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Floristic Variation of Tree Communities in Two Distinct Habitats within a Forest Park in Pahang, Peninsular Malaysia

(Variasi Flora bagi Komuniti Pokok di Dua Habitat Berbeza dalam Suatu Taman Rimba di Pahang, Semenanjung Malaysia)

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ABSTRACT

A study was conducted at Kenong Forest Park, Kuala Lipis, Pahang, to determine species composition and floristic variation of tree communities in two distinct habitats. Two plots of one hectare each were established adjacent to a limestone cave (BK) and in a lowland area (TR) of the forest park. A total of 2091 tree individuals with diameter at breast height (dbh) of 5.0 cm and above were enumerated in both plots where 1091 trees and 1000 trees occurred in the plots BK and TR, respectively. Floristic composition of tree communities at BK plot comprised of 45 families, 110 genera and 199 species, whilst the TR plot contained 232 tree species and 133 genera from 50 families. Altogether, combination of both plots produced floristic composition of 322 species, 161 genera and 54 families. Euphorbiaceae was the most speciose family for both plots, represented by 30 and 27 species in BK and TR plots, respectively. The most dominant species in the BK plot was Streblus ilicifolius (Moraceae) with Importance Value Index (IV_i) of 19.18%, whilst in the TR plot, Intsia palembanica (Leguminosae) was the most dominant species with IV_i of 14.58%. Total tree basal area for BK and TR plots was 26.91 m^2/ha and 29.23 m^2/ha, respectively, with Leguminosae dominated basal area in both plots. The Shannon-Weiner diversity Index (H') of tree communities in both plots show high diversity values where the BK plot indicates H' value of 4.42 (H'_{max}= 5.26) while the TR plot shows H' value of 4.79 (H_{max}= 5.44), of which the values were different significantly ($P<0.05$). Community similarity between the two plots was moderate with Sorenson Similarity Index for species composition showed a value of 0.48 (48%). The ordination diagram constructed using Detrended Correspondence Analysis (DCA) demonstrated floristic variation between the two study plots. The DCA obviously separated plots between sites and this indicated a gradient of species change from the BK to the TR sites.

Keywords: Detrended Correspondence Analysis; environmental gradient; Kenong Forest Park, limestone flora; species composition

ABSTRAK

Satu kajian telah dilakukan di Taman Rimba Kenong, Kuala Lipis, Pahang untuk menentukan komposisi spesies dan variasi flora bagi komuniti pokok di dua habitat yang berbeza dalam kawasan kajian. Dua plot berkeluasan 1 hektar setiap satu telah ditubuhkan di kawasan hutan berhampiran gua batu kapur (BK) dan satu lagi di kawasan tanah rendah (TR) dalam Taman Rimba ini. Sejumlah 2091 individu pokok dengan diameter pada paras dada (DBH) 5.0 cm dan ke atas telah dibanci yang mana sebanyak 1091 pokok dan 1000 pokok masing-masing hadir dalam plot BK dan TR. Komposisi taksonomi bagi komuniti pokok dalam plot BK merangkumi 45 famili, 110 genus dan 199 spesies, manakala plot TR pula mengandungi 232 spesies, 133 genus dan 50 famili. Secara keseluruhannya, gabungan daripada kedua-dua plot menghasilkan komposisi flora yang terdiri daripada 322 spesies, 161 genus dan 54 famili. Famili Euphorbiaceae merupakan famili yang mempunyai paling banyak spesies dalam kedua-dua plot, diwakili 30 dan 27 spesies masing-masing dalam plot BK dan TR. Spesies yang paling dominan dalam plot BK ialah Streblus ilicifolius (Moraceae) dengan nilai Indeks Kepentingan (IV_i) 19.18% manakala bagi plot TR pula, Intsia palembanica (Leguminosae) adalah spesies dominan dengan nilai IV_i 14.58%. Jumlah keluasan pangkal bagi plot BK dan plot TR masing-masing adalah 26.91 m^2/ha dan 29.23 m^2/ha, dengan Leguminosae mendominasi keluasan pangkal kedua-dua plot kajian. Indeks Kepelbagaian Shannon-Weiner bagi komuniti pokok dalam kedua-dua plot menunjukkan nilai kepelbagaian yang tinggi iaitu plot BK mempunyai nilai H' 4.42 (H'_{maks}= 5.26) manakala plot TR menunjukkan nilai 4.79 (H'_{maks}= 5.44), yang mana nilai-nilai indeks ini adalah berbeza secara signifikan ($P<0.05$). Kesamaan komuniti antara kedua-dua plot adalah sederhana dengan Indeks Kesamaan Sorenson bagi komposisi spesies menunjukkan nilai 48%. Rajah ordinasi yang dihasilkan daripada Analisis Kesetaraan Nyahtren (DCA) menunjukkan variasi flora antara dua kawasan kajian. DCA jelas memisahkan plot antara kawasan kajian dan ini menunjukkan satu kecerunan perubahan spesies daripada kawasan BK kepada kawasan TR.

Kata kunci: Analisis Kesetaraan Nyahtren; flora batu kapur; kecerunan persekitaran; komposisi spesies; Taman Rimba Kenong

INTRODUCTION

Tropical rainforest is remarkably known to contain high diversity and richness of tree species and this has been reported in many studies (e.g. Newbery et al. 1996; Webb & Peart 2000). However, little is known of its floristic variation and the processes and factors which determine its composition and maintain its very high diversity. The variation of floristic composition has been associated with physical habitat variables, in which this association has generated some of the most obvious patterns in the distribution and abundance of organisms (Whittaker 1956). Several studies have shown that topography and possibly soils changed markedly the floristic composition of a forest community (Austin et al. 1973; Clark et al. 1998). It is obvious that when the environmental variation is pronounced enough to create floristically differentiated communities within the forest, hence, spatial variation in species composition is expected, both in response to landscape-scale soil differences and in relation to local factors such as topography and associated soil catenas. Moreover, species abundance and floristic composition are expected to reflect spatial patterns in the environmental conditions, so that if there is spatial turnover in these patterns, corresponding and predictable turnover is also expected in the vegetation (Tuomisto & Poulsen 2000). In addition, tree species is expected to be most abundant where the environmental conditions are most favourable for it, the same dominant species are expected at sites with similar environmental conditions, while different dominants are expected at sites with differing environmental conditions (Tuomisto et al. 1998).

At Kenong Forest Park in Pahang, Peninsular Malaysia, the forest area is apparent to have distinct habitats that consists of limestone area and lowland forest area. These two distinct habitats perhaps support different tree communities due to different habitat characteristics, thus this study aims to investigate the floristic variation within the forest park. The variation in floristic composition would be analysed using the indirect gradient analysis which use the floristic data to determine floristic gradients between the plots (Kent & Coker 1992).

MATERIALS AND METHODS

STUDY AREA

Kenong Forest Park was selected as the study site. The site is situated about 180 km from Kuala Lumpur, and 35 km from the town of Kuala Lipis, Pahang, Peninsular Malaysia. The forest park covers an area of 12,644 hectare which includes the Yong Forest Reserve and the Yong Tambahan Forest Reserve (Figure 1), and it borders with the National Park at the northeast. The forest is classified as a lowland dipterocarp forest of hilly topography, with altitudes ranged between 60 m to 373 m above sea level. Further, the forest area has an interesting feature with the presence of several limestone caves such as the Batu Telahup Cave, Batu Tangga Cave, Batu Tangkup Cave, Batu Tinggi Cave, Harimau Cave and Hijau Cave.

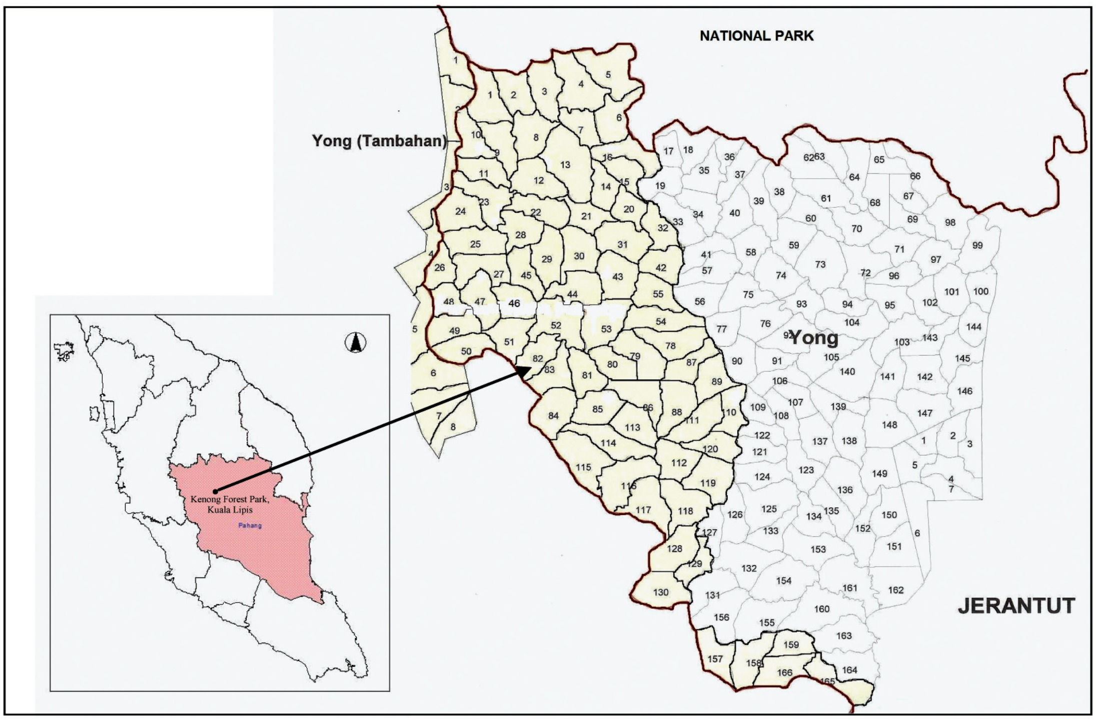

FIGURE 1. Location of Kenong Forest Park, Kuala Lipis, Pahang, and the study site that was located in Compartment 82, Yong Tambahan Forest Reserve

PLOTS ESTABLISHMENT AND TREE SAMPLING

Two study plots of one hectare each were established at the Kenong Forest Park, located in Compartment 82 of the Yong Forest Reserve. One plot was set up at a forested area adjacent to a limestone cave, namely, the Hijau Cave (BK Plot) positioned at 4° 13.28' N, 102° 11.66' E, while another plot (TR plot) was established in a lowland forest area that distant away, approximately 800 m from the BK plot, which was positioned at 4° 14.2' N, 102° 13.5' E. In each plot, 20 subplots of 10 m × 50 m were constructed to enable the sampling being conducted systematically. All trees with diameter at breast height (dbh) of 5 cm and above were tagged, and measured its diameter. Leaves specimens of each measured tree were collected for the preparation of voucher specimens and for species identification. The identification of the specimens was made possible using keys in the *Tree Flora of Malaya* (Whitmore 1972, 1973; Ng 1978, 1989).

DATA ANALYSIS

Data of all tree species that were enumerated in the two 1-ha plots were tabulated and summarized to describe the species composition and abundance of the tree communities. The abundance data include determination of density and basal area, whilst the Importance Value Index (IV_i) was calculated to determine species importance in the community. The IV_i was calculated by summing up the values of relative density (R_D), relative dominance (based on basal area) (R_B), and relative frequency (R_F) of each species or family [$IV_i = (R_D + R_B + R_F)/3$] (Brower et al. 1997). Species diversity was determined using the Shannon-Weiner Diversity Index (*H'*) (Shannon & Weaver 1949) as follows:

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

where s is the number of species; p_i is the proportion of individuals or the abundance of the ith species expressed as a proportion of total abundance. Community similarity between plots was determined using Sörensen's Similarity Index, *S*, (Kent & Coker 1992):

$$S = \frac{2a}{2a + b + c} \times 100$$

where a is the number of species common to BK and TR plots, b is the number of species occurring in BK plot only, and c is the number of species occurring in TR plot only.

Floristic patterns were examined by subjecting the sample data to Detrended Correspondence Analysis (DCA), a method derived from reciprocal averaging (Hill & Gauch 1980). The abundance data, i.e. the number of individuals of each species, were used in the analysis which were performed using CANOCO program version 4.0 (ter Braak & Šmilauer 1998). Rare species were eliminated from the analysis whereby species with two entry in the data matrix of 20 subplots of each plot, was deleted to increase the definition of the results (Zhang et al. 2005). This is because Gauch (1982) observed that ordinations by DCA are quite sensitive to the effects of rare species. Hence, a total of 96 species were retained for the ordination analyses after the deletion of the rare species. Moreover, since the data contain many small values and few extremely large abundant values, thus the data were transformed by taking logarithms as suggested by ter Braak and Verdonschot (1995). Both sites and species scores were then plotted in two-dimensional graphs to allow manageable representation of the ordination.

RESULTS AND DISCUSSION

FLORISTIC COMPOSITION AND SPECIES DIVERSITY

A total of 2091 trees with diameter at breast height (dbh) of 5 cm and above were enumerated from both plots, of which overall floristic composition consisted of 322 species from 161 genera and 54 families (Table 1). In the BK plot, there were 1091 trees belonging to 45 families, 110 genera and 199 species, whilst the TR plot contained a total of 1000 trees that comprised of 50 families, 133 genera and 232 species. This reflects that the TR plot of the lowland area contained high number of tree taxa compared to the limestone area (BK plot). The Table 1 also shows four families, i.e. Boraginaceae, Connaraceae, Malvaceae and Rutaceae occurred in the BK plot but were not recorded in the TR plot, whilst the TR plot recorded nine families, i.e. Apocynaceae, Elaeocarpaceae, Monimiaceae, Ochnaceae, Oxalidaceae, Proteaceae, Rosaceae, Sapotaceae and Urticaceae, that were not found in the BK plot. The Sorenson's Similarity Index indicates a high similarity of family composition between the two plots of 88%, whilst at species level, a fairly low similarity of species composition was observed with Sorensen Index of 48%. Low similarity of species composition between distinct forest habitats within a forested area had been reported by Juliana et al. (2005) where they found as low as 15% similarity for tree species between two habitats of alluvium soil and quartz rock in the Ulu Muda Forest Reserve, Kedah, Peninsular Malaysia. Newbery and Proctor (1984) who surveyed swamp forest, alluvium soil forest, limestone hill forest and dipterocarp forest at Gunung Mulu National Park, Sarawak, reported that differences in species composition between the forest habitats could be due to differences in soil chemical properties of the different study areas.

Overall, the most speciose family within the 2-ha plot was the Euphorbiaceae which was represented by 40 species in 15 genera. In both plots, the Euphorbiaceae again indicates as the most well represented family whereby the BK plot recorded 30 species in 11 genera, whilst the TR plot contained 27 species of 14 genera. Several studies have also reported similar observation of which the Euphorbiaceae was the most speciose family of a limestone hill forest in Sarawak (Adam & Zahiruddin 2005; Julaihi 2004) as well as in lowland dipterocarp forests in Peninsular Malaysia

TABLE 1. Number of genera and species for all tree families that were present in each study plot, and overall number of taxa based on combination of the two study plots at Kenong Forest Park, Pahang, Peninsular Malaysia (arranged in alphabetical order)

	Family	No. of Genus			No. of Species		
		BK	TR	Overall	BK	TR	Overall
1	Alangiaceae	1	1	1	2	1	2
2	Anacardiaceae	3	6	7	3	6	7
3	Annonaceae	9	8	12	12	13	19
4	Apocynaceae	-	1	1	-	1	1
5	Araliaceae	1	1	2	1	1	2
6	Araliadaceae	1	1	1	1	1	1
7	Bombacaceae	1	2	2	1	2	3
8	Boraginaceae	1	-	1	1	-	1
9	Burseraceae	2	4	4	4	12	12
10	Celasteraceae	1	2	2	1	2	2
11	Combretaceae	1	1	1	1	1	1
12	Connaraceae	1	-	1	1	-	1
13	Dilleniaceae	1	1	1	1	1	1
14	Dipterocarpaceae	4	2	4	9	5	12
15	Ebenaceae	1	1	1	9	13	16
16	Elaeocarpaceae	-	1	1	-	3	3
17	Euphorbiaceae	11	14	15	30	27	40
18	Fagaceae	1	1	1	1	2	3
19	Flacourtiaceae	5	4	6	8	6	11
20	Guttiferae	3	3	3	6	8	10
21	Icacinaceae	1	1	2	1	1	2
22	Lauraceae	4	9	8	9	14	21
23	Lecythidaceae	1	2	2	2	2	3
24	Leguminosae	6	9	10	6	11	12
25	Loganiaceae	1	2	2	1	2	1
26	Magnoliaceae	1	1	1	1	1	1
27	Malvaceae	1	-	1	1	-	1
28	Melastomataceae	2	2	2	3	3	4
29	Meliaceae	3	3	3	11	8	14
30	Monimiaceae	-	1	1	-	1	1
31	Moraceae	2	3	5	4	4	8
32	Myristicaceae	5	3	5	12	9	14
33	Myrsinaceae	1	1	1	3	2	3
34	Myrtaceae	1	1	1	5	8	10
35	Ochnaceae	-	1	1	-	1	1
36	Olacaceae	2	2	2	2	2	2
37	Oxalidaceae	-	1	1	-	1	1
38	Pandaceae	1	2	2	2	3	3
39	Polygalaceae	1	1	1	3	2	3
40	Proteaceae	-	1	1	-	2	2
41	Rhizophoraceae	1	2	2	1	3	3
42	Rosaceae	-	1	1	-	1	1
43	Rubiaceae	9	9	12	11	11	19
44	Rutaceae	1	-	1	1	-	1
45	Sapindaceae	5	6	7	7	11	12
46	Sapotaceae	-	3	3	-	3	3
47	Sterculiaceae	2	3	3	3	5	6
48	Theaceae	3	1	3	3	1	3
49	Thymelaeaceae	1	1	1	2	1	2
50	Tiliaceae	2	2	2	5	5	6
51	Ulmaceae	1	2	2	2	3	3
52	Urticaceae	-	1	1	-	1	1
53	Verbenaceae	3	1	3	3	2	4
54	Violaceae	1	1	1	2	1	3
	Total	110	133	161	198	230	322

(Nizam et al. 2004, 2006a). This is not surprising because Euphorbiaceae is reported as the second largest plant family (after Rubiaceae) in Peninsular Malaysia represented with 70 genera and 364 species that include trees, shrubs and lianas (Turner 1995).

As for species diversity, the Shannon-Weiner Diversity Index (*H*') for BK plot showed an index value of 4.42 (H'_{max} = 5.26), whereas the TR plot indicated a value of 4.79 (H'_{max} = 5.26), of which the values are different significantly (*t*-test; p<0.05). Both *H*' values show that the study plots can be considered to display fairly high species diversity based on comparison with various studies conducted in various forest habitats in Peninsular Malaysia, such as at Bukit Bauk Forest Reserve, Terengganu (*H*'=3.57; Jeffri 2005), Gunung Matchinchang Forest Reserve, Langkawi (*H*'=4.33; Raffae 2003) and at a limestone forest in Bau, Kuching, Sarawak (*H*'=3.72; Adam & Zahiruddin) .

ABUNDANCE AND SPECIES IMPORTANCE

Density of trees in BK and TR plots was 1091 trees/ha and 1000 trees/ha, respectively. Euphorbiaceae contributed the highest density in both BK and TR plots with 174 trees/ha (15.9%) and 212 trees/ha (19.4%), respectively (Table 2). Moraceae had the second highest density in the BK plot with 132 trees/ha (12.1%), whilst in the TR plot, Annonaceae was ranked the second highest density with 112 trees/ha (10.3%). Species-wise, *Streblus ilicifolius* (Moraceae) with 128 trees/ha and *Pseuduvaria macrophylla* var. *macrophylla* (Annonaceae) of 43 trees/ha, were the species that had the highest density in the BK plot and TR plot, respectively (Table 2).

Further, the BK plot showed a total tree basal area (BA) of 26.91 m^2/ha while the TR plot indicated a total BA of 29.23 m^2/ha. Leguminosae dominated BA of both plots with values of 3.10 m^2/ha in the BK plot and 5.76 m^2/ha in the TR plot (Table 2). Dipterocarpaceae had the second highest BA in the BK plot with BA of 2.93 m^2/ha followed by Euphorbiaceae with 2.87 m^2/ha. On the contrary, Euphorbiaceae represented the second highest BA in the TR plot with BA of 2.39 m^2/ha while Dipterocarpaceae was the third highest with BA of 2.09 m^2/ha. At species level, *Pentaspodon velutinus* (Anacardiaceae) was the species with the highest total BA in the BK plot with value

TABLE 2. Summary of tree density, basal area (BA) and Importance Value (IV_i) of five leading families and species at both BK and TR plots at Kenong Forest Park, Pahang

	BK PLOT		TR PLOT	
	Family		*Family*	
	Euphorbiaceae	174	Euphorbiaceae	212
	Moraceae	132	Annonaceae	112
	Annonaceae	128	Myristicaceae	63
	Ebenaceae	94	Leguminosae	60
DENSITY (trees/ha)	Leguminosae	76	Myrtaceae	42
	Species		*Species*	
	Streblus ilicifolius	128	*Pseuduvaria macrophylla* var. *macrophylla*	43
	Cleistanthus hirsutulus	50	*Cleistanthus kingii*	39
	Orophea enterocarpa	45	*Baccaurea racemosa*	28
	Diospyros nutans	36	*Cleistanthus hirsutulus*	27
	Diospyros toposioides	33	*Knema patentinervia*	25
	Family		*Family*	
	Leguminosae	3.10	Leguminosae	5.76
	Dipterocarpaceae	2.93	Euphorbiaceae	2.39
	Euphorbiaceae	2.87	Dipterocarpaceae	2.09
	Saptreesaceae	1.95	Anacardiaceae	1.76
BASAL AREA (m^2 ha^{-1})	Tiliaceae	1.93	Moraceae	1.64
	Species		*Species*	
	Pentaspadon velutinus	1.51	*Intsia palembanica*	3.55
	Callerya atropurpurea	1.28	*Shorea assamica* ssp. *globifera*	1.83
	Pentace microlepidota	1.25	*Mangifera foetida*	1.36
	Shorea assamica ssp.	1.25	*Koompassia excelsa*	1.04
	globifera	1.16	*Antiaris toxicaria*	1.02
	Streblus ilicifolius			
	Species		*Species*	
	Streblus ilicifolius	6.39	*Intsia palembanica*	4.86
	Callerya atropurpurea	3.03	*Shorea assamica* ssp. *globifera*	2.75
IV_i (%)	*Cleistanthus hirsutulus*	2.84	*Pseuduvaria macrophylla* var. *macrophylla*	2.53
	Hydnocarpus castanea	2.50	*Chisocheton patens*	2.32
	Cleistanthus kingii	2.03	*Saraca cauliflora*	2.81

of 1.51 m^2/ha, whilst in the TR plot, *Intsia palembanica* (Leguminosae) dominated the BA of 3.55 m^2/ha (Table 2). It is apparent that the total BA of trees in the plot at limestone area (BK plot) was relatively lower compared to the total BA in the TR plot. A similar observation was also reported by Proctor et al. (1983) where they found a lower BA for trees of limestone habitat compared to the trees surveyed in the lowland dipterocarp forest at Gunung Mulu, Sarawak.

Based on the calculated Importance Value Index (IV_i), *Streblus ilicifolius* (Moraceae) was the most important species in the BK plot with an IV_i of 6.39%, followed by *Callerya artropurpurea* (Leguminosae) with an index value of 3.03% (Table 2). As for the TR plot, *Intsia palembanica* (Leguminosae) was the most important species (IV_i = 4.86%) while *Shorea assamica* ssp. *globifera* (Dipterocarpaceae) was the second most important species with IV_i of 2.75%. The importance of *Streblus ilicifolius* in the BK plot was in accordance with reports by Chin (1977) and Turner (1995) who stated that the *S. ilicifolius* is a common species of limestone forest throughout Peninsular Malaysia.

FLORISTIC VARIATION PATTERN

Analysis of floristic variation pattern using the Detrended Correspondence Analysis (DCA) technique produced ordination diagrams as shown in Figures 2 and 3. The DCA which is an indirect gradient analysis technique, enable an inference on environmental gradients to be made from the species composition data (Leps & Smilaeur 2003). The abundance of species normally covary in a systematic fashion because they are reacting to the same underlying environmental variables (Jongman et al. 1995). The indirect ordination examines the similarity or dissimilarity of floristic composition of vegetation samples, whereby the distances between the points on the diagrams are taken as a measure of their degree of similarity or difference. Points that are close together will represent plots that are similar in species composition; the further apart any two points are, the more dissimilar or different the plots will be.

In Figure 2, point A denotes the subplots established in the limestone area (BK), while point B represents the subplots established in the lowland area (TR). The Figure 2 illustrates two unique tree assemblages within the forest

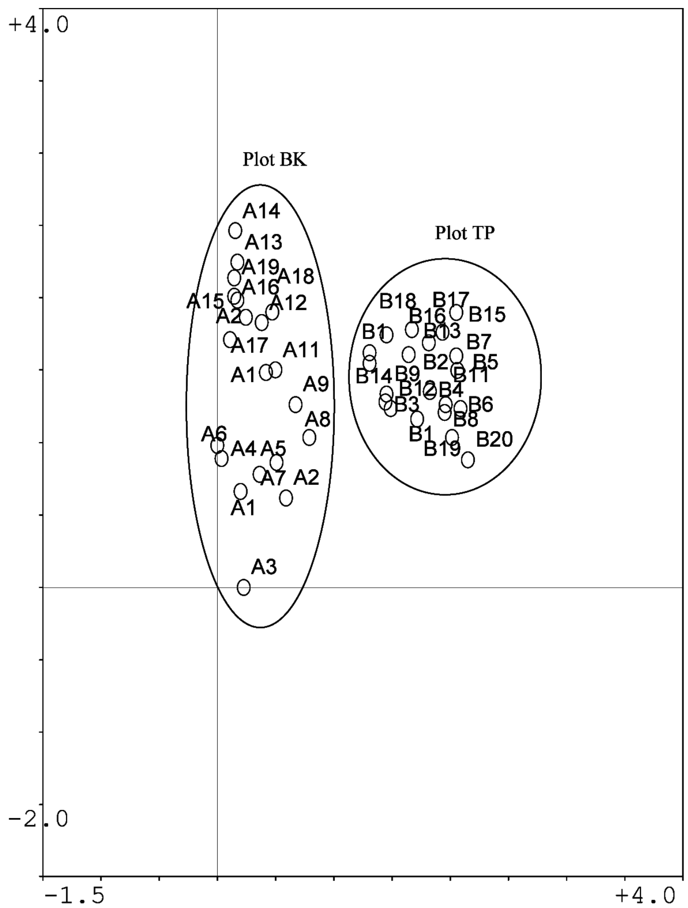

FIGURE 2. DCA ordination diagram of subplots based on the abundance of the tree species at Kenong Forest Park, Pahang. Numbers are related to subplots at each study plot (A = BK plot of limestone area; B = TR plot of lowland dipterocarp forest)

park, whereby subplots within the respective plot were clumped together reflecting the subplots are relatively similar floristically; nevertheless, the two clumps of BK and TR plots are separated clearly which indicates the dissimilar in terms of floristic composition between the two plots. The two assemblages are apparently dominated by different tree species of which the BK plot (points A) and TR plot (points B) has *Streblus ilicifolius* and *Intsia palembanica,* respectively as their dominant species. From this indirect gradient analysis, we may predict that there must be factors controlling the pattern of this scenario. Environmental variables are obviously the factors that significantly influence the community patterns. This has been supported by many studies that look on relationships between floristic patterns and environmental gradients, and most of them stated soil characteristics as the significant factor that control the vegetation pattern in a community (e.g. Ferreyra et al. 1998; Jose et al. 1996; Tuomisto et al. 2003).

Species ordination (Figure 3) shows that every point represents the species while the distance between the points depicts the similarities between species in all subplots. Every number on the points represents the species that are listed in Table 3. Generally, the presence of a rather compact cluster of points indicates a relatively low degree of variation in species abundance. Those species that are positioned close to each other such as *Baccaurea parviflora* (31), *Dysoxylum cauliflorum* (58) and *Knema hookeriana* (61) are considered as having similar abundance, and perhaps are influenced by similar environmental variables. From the Figure 3, it is apparent that there are species that are distantly separated from each other, thus this would infer the difference in terms of environmental variables that influence the occurrence of the species. For instance, the species *Aporusa selangorica* (28) is far separated from the *Madhuca korthalsii* (84), reflecting different abundance and number of occurrence. Moreover, the most important species at the BK plot, i.e. *Streblus ilicifolius* (59) is positioned on the left side of the diagram, which is distant away from the most important species in the TR plot, i.e. *Intsia palembanica*, that is located on the far right of the ordination diagram. This observation confirms that the presence of environmental gradient from limestone forest habitat to common lowland dipteropcarp forest had

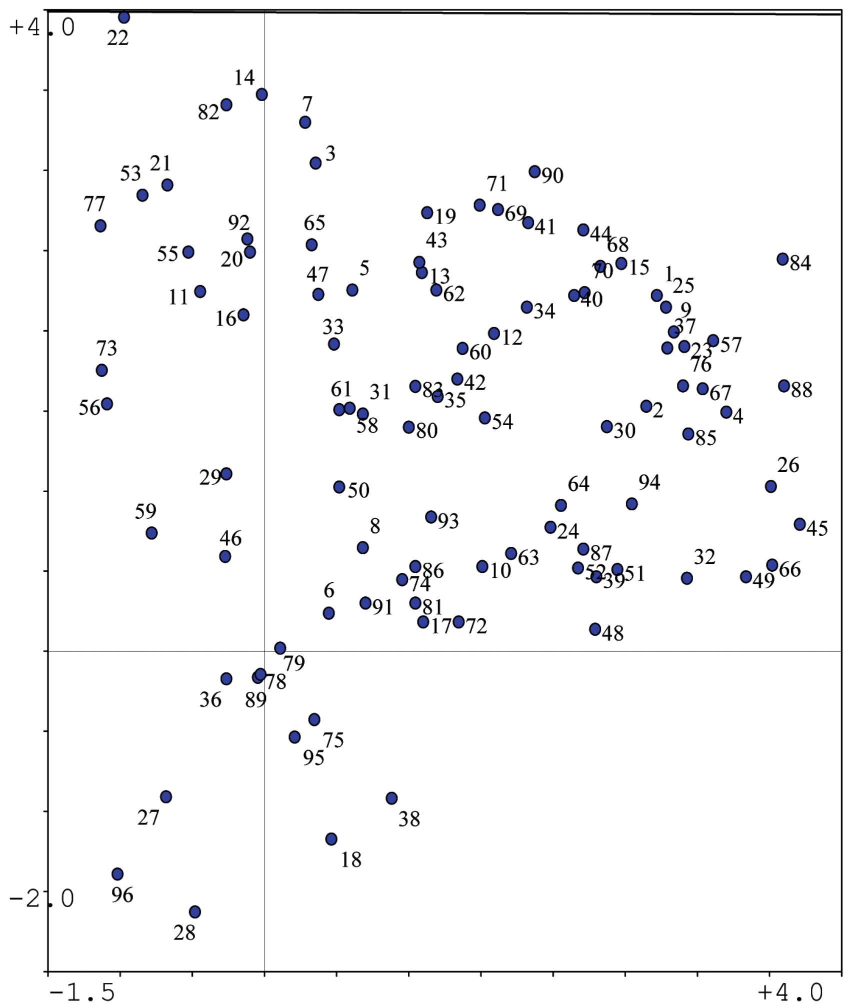

FIGURE 3. Species ordination derived from DCA of the Kenong Forest Park floristic data. Numbers represent tree species that are listed in Table 3

TABLE 3. List of tree species and its number for the DCA ordination diagram in Figure 3

No.	Spesies	No.	Spesies	No.	Spesies
1	*Alangium griffithii*	34	*Cleistanthus kingii*	67	*Syzygium diospyrifolium*
2	*Buchanania sessifolia*	35	*Croton argyratus*	68	*Syzygium dyerianum*
3	*Pentaspadon velutinus*	36	*Mallotus peltatus*	69	*Syzygium kemamanense*
4	*Semecarpus curtisii*	37	*Paracroton pendulus*	70	*Ochanostachys amentacea*
5	*Anaxagorea javanica* var. *javanica*	38	*Wetria insignis*	71	*Strombosia javanica*
6	*Enicosanthum macranthum*	39	*Hydnocarpus castanea*	72	*Galearia fulva*
7	*Orophea enterocarpa*	40	*Osmelia maingayi*	73	*Microdesmis caseariifolia*
8	*Polyalthia obliqua*	41	*Garcinia scortechinii*	74	*Xanthophyllum wrayi*
9	*Polyalthia stenopetala*	42	*Mesua ferruginea*	75	*Pellacalyx saccardianus*
10	*Pseuduvaria macrophylla* var. *macrophylla*	43	*Mesua grandis*	76	*Canthium confertum*
11	*Aralidium pinnatifitidum*	44	*Barringtonia macrostachya*	77	*Ixora javanica* var. *javanica*
12	*Canarium littorale*	45	*Planchonia valida*	78	*Nephelium costatum*
13	*Dacryodes kingii*	46	*Callerya atropurpurea*	79	*Nephelium juglandifolium*
14	*Dacryodes laxa*	47	*Cynometra malaccensis*	80	*Paranephelium xestophyllum*
15	*Terminalia bellirica*	48	*Dialium platysepalum*	81	*Pometia pinnata*
16	*Dillenia reticulata* var. *psilocarpella*	49	*Intsia palembanica*	82	*Xerospermum laevigatum*
17	*Shorea assamica* ssp. *globifera*	50	*Saraca cauliflora*	83	*Xerospermum noronhianum*
18	*Shorea parvifolia* ssp. *velutinata*	51	*Memecylon acuminatum* var. *acuminatum*	84	*Madhuca korthalsii*
19	*Diospyros andamanica*	52	*Pternandra galeata*	85	*Palaquium rostratum*
20	*Diospyros cauliflora*	53	*Aglaia argentea*	86	*Pterocymbium tinctorium*
21	*Diospyros nutans*	54	*Aglaia odoratissima*	87	*Adinandra corneriana*
22	*Diospyros toposioides*	55	*Chisocheton patens*	88	*Microcos antidesmifolia*
23	*Antidesma tomentosum*	56	*Chisocheton pauciflorus*	89	*Pentace acuta*
24	*Aporusa arborea*	57	*Chisocheton tomentosus*	90	*Pentace curtisii*
25	*Aporusa aurea*	58	*Dysoxylum cauliflorum*	91	*Pentace microlepidota*
26	*Aporusa bracteosa*	59	*Streblus ilicifolius*	92	*Pentace triptera*
27	*Aporusa octandra*	60	*Knema furfuracea*	93	*Gironniera hirta*
28	*Aporusa selangorica*	61	*Knema hookeriana*	94	*Gironniera nervosa*
29	*Aporusa whitmorei*	62	*Knema laurina* var. *laurina*	95	*Vitex pinnata*
30	*Baccaurea lanceolata*	63	*Knema patentinervia*	96	*Rinorea sclerocarpa*
31	*Baccaurea parviflora*	64	*Ardisia lanceolata*		
32	*Baccaurea racemosa*	65	*Ardisia oxyphylla*		
33	*Cleistanthus hirsutulus*	66	*Syzygium anisosepalum*		

influenced the variation in floristic patterns of the study area. Thus, the species ordination is very informative as an ecological interpretation for defining the underlying environmental gradients within a set of vegetation data analysed by the DCA.

The underlying environmental variables that drive the ordination pattern in such a way include variables such as soil characteristics and topographies (Palmiotto et al. 2004; Paoli et al. 2006; Phillips et al. 2003). Some of the many soil factors that may influence the floristic variation in the study area at Kenong Forest Park are the calcium element and soil pH, based on the facts that the limestone area (BK plot) has high calcium concentration, which also signifies high pH content. Johnston (1992) showed that calcium concentration in soil and pH correlated with tree species composition in a one-hectare plot in Puerto Rico. Moreover, Nizam et al. (2006b) observed the soil pH as one of the important environmental factors that influenced tree species distribution at the National Park in Merapoh, Pahang. Although soil properties are reported as the main factor that influence the floristic variation, nonetheless, factor of environmental disturbances are also contributing to the distribution pattern of vegetation communities (Toniato & Oliveira-Filho 2004).

CONCLUSION

Tree communities between two different forest habitats of limestone and lowland dipterocarp forest at the Kenong Forest Park, Pahang show differences in terms of richness, diversity and dominance of tree species. Floristic variation patterns between the distinct habitats of the forest park suggest that there are environmental gradients that influence the floristic patterns. Identifying the key underlying gradients, abiotic conditions and major soil influences on vegetation patterns is essential in formulating plans to protect and conserve forest habitats of conservation interest.

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