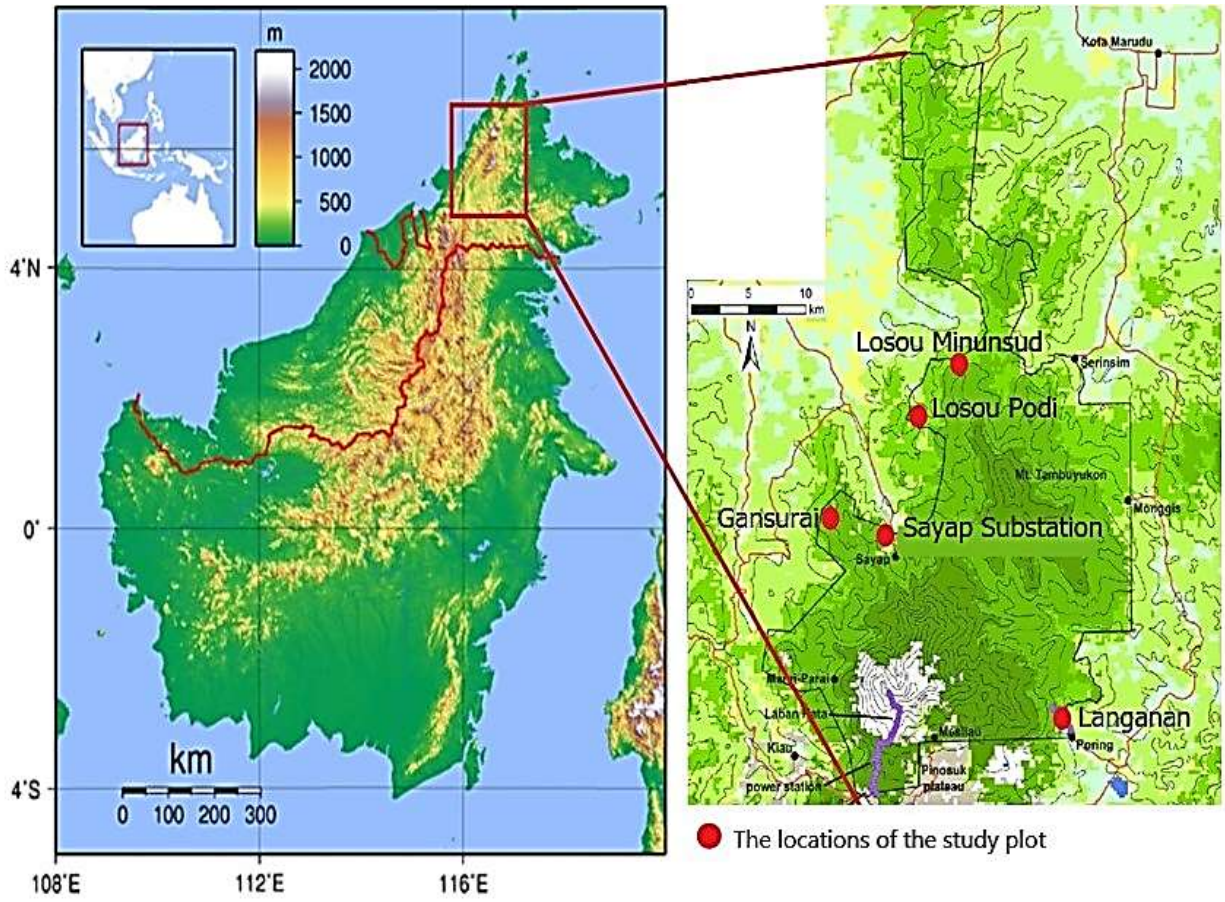

Figure 1: Position of research plots at Kinabalu Park.
Source: Modified from Harris *et al.* (2012)

Plot Preparation

Five selected plots have been established in the Kinabalu Park area; namely Losou Podi (LP) (N 06^{O} 19' 13.9'' and E 116^{O} 38' 32.8"), Losou Minunsud (LM) (N 06^{O} 20' 54.7'' and E 116^{O} 37' 47.1"), Sayap Substation (SS) (N 06^{O} 10' 02.8'' and E 116^{O} 33' 51.6"), Gansurai (GA) (N 06^{O} 11' 25.0'' and E 116^{O} 29' 57.0") and Langanan (LA) (N 06^{O} 03' 49.9'' and E 116^{O} 41' 14.8"). Plot selection was made based on the presence of a *Rafflesia* host, (*Tetrastigma* sp.) at the study location.

The constructed plot was circular in shape with a radius size of 20 meters (Figure 2), created by setting the *Rafflesia* host to a value point of 0 (Quintela-Sabarís *et al*., 2020) with the total plot area being 0.6285 ha^{-1}. Each plot was constructed with subplots with radius sizes of 20 meters, 10 meters and 1 meter (Fill *et al.*, 2017). Plants with a diameter of ≥ 5 cm at chest level (DBH) and above were measured for the subplots with a diameter of 20 meters while plants with a diameter of 1 to 4.9 cm were measured for subplots with a diameter of 10 meters. Meanwhile, vegetations within subplots with a diameter of 1 meter were recorded as forest floor vegetation.

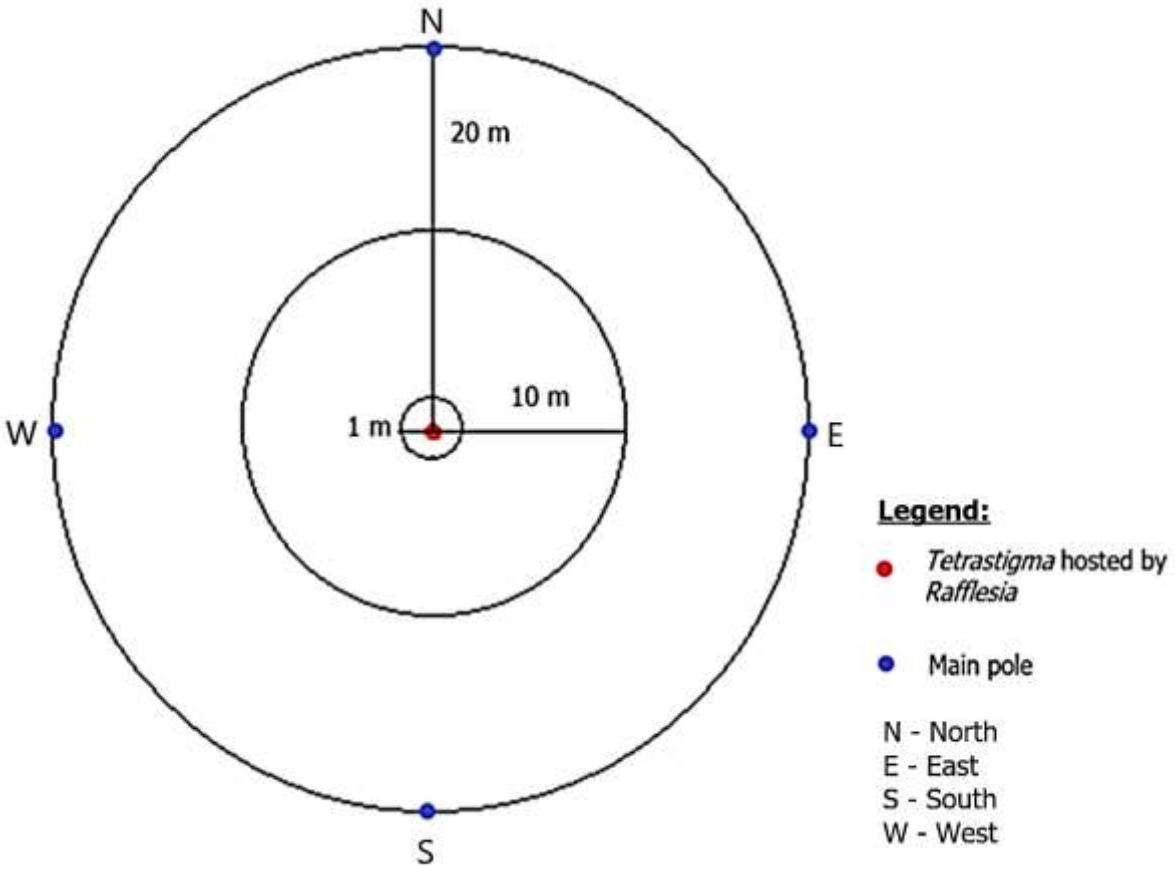

Figure 2: Design of research plots.

The identification of trees and plants found in the plot was done directly in the field with the help of a Sabah Parks staff. However, some trees were unable to be directly identified. Therefore, specimens were taken and marked using stringed paper tags to avoid confusion during the advanced identification process at the Sabah Parks (SP) herbarium, Taman Kinabalu (Akhriadi, 2010; Hazimah *et al.*, 2015; Newmaster *et al.*, 2005; van der Ent *et al.*, 2015). The specimens were deposited at Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah. The curation process was based on Bridson & Forman (1998), whereby the specimen was dried in an oven at a temperature of 50º for 3 days or more depending on the time required for the specimen to dry completely. All specimens were identified with reference by Beaman & Anderson (2001), Beaman & Anderson; & Beaman (2001), Harris & Harris (1994), Seopadmo *et al.* (2002) and Seopadmo & Wong (1995) and assisted by qualified botanists from Sabah Park.

Diversity Analysis

1. Analysis of Vegetation Diversity

Shannon-Wiener Index (H') was used to measure the abundance and diversity of species found in a community. Moreover, compositional information such as wealth and number of species in a community is known based on this index (Magurran, 2004).

$$H = \sum pi(\ln pi)$$

Which is;

p_i = (n_i/N)

n_i = Number of individual species *i*

N = the total number of individuals ($\sum ni$)

2. Uniformity of Species Distribution

The degree of dominance between species in the plant community of the *Rafflesia*'s host habitat was enumerated using the Evenness Index (E). From the E values obtained, the degree of uniformity for individual abundance between species can be explained (Magurran, 2004).

$$E = \sum H'/lnS$$

Which is;
H' = Shannon-Wiener Index
S = Number of species

3. Family and Species Similarities

This study used the Bray-Curtis (S_{BC}) method to determine the rate of familial similarity between study plots. Whereas the Jaccard (S_J) method was used to determine the rate of species similarity between the study plots. The equations used are the same as those described by Magurran (2004):

$$\text{SBC} = \frac{2a}{2a + b + c} \qquad \text{SJ} = \frac{a}{a + b + c}$$

Which is;
a = Number of same species that can be found in both plots
b = Number of species in plot 1
c = Number of species in plot 2
With indications;
If the value of S approaches 1: the species similarity is high
If the value of S approaches 0: the species similarity is low

RESULTS AND DISCUSSION

Rafflesia Population Status And Host Diameter

There were two species of *Rafflesia* found within all the study plots, which is *Rafflesia keithii* found at LM, LP, GA and SS; and *Rafflesia pricei* at LA (Figure 3). Table 1 shows a total of 20 wound effects on the host; 16 flower buds and only three flowering flowers were found in all study plots covering an area of 0.6283 hectares. With this, it can be estimated that there were 32 pieces of evidence of the presence of *Rafflesia* from wound marks, 25 flower buds, and five flowers can be found for every hectare of the area in Kinabalu Park during the study period. The number of scarring effects found was higher when compared to any other indicator because the survival rate of the *Rafflesia* buds is low (Laksana *et al.*, 2018; Mursidawati *et al.*, 2014). Ramadhani *et al.* (2017) recorded only 2% of *Rafflesia* sp. bloomed, compared to 8% of buds-dead, 26% of flowers bloom-dead, and 64% of buds-alive.

Among the causes of damage to flower buds were pests such as termites that cause decay to the flower buds (Wan Norqayyum Nadia, 2014). Besides, flower buds positioned higher than the forest floor surface were subjected to heavy gravity attraction, causing the flower buds to fall to the ground (Farah Khaliz *et al.*, 2018). Natural disasters similar to the 2003 tsunami in Acheh have resulted in the loss and decline of several *Rafflesia* populations in Meru Betiri National Park, East Java (Hikmat, 2006). In fact, some *Rafflesia* populations near the study area are facing the threat of destruction as a result of villagers cutting down hosts during forest clearing for domestic agricultural purposes.

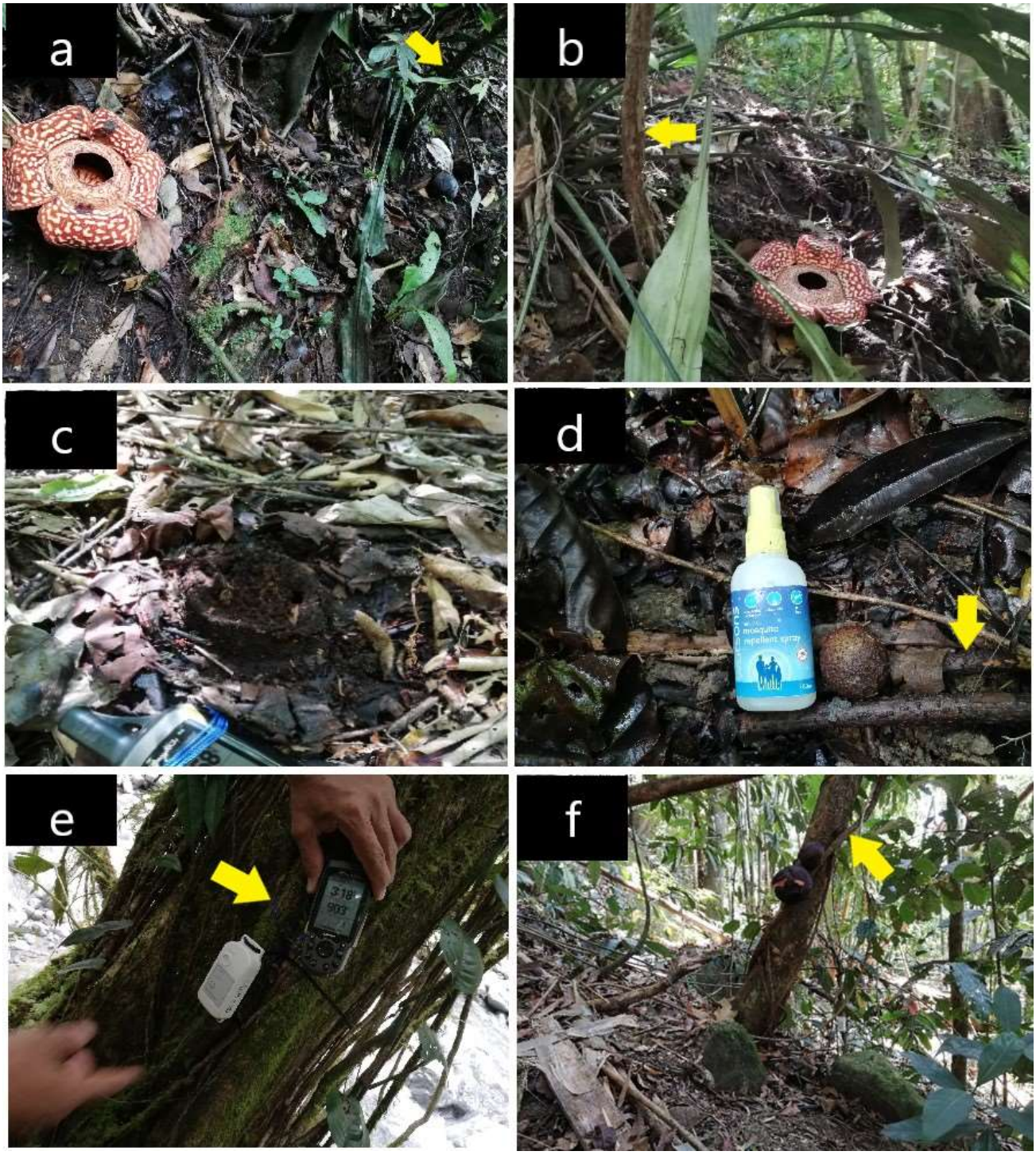

Figure 3: The *Rafflesia* in each plot; in various phases, and the *Tetrastigma* sp. (yellow arrow). **a-b:** *R. pricei* at Langanan. **c:** *R. keithii* flower that was decaying at Losou Minunsud. **d:** Bud of *R. keithii* at Losou Podi. **e:** *Tetrastigma* sp. at Sayap Substation. **f:** Flower bud of *R. keithii* found on the shaft of *Tetrastigma* sp. at Gansurai.

The hosts' size was small, with a diameter range of 2.2–4.8 cm only. Most of the hosts found in other habitats had a larger diameter size of more than 5.0 cm. *Tetrastigma leucostaphylum*, the host of *Rafflesia patma* in West Java, has a diameter of 8.94–13.24 cm (Ali *et al.*, 2015). Wan Norqayyum Nadia (2014) and Pranata *et al.* (2020) also stated that the diameter size of the hosts in Lojing Highlands, Kelantan and in Panorama Baru Ngarai Sianok, West Sumatra ranged from 5.0-15.0 cm and 4.78-6.11, respectively.

Table 1: The total number of scars, buds and flowers of *Rafflesia* according to the surveyed plots.

Plot	*Rafflesia's* Spesies	*Tetrastigma's* Diameter (cm)	Scar	Bud	Flower
LP	*Rafflesia keithii*	2.2	4	4	0
LM	*Rafflesia keithii*	4.8	3	2	1
SS	*Rafflesia keithii*	3.0	2	0	0
LA	*Rafflesia pricei*	3.5	4	5	2
GA	*Rafflesia keithii*	3.8	7	5	0
Total			**20**	**16**	**3**

Note: LP=Losou Podi; LM=Losou Minunsud; SS=Substesen Sayap; LA=Langanan; GA=Gansurai.

Floristic Composition

There were 778 plant community individuals identified, consisting of 53 families, 111 genera and 250 species obtained from all study plots. The tree density in the study area is high at 1238 trees^{-ha}. Based on Figure 5, the differences in number of individuals, families, genus and species found in each plot can be observed. LP has the highest number of individuals at 231 individuals recorded, belonging from 32 families, 48 genus and 90 species. This was followed by plot SS; which had 153 individuals recorded from 57 species, 46 genus with 31 families. A total 138 individuals from 56 species, 37 genus and 29 families were found in LM. LA has recorded 135 individuals from 59 species. The highest number of genus was recorded in LA, which was 51 genus with 36 families. The least number of individuals recorded was at GA with 121 individuals from 62 species. GA also recorded the least number of genus at 35 genus with 25 families.

The tree densities found in all the plots of this study were similar to those recorded by Mohd Afiq Aizat (2018); the tree densities in two different habitats in Hulu Dong were 1560 tree^{-ha} at Hutan Lipur Lata Jarum and 1246 tree^{-ha} at Sungai Kenong. The study conducted by Nizam *et al.* (2012) in Kenong Forest Reserve (Pahang) also had a high tree density, at 1000 trees^{-ha} for lowland forest types. However, the Royal Belum State Park has only half of the tree density value, which were 656 tree^{-ha} (Nur Hayati et al., 2020) when compared to this study.

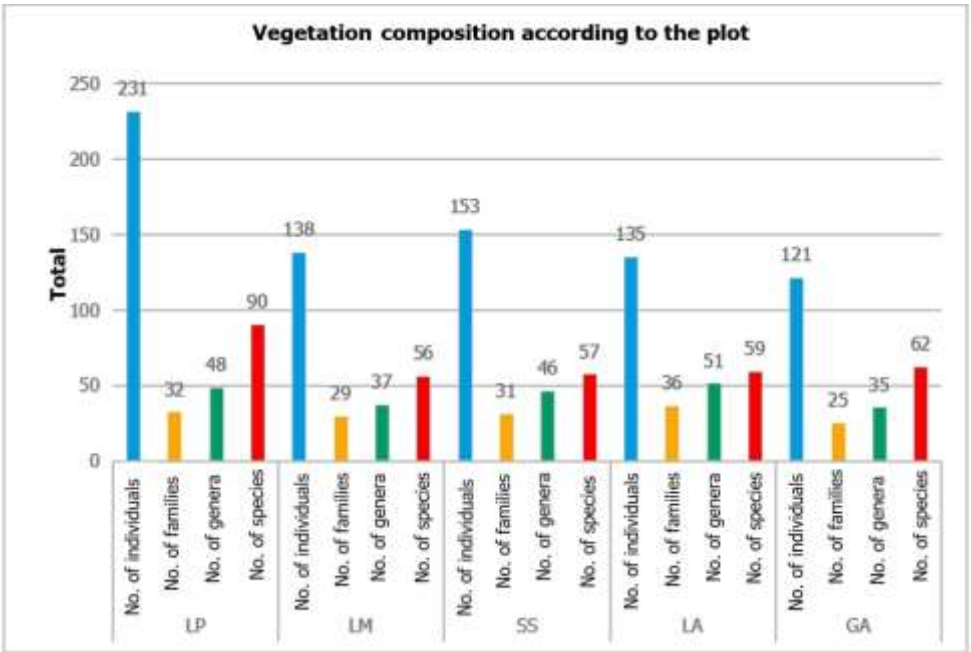

Figure 4: Comparison between the number of individuals, species and genus by family in the study area
Note: LP=Losou Podi; LM=Losou Minunsud; SS=Sayap Substation; LA=Langanan; GA=Gansurai

Figure 6 showed that the family Lauraceae had the most significant number of individuals at 86 and the total number of species was 28 in the entire study area. However, Rubiaceae seems to be the family with the most genera, with 12 genera in total. In the LP plot, the family Phyllanthaceae has the most significant number of individuals at 31 individuals. The family Meliaceae has the highest number of individuals in LM with 15 individuals. The SS plot has the highest number of individuals from the family Araceae at 26 individuals. The family Lauraceae has the highest number of individuals in the LA plot, at 17 individuals. As for the GA plot, a total of 16 individuals recorded from the family Euphorbiaceae, resulting in the family with the highest number of individuals there.

Suwartini (2008) and Rahma *et al.* (2017) also stated that Lauraceae, Moraceae and Rubiaceae were the most dominant families found in a *Rafflesia*'s habitat on the islands of Sumatra and Java, Indonesia. Moreover, the study of vegetation in Kinabalu Park by van der Ent *et al.* (2016) found that Lauraceae is a predominant family around the same altitude, at 500-1000 meters above sea level. However, Aiba & Kitayama (2020) stated that Myrtaceae and Fagaceae were the families with the most number of individuals at altitudes of 1200-2350 meters above sea level. In addition, Aiba & Kitayama (2020) also pointed out that there were significant differences in the number of individuals, families, genus and species between the two types of soil ages in Kinabalu Park.

But, these findings are contrary to the Royal Belum State Park, Perak. This is because Euphorbiaceae was the most dominant family in the habitat, followed by Meliaceae (Nur Hayati *et al*., 2020). Mohd Afiq Aizat (2018) also stated that Annonaceae and Fabaceae were the most dominant families in two types of habitat in Hulu Dong, Pahang, Sungai Kenau and Hutan Lipur Lata Jarum. For this study, Annonaceae was the second highest family with a total of 67 individuals recorded. Meanwhile, Euphorbiacea and Fabaceae were found to have only 36 and 12 individuals, respectively. Laksana *et al.* (2018) and Ali *et al.* (2015) stated that trees from the family Annonaceae, Sapindaceae, Rubiaceae and Moraceae are usually suitable for climbing by the *Tetrastigma* sp. to obtain light supply.

For the number of individuals by species, *Xantophyllum macrophyllum* (Polygalaceae) was the most abundant species in the study area at 28. This was followed by the species *Schismatoglottis calyptrate* (Araceae), 25 individuals and *Alpinia lagiulata*, 24 individuals. However, in Mohd Afiq Aizat (2018) and Nur Hayati *et al*. (2020), they found that the most common species found in the Hulu Dong area and Royal Belum State Park were *Saraca cauliflora* (Fabaceae) and *Erismanthus oblique* (Euphorbiaceae), respectively.

The species *Baccaurea lanceolata* (Phyllantaceae) was found in all study plots. In addition, there are several species of community plants climbed by *Tetrastigma* and was located within 5 meters to the host of *Rafflesia*. Among the species are *Polyalthia tanuipes, Shorea laevis, Canthium* sp., *Diplospora malaccensis, Neoraulea gigantea* and *Xanthophyllum macrophyllum*. Though, each of the different study locations of *Rafflesia* habitat showed unique species differences when compared to each other. *Cyathocalys biovulatus* (Annonaceae) is a common species found in West Java (Ali *et al*., 2015). While in East Java, it was *Sterculia campanulate* (Malvaceae) and *Tetrameles mudiflora* (Tertamelaceae), which are species typical to their habitat (Laksana *et al*., 2018).

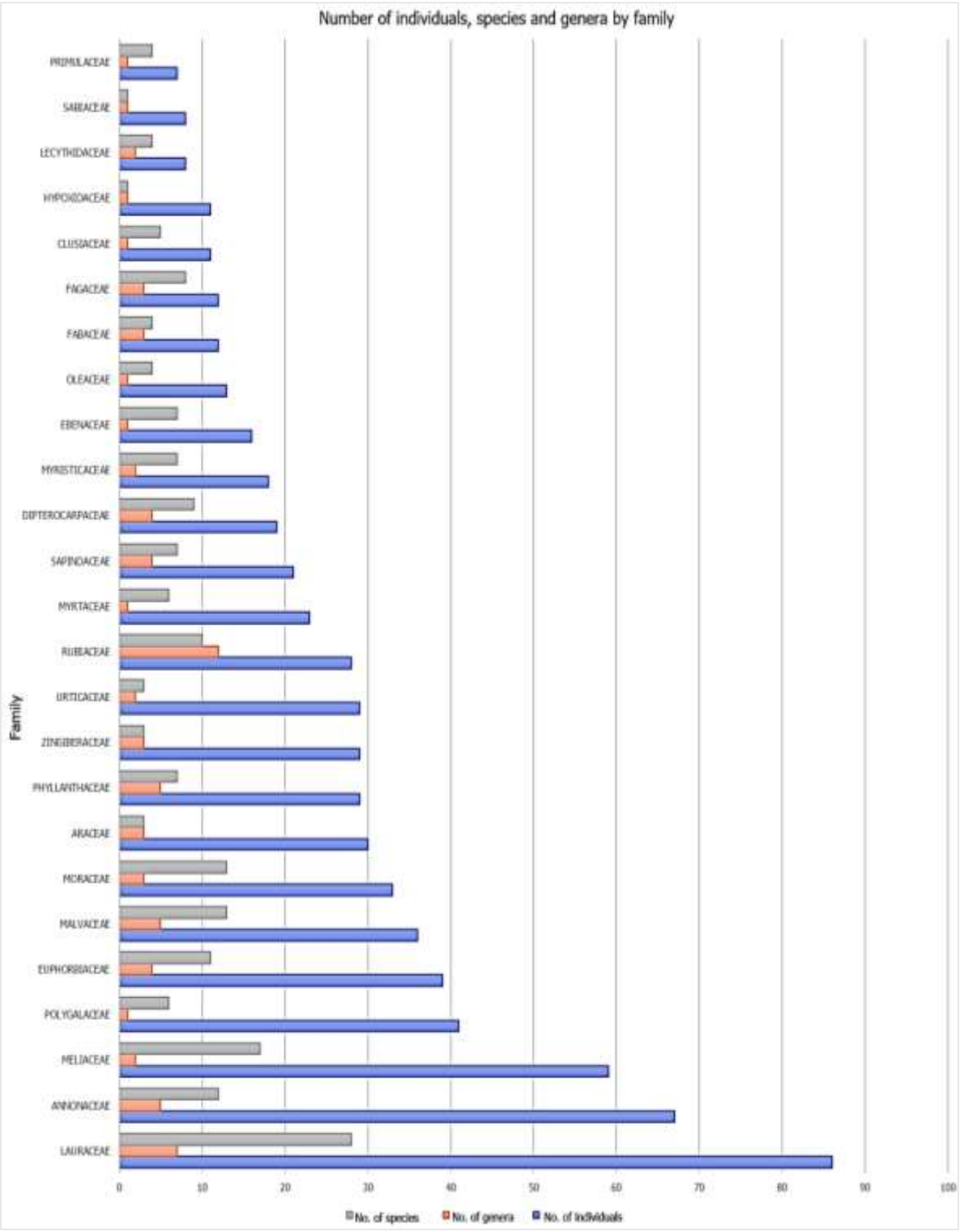

Figure 5: Comparison between the number of species and the number of genera found in the *Tetrastigma* habitat.

Species Diversity

The diversity of species in the study area was high, because the value of H' is 3.23, exceeding 2.0 as stated by Lathifah *et al.* (2018). H' values were even higher when assessed at the plot level (Figure 7), with LP having the highest species richness (H'=3.96). In comparison, SS has the lowest species richness among the plots (H'=3.55).

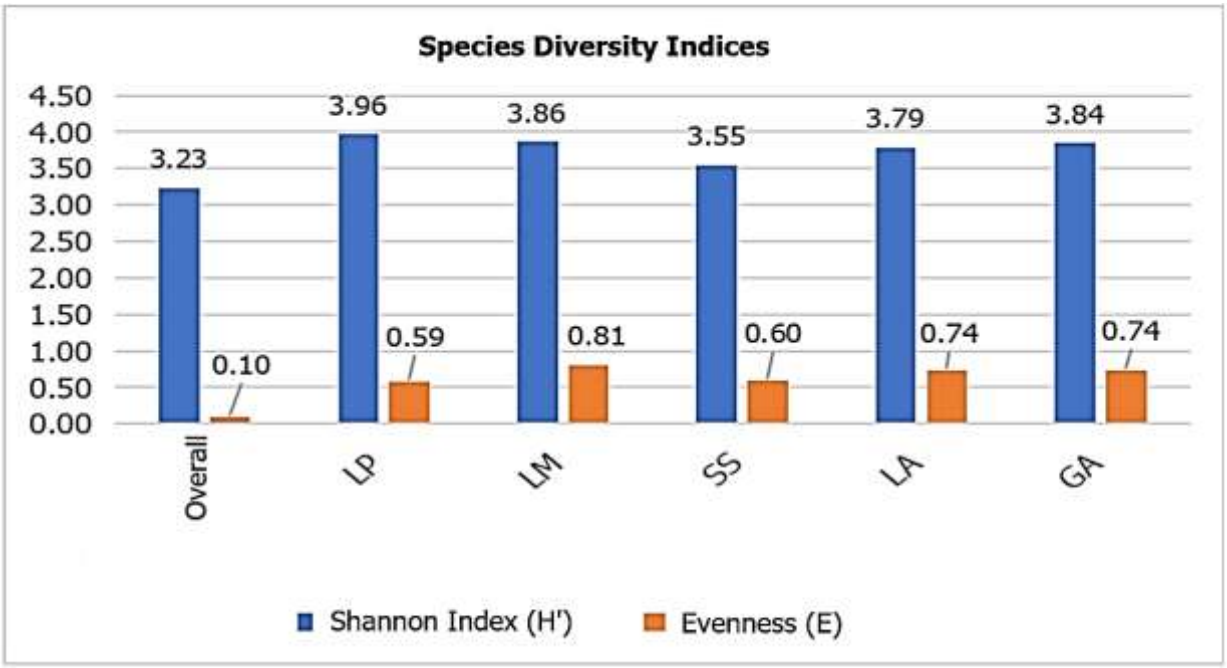

Figure 6: Diversity and Uniformity Indices of vegetation species in the Tetrastigma habitat in Kinabalu Park.
Note: LP=Losou Podi; LM=Losou Minunsud; SS=Sayap Substation; LA=Langanan; GA=Gansurai.

The abundance of species (E) in the entire study area was low and less diverse because E=0.10. Magurran (2004) stated that species abundance is measured from a value of 0 to 1.0; with the highest species abundance rate being 1.0, and a value of 0 being the lowest. A high number of individual differences between species in the study plot occurred, because there were dominating species and therefore, resulted in low evenness values. Figure 7 shows the abundance of species at the medium to high plot level with a range of 0.59–0.81. The plot LM had the highest species abundance with E=0.81, and the plot LP had the lowest abundance with E=0.59.

The species diversity in this study area was similar to that in some other *Tetrastigma* habitats. This is because the value of H' in the host's habitat in West Java was 2.81 (Suwartini *et al.,* 2008), 2.80 in East Java (Ali *et al.,* 2015), and 3.16 in Central Java (Laksana *et al.,* 2018). The *Rafflesia* host's habitats in the Royal Belum State Park had a higher Shannon-Wiener Index value at H'=5.14 (Nur Hayati *et al*., 2020). Several other studies in Sabah also showed that the diversity and richness of its species was high. As noted by Aiba & Kitayama (2020), the value of H' around Kinabalu Park was high, within the range of 3.68-4.19. Even Sellan *et al.* (2019) also stated that the species diversity in Sepilok Forest Reserve, Sandakan was high with a value of H'=3.48 ± 0.23.

However, the abundance of plant community species in some other host habitats was higher when compared to the habitats of this study. In Suwartini *et al*. (2008), the author stated that the E values obtained in West Java were within the 0.88-0.91 range. E values in East Java were from 0.66–0.76 range (Ali *et al.*, 2015), and were from 0.45–0.71 range in Central Java (Laksana *et al.*, 2018). Even Nur Hayati *et al.* (2020) stated that the range of E values in Royal Belum State Park, Perak was higher with a range of 0.85–0.97.

Family And Species Similarities

Of the 53 families recorded in this habitat, only 11 (20.75%) families could be found in all plots; Annonaceae, Dipterocarpaceae, Fagaceae, Lauraceae, Malvaceae, Meliaceae, Moraceae, Phyllanthaceae, Polygalaceae, Rubiaceae and Sapindaceae (Figure 8). These families are commonly found in a *Rafflesia*'s habitat (Rahma *et al*., 2017; Suwartini *et al*., 2008). Families of Calophyllaceae,

Putranjivaceae, Proteaceae and Sabiaceae were only found in the LP plot, whereas Apocynaceae, Athyriaceae, Gesneriaceae and Monimiaceae were only found in SS plots. In the LM plot, only two families were documented, namely Achariaceae and Anacardiaceae. As for the LA plot, the families Hanguanaceae, Leeaceae, Loganiaceae, Melastomaceae, Memecylaceae and Polypodiaceae were only found in this plot. Whereas for the GA plot, Samydaceae is a family that can only be found in this plot. The remaining 47.17% of other families were found unevenly in all five plots.

The Bray-Curtis Similarity (S_{BC}) method used to determine the percentage of family similarities between each plot, showed that the family similarities between plots were in the moderate range with values of 48.23–70.19% (Table 2). It is also known that GA-LM plot has the highest percentage of family similarity. In contrast, the LP-SS plot has the lowest percentage of family similarities.

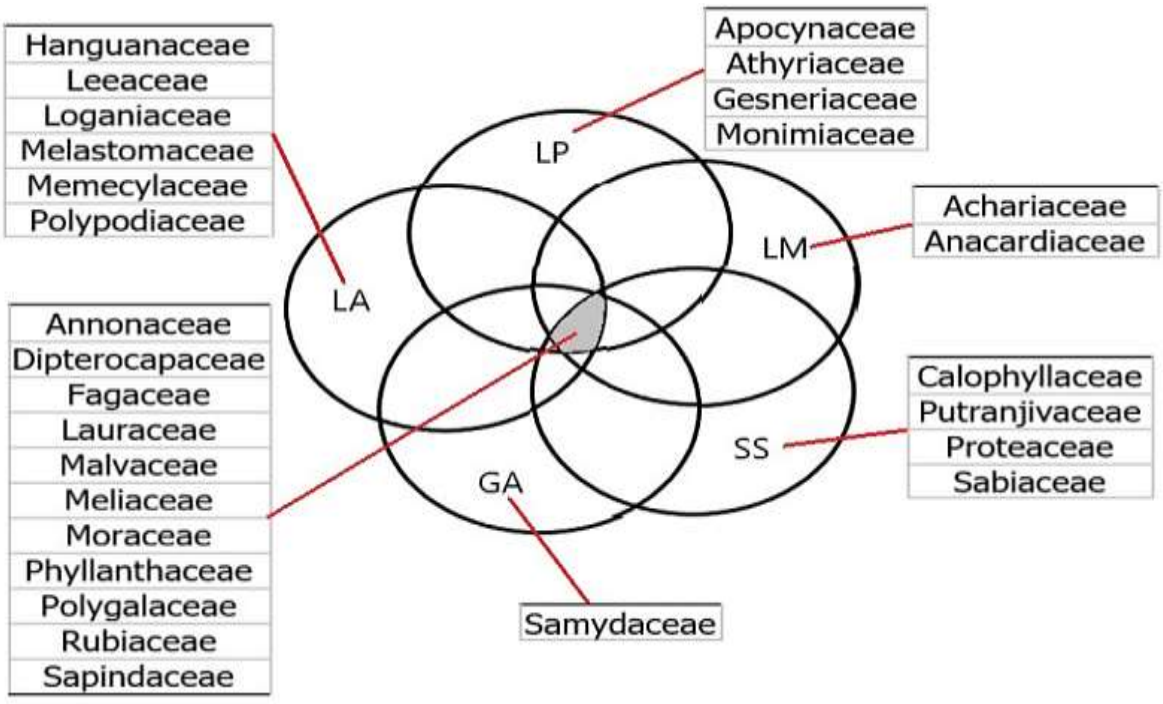

Figure 7: A list of families unique to each plot and family similarities found in all plots
Note: LP=Losou Podi; LM=Losou Minunsud; SS=Sayap Substation; LA=Langanan; GA=Gansurai

Table 2: Family similarities found between plots, using the Bray-Curtis Method, S_{BC}.

	GA	LA	LM	LP
LA	0.5660	1	-	-
LM	0.7019	0.6325	1	-
LP	0.5646	0.4839	0.5552	1
SS	0.6193	0.6575	0.6571	0.4823

Note: LP=Losou Podi; LM=Losou Minunsud; SS=Sayap Substation; LA=Langanan; GA=Gansurai.

The Jaccard Similarity Method was used to determine the percentage of species similarity. The analysis showed that the percentage of species similarity between the study plots was very low, ranging between 4.31-11.54%. The GA-SS plot showed the lowest percentage of species similarity, and the LA-SS plot had the highest percentage of similarity (Table 3). This low percentage of species similarity indicates that only a few species have similarities between the study plots. However,

habitats in East Java as stated by Laksana *et al*. (2018) had a higher percentage of species similarity with values of 44%.

Table 3: Species similarity between plots using the Jaccard Method, S_J.

	LP	LM	SS	LA
LM	0.1128	1	-	-
SS	0.1061	0.0943	1	-
LA	0.0803	0.1132	0.1154	1
GA	0.1087	0.1081	0.0431	0.0603

Note: LP=Losou Podi; LM=Losou Minunsud; SS=Sayap Substation; LA=Langanan;GA=Gansurai.

CONCLUSION

There were two species of *Rafflesia* sp. found in Kinabalu Park and its surrounding areas, namely *R. keithii* in Losou Podi, Losou Minunsud, Gansurai and Sayap Substation located in Kota Belud district, and *R. pricei* in Langanan, Poring. There were a total of 778 individuals documented, comprising of 53 families, and 250 species, and they were recorded based on environmental vegetation observations, with family Lauraceae dominating this habitat with 86 individuals (11.05%). At the species level, *Xanthophyllum macrophyllum* (Polygalaceae) predominated with 28 individuals (3.60%). Meanwhile, *Baccaurea lanceolata* (Phyllantaceae) was the only species found in all five study plots. This study indicated that *Xanthophyllum macrophyllum* and *Baccaurea lanceolata* might have an association with the *Rafflesia* population in Kinabalu Park as both species were located nearest to the *Rafflesia* and its host.

The species richness in this habitat was high, with a value of H'=3.55–3.96, while, the Evenness Index was recorded with moderate to high from E=0.59 to 0.81. Thus, it is known that the level of dominance between species in the surrounding vegetation is uneven and explains why the individual abundance between species is low. The family similarity between plots was high with a range of SBC=70.19–48.23%. However, the species similarity between plots was very low with a range of SJ=4.31–11.54%. These differences occurred probably due to interference from humans present in the study plots. Most of the plots were close to the land area of the villagers, who carry out agricultural activities. Moreover, there might be slightly different soil characteristics for each plot.

APPRECIATION

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Famili	Species	Famili	Species
ACHARIACEAE	*Pangium edule*	**ACTINIDIACEAE**	*Saurauia aganae*
ACTINIDIACEAE	*Saurauia actinidifolia*	**ACTINIDIACEAE**	*Saurauia longistyla*
ANACARDIACEAE	*Anacardiaceae 1*	**ANNONACEAE**	*Polyalthia insignis*
ANNONACEAE	*Goniothalamus fasciculatus*	**ANNONACEAE**	*Polyalthia microtus*

ANNONACEAE	*Goniothalamus ridleyi*	**ANNONACEAE**	*Polyalthia sp.1*
ANNONACEAE	*Goniothalamus sp.1*	**ANNONACEAE**	*Polyalthia sp.2*
ANNONACEAE	*Monoon grandiflorum*	**ANNONACEAE**	*Polyalthia sp.7*
ANNONACEAE	*Neo-uvaria acuminatissima*	**ANNONACEAE**	*Polyalthia tanuipes*
ANNONACEAE	*Polyalthia cauliflora*	**ANNONACEAE**	*Popowia pisocarpa*
APOCYNACEAE	*Hoya sp.1*	**ARACEAE**	*Scindapsus sp.1*
ARACEAE	*Araceae 1*	**ARECACEAE**	*Calamus sp.*
ARACEAE	*Schismatoglottis calyptrata*	**ARECACEAE**	*Calamus sp.1*
ARACEAE	*Scindapsus sp*	**ATHYRIACEAE**	*Diplazium sp.1*
BARRINGTONIACEAE	*Barringtonia asiatica*	**BARRINGTONIACEAE**	*Dacryodes costata*
BARRINGTONIACEAE	*Barringtonia macrotachya*	**BURSERACEAE**	*Canarium hirsutum*
BARRINGTONIACEAE	*Barringtonia scortechinii*	**BURSERACEAE**	*Canarium sp.2*
CALOPHYLLACEAE	*Calophyllum blancoi*	**CLUSIACEAE**	*Garcinia parvifolia*
CLUSIACEAE	*Garcinia diospyrifolia*	**CLUSIACEAE**	*Garcinia sp.1*
CLUSIACEAE	*Garcinia lateriflora*	**CLUSIACEAE**	*Garcinia trianii*
DIPTEROCARPACEAE	*Dipterocarpus sp.1*	**DIPTEROCARPACEAE**	*Shorea parvistipulata*
DIPTEROCARPACEAE	*Parashorea tomentella*	**DIPTEROCARPACEAE**	*Shorea sp.2*
DIPTEROCARPACEAE	*Shorea faguetiana*	**DIPTEROCARPACEAE**	*Vatica oblongifolia*
DIPTEROCARPACEAE	*Shorea laevis*	**DIPTEROCARPACEAE**	*Vatica umbonata*
DIPTEROCARPACEAE	*Shorea malaanonan*	**EBENACEAE**	*Diospyros andaman*
EBENACEAE	*Diospyros cauliflora*	**EBENACEAE**	*Diospyros polyalthoides*
EBENACEAE	*Diospyros graciliflora*	**EBENACEAE**	*Diospyros sp.1*
EBENACEAE	*Diospyros pilosanthera*	**EBENACEAE**	*Diospyros sp.2*
EUPHORBIACEAE	*Blumeodendron tokbrai*	**EUPHORBIACEAE**	*Mallotus moritrianus*
EUPHORBIACEAE	*Macaranga gigantea*	**EUPHORBIACEAE**	*Mallotus sp.4*
EUPHORBIACEAE	*Macaranga pearsonii*	**EUPHORBIACEAE**	*Mallotus sp.5*
EUPHORBIACEAE	*Macaranga tanarius*	**EUPHORBIACEAE**	*Mallotus wyari*
EUPHORBIACEAE	*Mallotus dispar*	**EUPHORBIACEAE**	*Ptychopyxis bacciformis*
EUPHORBIACEAE	*Mallotus lacbeyi*	**FABACEAE**	*Fabaceae 1*
FABACEAE	*Fabaceae 2*	**FAGACEAE**	*Lithocarpus ferruginens*
FABACEAE	*Intsia sp.1*	**FAGACEAE**	*Lithocarpus grandis*
FABACEAE	*Whitfordiondenron niewnhuisii*	**FAGACEAE**	*Lithocarpus porcatus*
FAGACEAE	*Castanopsis densinervia*	**FAGACEAE**	*Lithorcarpus conocarpus*
FAGACEAE	*Castanopsis motleyana*	**FAGACEAE**	*Quercus argentata*

FAGACEAE	*Lithocarpus elegans*	**GENTIANACEAE**	*Fagraea cuspidata*
GENTIANACEAE	*Fagraea sp.1*	**HYPOXIDACEAE**	*Curculigo latifolia*
GESNERIACEAE	*Cytandra sp.1*	**HYPOXIDACEAE**	*Curculigo sp.*
HANGUANACEAE	*Hanguana malayana*	**LAURACEAE**	*Actinodaphne myriantha*
LAURACEAE	*Beilschmiedia assamica*	**LAURACEAE**	*Litsea oblanceolata*
LAURACEAE	*Caryodaphnopsis tonkinensis*	**LAURACEAE**	*Litsea oppositifolia*
LAURACEAE	*Cinnamomum kinabaluensis*	**LAURACEAE**	*Litsea sessilis*
LAURACEAE	*Dehaasia brachbotrys*	**LAURACEAE**	*Litsea sp.1*
LAURACEAE	*Dehaasia incrassata*	**LAURACEAE**	*Litsea sp.10*
LAURACEAE	*Lauraceae 1*	**LAURACEAE**	*Litsea sp.11*
LAURACEAE	*Lauraceae 2*	**LAURACEAE**	*Litsea sp.12*
LAURACEAE	*Litsea accedens*	**LAURACEAE**	*Litsea sp.2*
LAURACEAE	*Litsea angulata*	**LAURACEAE**	*Litsea sp.3*
LAURACEAE	*Litsea elliptica*	**LAURACEAE**	*Litsea sp.4*
LAURACEAE	*Litsea fenestrata*	**LAURACEAE**	*Litsea sp.6*
LAURACEAE	*Litsea ferruginea*	**LAURACEAE**	*Litsea sp.8*
LAURACEAE	*Litsea garciae*	**LAURACEAE**	*Litsea unita*
LAURACEAE	*Litsea lancifolia*	**LEEACEAE**	*Leea sp.1*
LOGANIACEAE	*Loganiaceae 1*	**MAGNOLIACEAE**	*Taulama gintingensis*
MAGNOLIACEAE	*Magnolia gigantifolia*	**MAGNOLIACEAE**	*Taulama rigida*
MALVACEAE	*Durio zibethinus*	**MALVACEAE**	*Pentace sp.2*
MALVACEAE	*Microcos crassifolia*	**MALVACEAE**	*Pentace sp.3*
MALVACEAE	*Microcos fibrocarpa*	**MALVACEAE**	*Pterospermum javanicum*
MALVACEAE	*Microcos ilasticus*	**MALVACEAE**	*Pterospermum sp.1*
MALVACEAE	*Microcos sp.1*	**MALVACEAE**	*Sterculia oblangata*
MALVACEAE	*Microcos sp.2*	**MALVACEAE**	*Sterculia rubiginosa*
MALVACEAE	*Microcos sp.3*	**MALVACEAE**	*Sterculia sp.1*
MALVACEAE	*Microcos sp.4*	**MALVACEAE**	*Sterculia sp.4*
MALVACEAE	*Pentace chartacca*	**MALVACEAE**	*Sterculia stipitata*
MELASTOMACEAE	*Blastus borneensis*	**MELASTOMACEAE**	*Melastoma calagatis*
MELIACEAE	*Aglaia harmsiana*	**MELIACEAE**	*Aglaia sp.3*
MELIACEAE	*Aglaia lencophylla*	**MELIACEAE**	*Aglaia sp.4*
MELIACEAE	*Aglaia luzoniensis*	**MELIACEAE**	*Aglaia sp.5*
MELIACEAE	*Aglaia meliosmoides*	**MELIACEAE**	*Aglaia tomentosa*
MELIACEAE	*Aglaia odoratissima*	**MELIACEAE**	*Dysoxylum alliaceum*
MELIACEAE	*Aglaia ramotricha*	**MELIACEAE**	*Dysoxylum arborescens*
MELIACEAE	*Aglaia rivularis*	**MELIACEAE**	*Dysoxylum cauliflorum*
MELIACEAE	*Aglaia sp.*	**MELIACEAE**	*Dysoxylum densiflorum*

MELIACEAE	*Aglaia sp.1*	**MEMECYLACEAE**	*Memecylon oleifolium*
MONIMIACEAE	*Kibara obtusa*	**MORACEAE**	*Artocarpus anisophyllus*
MORACEAE	*Artocarpus dadah*	**MORACEAE**	*Ficus gul*
MORACEAE	*Artocarpus ilasticus*	**MORACEAE**	*Ficus sp.1*
MORACEAE	*Artocarpus odoritisimus*	**MORACEAE**	*Ficus sp.2*
MORACEAE	*Artocarpus sp.2*	**MORACEAE**	*Ficus sp.3*
MORACEAE	*Artocarpus tamaran*	**MORACEAE**	*Ficus sp.5*
MORACEAE	*Ficus aurata*	**MORACEAE**	*Paratocarpus sp.1*
MORACEAE	*Ficus aurita*	**MORACEAE**	*Paratocarpus sp.2*
MORACEAE	*Ficus cereicarpa*	**MYRISTICACEAE**	*Knema cinae*
MYRISTICACEAE	*Knema cinerea*	**MYRISTICACEAE**	*Knema sp.2*
MYRISTICACEAE	*Knema kunstleri*	**MYRISTICACEAE**	*Knema sp.4*
MYRTACEAE	*Knema sp.1*	**MYRISTICACEAE**	*Myristica guaterrifolia*
MYRTACEAE	*Syzygium leptostemon*	**MYRTACEAE**	*Syzygium sp.*
MYRTACEAE	*Syzygium malaccensis*	**MYRTACEAE**	*Syzygium sp.1*
OLEACEAE	*Syzygium racemum*	**MYRTACEAE**	*Syzygium valdevenosum*
OLEACEAE	*Chionanthus cuspidatus*	**OLEACEAE**	*Chionanthus ramiflorus*
PHYLLANTHACEAE	*Chionanthus pluriflorus*	**OLEACEAE**	*Chionanthus spicatus*
PHYLLANTHACEAE	*Antidesma montanum*	**PHYLLANTHACEAE**	*Baccaurea membranacea*
PHYLLANTHACEAE	*Aporusa frutescens*	**PHYLLANTHACEAE**	*Baccaurea sp.1*
PHYLLANTHACEAE	*Aporusa sp.1*	**PHYLLANTHACEAE**	*Baccaurea sp.2*
PHYLLANTHACEAE	*Baccaurea lanceolata*	**PHYLLANTHACEAE**	*Bridelia sp.1*
POLYGALACEAE	*Baccaurea macrocarpa*	**PHYLLANTHACEAE**	*Cleistanthus sp.1*
POLYGALACEAE	*Xanthophyllum adenotus*	**POLYGALACEAE**	*Xanthophyllum macrophyllum*
POLYGALACEAE	*Xanthophyllum affine*	**POLYGALACEAE**	*Xanthophyllum microphyllum*
POLYPODIACEAE	*Xanthophyllum flavescens*	**POLYGALACEAE**	*Xanthophyllum sp.4*
PRIMULACEAE	*Tectaria sp.1*	**PRIMULACEAE**	*Ardisia sp.2*
PRIMULACEAE	*Ardisia macrophylla*	**PROTEACEAE**	*Eleocarpus gustaviifolius*
PRIMULACEAE	*Ardisia fuliginosa*	**PUTRANJIVACEAE**	*Drypetes longifolia*
RUBIACEAE	*Ardisia goodenoughii*	**RHAMNACEAE**	*Ziziphus angustifolia*
RUBIACEAE	*Aidia sp.1*	**RUBIACEAE**	*Neoraulea gigantea*
RUBIACEAE	*Canthium sp.1*	**RUBIACEAE**	*Praravinia polymera*
RUBIACEAE	*Carallia borneensis*	**RUBIACEAE**	*Psychotria agamae*
	Diplospora malaccensis	**RUBIACEAE**	*Psychotria angulata*

RUBIACEAE	*Ludekia borneensis*	**RUBIACEAE**	*Rubiaceae 1*
RUBIACEAE	*Nauclea gigantea*	**RUBIACEAE**	*Urophyllum glabrum*
RUBIACEAE	*Neonauclea bernandoi*	**RUTACEAE**	*Clausena excavata*
RUTACEAE	*Glycosmis chlorosperma*	**SABIACEAE**	*Meliosma sumatrana*
SAMYDACEAE	*Semecarpus bunburyana*	**SAPINDACEAE**	*Nephelium sp.1*
SAPINDACEAE	*Lepisanthes sp*	**SAPINDACEAE**	*Paranephelium nitidum*
SAPINDACEAE	*Nephelium mangayi*	**SAPINDACEAE**	*Paranephelium xestophyllum*
SAPINDACEAE	*Nephelium ramboutan-ake*	**SAPINDACEAE**	*Sapindaceae 1*
SAPOTACEAE	*Palaquium sp.1*	**SAPOTACEAE**	*Payena acuminata*
SAPURACEAE	*Carexia sp.1*	**SELLAGENILLACEAE**	*Selaginella sp.*
SONNERATIACEAE	*Duabanga moluccana*	**SYMPLOCACEAE**	*Symplocos odoratissima*
SYMPLOCACEAE	*Pyrenaria acuminata*	**SYMPLOCACEAE**	*Symplocos sp.2*
SYMPLOCACEAE	*Symplocos fasiculata*	**SYMPLOCACEAE**	*Symplocos sp.3*
URTICACEAE	*Dendrocnide stimulans*	**ZINGIBERACEAE**	*Alpinia lagiulata*
URTICACEAE	*Dendrocnide subclausa*	**ZINGIBERACEAE**	*Globa*
URTICACEAE	*Elatostemma sp.1*	**ZINGIBERACEAE**	*Zingiberaceae 1*

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