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EDAPHIC RELATIONSHIPS AMONG TREE SPECIES IN THE NATIONAL PARK AT MERAPOH, PAHANG, MALAYSIA

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Abstrak: Satu kajian telah dijalankan di Taman Negara di Merapoh, Pahang, Semenanjung Malaysia untuk meneliti perhubungan antara komuniti pokok dengan ciri-ciri tanah di kawasan kajian. Inventori spesies pokok dan pensampelan tanah telah dilakukan di 18 subplot berukuran 10 m x 10 m dalam satu plot kekal 2 ha. Variabel tanah yang diukur termasuk pH; kandungan bahan organik; Mg, P dan K tersedia; jumlah nitrogen tak organik; dan kandungan liat serta kelodak. Sejumlah 251 pokok telah dikira yang mengandungi 150 spesies daripada 83 genus dan 39 famili. Spesies paling penting berdasarkan nilai kepentingan tertinggi ialah *Knema furfuracea* dengan nilai kepentingan 3.96%. Tanah di kawasan kajian adalah berasid dan menunjukkan tekstur lempung, manakala nutrien tersedia adalah berkepekatan rendah kepada sederhana. Satu corak komposisi flora telah diperhatikan antara kesemua subplot yang dikaji, yang berkait dengan variabel edafik sebagaimana yang dihuraikan oleh analisis perhubungan kanonikal. Variabel pH tanah, nitrogen tak organik dan fosforus memperlihat sebagai faktor persekitaran utama bagi komuniti pokok dalam plot kajian.

Abstract: A study was conducted in the National Park at Merapoh, Pahang in Peninsular Malaysia to examine the relationships between tree communities and its soil characteristics. Tree species inventory and soil samplings were carried out in 18 subplots of 10 m x 10 m within a 2-ha permanent plot. The measured soil variables include pH; organic matter (OM) content; available Mg, P and K; total inorganic-N; and content of clay and silt. A total of 251 trees were enumerated comprising of 150 species from 83 genera and 39 families. The most important species based on the highest importance value (IV_i) was *Knema furfuracea* with an IV_i of 3.96%. Soils of the study site were acidic and showed clay texture, while available nutrients were of low to medium concentrations. A floristic compositional pattern was observed among all surveyed subplots which were correlated to the edaphic variables as revealed by canonical correspondence analysis. Soil pH, inorganic-N and phosphorus appear to be the principal environmental determinants of tree communities in the study plots.

Keywords: Edaphic Factors, Floristic Pattern, Vegetation-environment Relationships

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INTRODUCTION

The importance of external environmental factors in governing vegetation community structure and composition has been reported in many studies covering from lowland forests to mountain forests (Ferreyra *et al*. 1998; Lyon & Gross 2005; Palmiotto *et al*. 2004). Most of the studies showed that the association of vegetation species with physical habitat variables generates some obvious patterns in distribution and abundance of organisms. For example, differences among species in their habitat associations with soil type or elevation clearly contribute to species diversity on a landscape scale (Webb & Peart 2000). Furthermore, habitat heterogeneity is one of the important factors in maintaining high tree species richness of tropical rain forest. This has been supported by Tilman and Pacala (1993) who predicted coexistence of plant species based on habitat heterogeneity. Nevertheless, on the scales relevant to adult trees, Webb and Peart (2000) doubted whether actual habitat heterogeneity in rain forests, and the responses of species to that heterogeneity, are sufficient to maintain the local coexistence of so many species.

Relationships between soil properties and plant species diversity have been described in various habitats of grassland communities (Janssens *et al*. 1998), savannas (Baruch 2005) as well as tropical rain forests (Newbery *et al*. 1996). An extensive survey by Baillie *et al*. (1987) in Sarawak suggested the role of edaphic factors in the form of reserve nutrients for determining the distribution of Dipterocarpaceae. Moreover, Newbery and Proctor (1984) conducted a study to look at differences in floristic composition within four 1-ha plots in Mulu, Sarawak, which might be related to changing edaphic conditions within each plot. They reported that differences were found for the alluvial and heath forest plots, but not for the dipterocarp and limestone plots. Their study revealed that differences in soil chemistry were associated with the classified floristic changes. In addition, related studies at Pasoh, Peninsular Malaysia (Ashton 1976) showed floristic changes correlated with local topographic change within 2-ha plots [trees ≥ 10 cm girth at breast height (gbh)]. Nevertheless, Proctor (1995) stated that there is no evidence being demonstrated on effects of soil nutrients per se on tree distributions; most tropical trees appear to have very broad tolerances of soil nutrient levels.

This paper reports results on a study to look at the distribution of tree species in relation to several soil parameters in the National Park at Merapoh, Pahang, Peninsular Malaysia (Fig. 1). The National Park Malaysia which is located in the centre of Peninsular Malaysia, covers an area of 4343 km^2 of virgin tropical rain forest in three states, namely Pahang, Kelantan and Terengganu. Topography of the National Park varies, from lowland to mountain terrains with altitudes ranged from 61 m to the highest peak of Gunung Tahan at 2187 m. The main entrance to the National Park is in Kuala Tahan in Jerantut, Pahang; and in May 1993, the second entrance at Merapoh, Pahang was opened to public. Due to the large area of the Park, floristic studies are not comprehensively being conducted, whereby there are many areas have yet to be documented. Several early studies reported on the flora of the National Park, which includes Soepadmo (1971) who described vegetation along trails from Kuala Tahan to the peak of Gunung Tahan. In addition, Parris and Edwards (1987) collected fern and fern allies, while a comprehensive study on bryophytes was conducted by Yong (2002) who covered the National Park at Merapoh and Kuala Koh areas. It is hoped that the results from this study may provide significant information to the management authorities for conservation purposes.

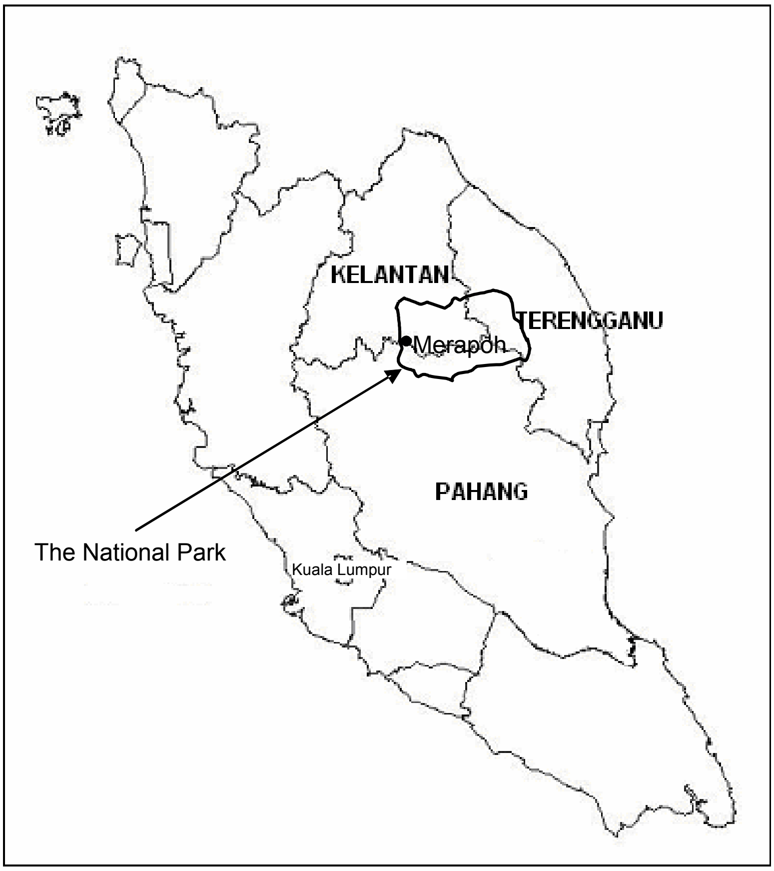

Figure 1: Map of Peninsular Malaysia showing the location of the National Park at Merapoh, Pahang.

MATERIALS AND METHODS

Study Plots and Tree Sampling

The study site was in the Merapoh area, a western part of the National Park that is located 30 km from Gua Musang in Kelantan and 100 km from Kuala Lipis in Pahang. A 2-ha (200 m × 100 m) permanent plot was established at Sungai Cheruai area (4º 39'N, 102º 05'E; altitude 110 m asl) in the National Park. The plot was built with an objective to conduct a detailed ecological study on vegetation at the area, whereby the forested area was a virgin forest that was never been logged (Norziana 2004). The plot was located approximately 5 km from the Department of Wildlife and National Parks staffs' quarters and 200 m from the main track to Kuala Juram (Fig. 2). The forest at the chosen site was still intact and no sign of disturbances seen occurred in the area. Two hundred subplots of 10 m × 10 m were set up (Fig. 3), enabling sampling and data collection of the main study to be carried out easily and in a systematic manner. Eighteen subplots within the 2-ha subplots were chosen randomly for the purpose of this study, and the chosen subplots are shown in Figure 3. In each plot, all trees with 5 cm diameter at breast height (DBH) and above were tagged and manually measured using the diameter tape at 1.3 m above the ground. All specimens of each measured tree were collected for the preparation of voucher specimens and species identification. The identification of the specimens was made possible using keys in the *Tree flora of Malaya* (Whitmore 1972, 1973; Ng 1978, 1989). The voucher specimens were deposited in the Universiti Kebangsaan Malaysia Herbarium (UKMB).

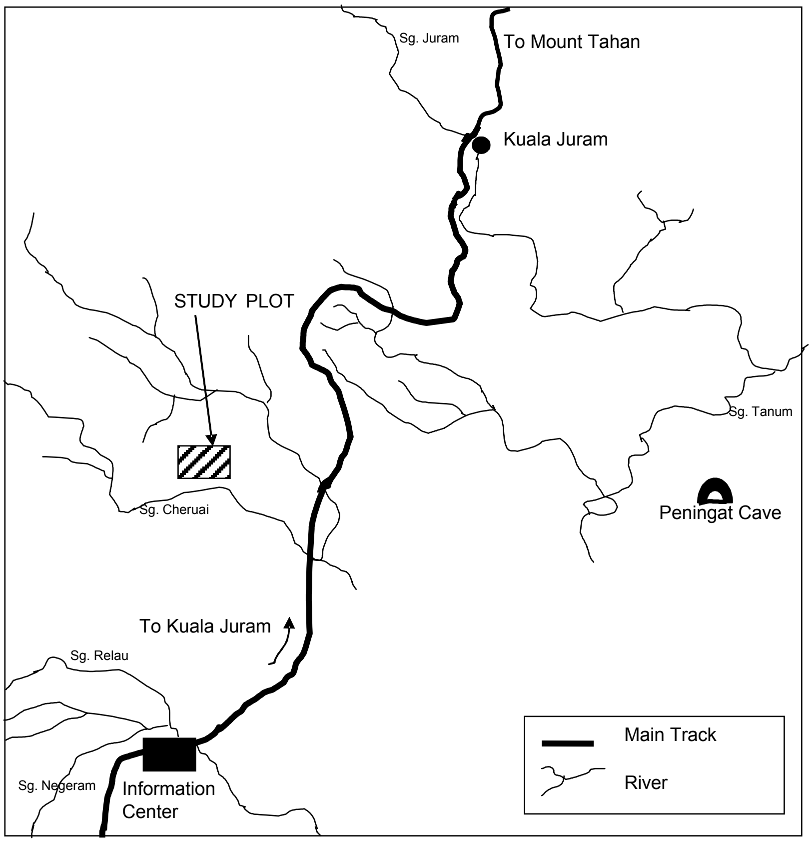

Figure 2: Map of the National Park at Merapoh, Pahang, showing the location of the study site.

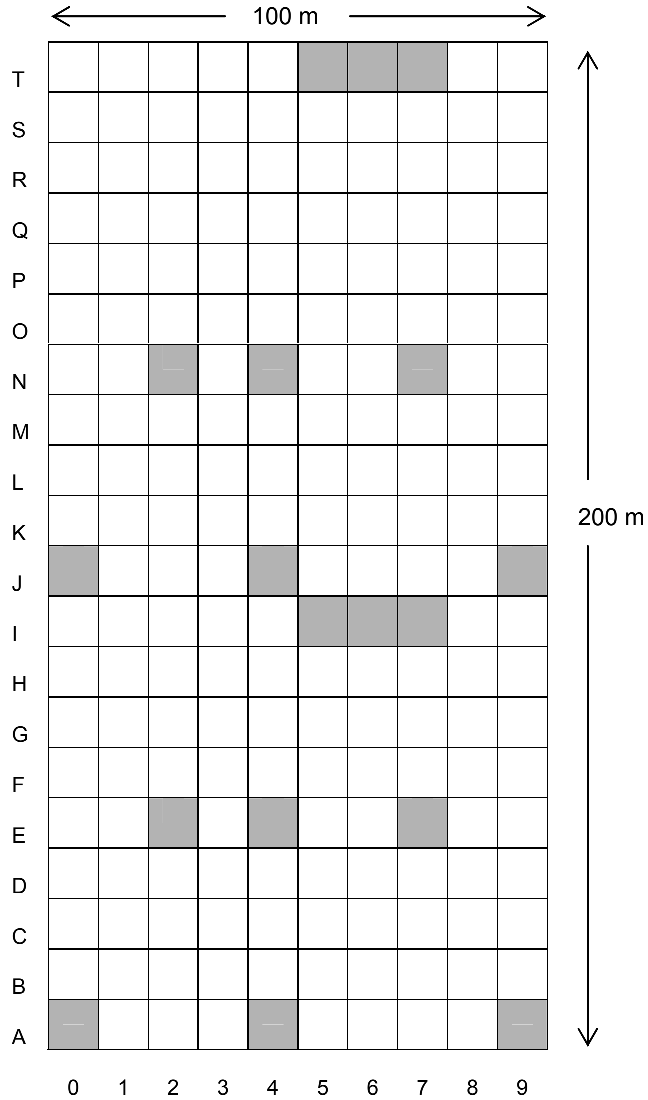

Figure 3: Layout of the established 2-ha permanent plot in the National Park at Merapoh, Pahang. The shaded boxes were subplots chosen for this study.

Soil Analysis
In all 18 subplots, three topsoil samples (0–20 cm depth) were taken randomly within the subplot and the three samples were then bulked together to represent soil sample of each subplot. Particle size distribution was determined using the pipette method together with dry sieving (Abdulla 1966). Texture of soil was obtained by plotting the sand, silt and clay content in the triangle of texture. Organic matter (OM) content was determined by loss-on-ignition method, igniting soils for 16 h at 400ºC (Avery & Bascomb 1982), while soil pH was measured using pH meter in soil:water ratio of 1:2.5 (Metson 1956). Soils were extracted with 1 M potassium chloride (KCl) for exchangeable acidic cations (Al^{3+} and H^+), which were determined by titration. As for exchangeable base cations (K^+, Na^+, Ca^{2+} and Mg^{2+}), the soil samples were extracted in 1 M ammonium acetate and the extract was determined by flame atomic absorption spectrophotometer (FAAS). Available macronutrients and micronutrients in the soil were extracted using 1 M ammonium acetate-acetic acid. The extract was run under the ultraviolet (UV) spectrophotometer for the determination of phosphorus, while the availability of potassium (K), magnesium (Mg), cuprum (Cu), ferum (Fe), mangan (Mn) and zink (Zn) in the extracts were determined using the atomic absorption spectrophotometer (AAS).

Data Analysis
All trees enumerated the plots at all transects were summarized for the overall taxonomic composition, and quantitative data were analysed to determine abundance. These include determination of basal area (BA), as well as calculating the density and frequency of occurrence of each species. Frequency of occurrence indicates the number of subplots in which a species occurs and is expressed as the proportion of the total number of samples taken that contains the species in question (Brower *et al.* 1997), and the value is often expressed as percentage. As for the BA, the parameter was calculated based on equation from Husch *et al.* (1982) below:

$$\text{BA} = \frac{\pi D^2}{4} \ \text{cm}^2$$

where π = 3.1416
D = DBH (cm)

Importance value index (IV_i) was calculated to determine species importance. The IV_i was calculated by summing up the values of relative density (RD), relative dominance (based on BA) (RB) and relative frequency (RF) of each species or family ($IV_i = RD + RB + RF$) (Brower *et al.* 1997).

Patterns in tree species composition in relation to the measured edaphic variables were analyzed using canonical correspondence analysis (CCA) (Ter Braak & Prentice 1988; Ter Braak 1992), which were performed using CANOCO version 4.0 (Ter Braak & Šmilauer 1998). Species with only one entry in the data matrix was deleted to increase the definition of the results. CCA is a constrained direct ordination technique wherein an 'optimal' solution is obtained by arranging sites and species in multidimensional space, with the restriction that the ordination axes must be linear combinations of the specified underlying environmental variables. The CCA output includes a set of vectors that visually represent the strength and directionality of the relationship between the environmental variables and ordination axes. The parameters used in the analysis were species density and soil variables (pH; OM content; available P, K and Mg; nitrate-N ammonium-N; content of clay and silt). The significance of each edaphic variables in determining the species compositional changes was assessed through a Monte Carlo permutation test based on 99 random trials at a 0.05 significance level (Ter Braak 1990).

RESULTS AND DISCUSSION

General Characteristics of the Tree Communities

A total of 251 trees were enumerated in 18 subplots (0.18 ha) within the 2-ha permanent plot. Taxonomic composition of these enumerated trees comprised of 150 species from 83 genera and 39 families. The largest family based on the highest number of species was represented by Burseraceae and Euphorbiaceae where both of the families have a total of 15 species (Table 1). Table 1 also shows that the best represented genera are *Diospyros* and *Syzygium* with 8 species. *Macaranga lowii* (Euphorbiaceae) was the most frequent species with a frequency of 33%, whereby it occurred in 6 subplots out of 18 subplots; the species also showed the highest number of individuals with 9 stands found in all surveyed subplots (Table 2). The species *M. lowii* was reported by Turner (1995) as a species that commonly found in primary lowland forest throughout the country. Moreover, total BA of tree species over the 18 subplots was 35.50 m^2/ha of which *Knema furfuracea* (Myristicaceae) indicated the highest BA of 2.57 m^2/ha. Table 2 also shows the first 10 leading species based on IV_i, whereby *K. furfuracea* (Myristicaceae) was the most important species with IV_i of 3.96%, followed by *Garcinia pyrifera* (Guttiferae) and *Mallotus griffithianus* (Euphorbiaceae) with values of 3.38% and 2.84%, respectively. Out of the 18 subplots, the subplot J0 contains the highest species number, whereby from 18 stands (≥ 5 cm DBH) found in the subplot 17 species from 17 genera and 14 families were identified (Table 3). In general, mean floristic richness was 12 species per subplot and mean number of stands was 14 stands per subplot.

Table 1: Five leading families and genera based on number of species.

The largest families	The best represented genera
Burseraceae (n = 15)	*Diospyros* (n = 8)
Euphorbiaceae (n = 15)	*Syzygium* (n = 8)
Guttiferae (n = 11)	*Santiria* (n = 7)
Lauraceae (n = 9)	*Dacryodes* (n = 6)
Ebenaceae (n = 8)	*Calophyllum* (n = 5)
Myrtaceae (n = 8)	*Knema* (n = 5)

Table 2: IV_i of 10 leading species in 18 subplots at the National Park, Merapoh, Pahang.

Species	Family	No. of stand	BA (m^2/ha)	Frequency (%)	IV_i (%)
Knema furfuracea	Myristicaceae	6	2.57	28	3.96
Garcinia pyrifera	Guttiferae	6	1.96	28	3.38
Mallotus griffithianus	Euphorbiaceae	8	1.26	22	2.84
Macaranga lowii	Euphorbiaceae	9	0.33	33	2.40
Syzygium syzygoides	Myrtaceae	6	0.51	28	2.02
Aporusa confusa	Euphorbiaceae	1	1.84	6	2.01
Xanthophyllum affine	Polygalaceae	6	0.45	28	1.96
Diospyros maingayi	Ebenaceae	2	1.47	11	1.95
Durio griffithii	Bombacaceae	5	0.57	28	1.95
Dacryodes rostrata	Burseraceae	4	0.63	22	1.72

Table 3: Summary of total number of stands and number of plant taxa in 18 subplots at the National Park, Merapoh, Pahang.

Subplot	Number of stands	Number of species	Number of genera	Number of family
A0	13	12	12	9
A4	15	12	11	9
A9	5	5	4	3
E2	13	12	11	8
E4	14	14	13	11
E7	13	9	7	6
I5	16	15	13	11
I6	12	11	10	8
I7	12	12	10	8
J0	18	17	17	14
J4	15	14	11	9
J9	12	12	11	11
N2	20	16	16	14
N4	18	14	13	11
N7	14	13	10	6
T5	15	12	11	11
T6	12	11	11	9
T7	14	14	13	9
Mean	**14**	**12**	**11**	**9**

General Soil Characteristic

In general, soil samples taken from all 18 subplots demonstrated clay texture with high mean clay content of 60.09 ± 1.62% (Table 4). High clay content in the soil of the study plots indicates that the soil is at old age where weathering process changed the sand and silt content of soil to clay. Soil pH of the study plots showed low pH values with mean value of 3.53 ± 0.02. The acidic soil found in the area agrees with the statement by Othman and Shamshuddin (1982) who mentioned that most soils in tropical rain forests in Peninsular Malaysia were acidic with pH between 3.5 and 5.5. This common scenario in the wet tropical regions has resulted in soil becoming so weathered and leached (Lal & Greenland 1979); base cations are leached and being replaced by H^+ and Al^{3+} ions that caused the high acidity in the soil. OM content in the soil showed a low percentage with a mean of 5.83 ± 0.30%; the low content is perhaps due to the climate factor of tropical rain forest where the hot and wet climate increase the decomposition rate of organic residue in the soil (Longman & Jenik 1987). Nevertheless, from Table 5, it appears that OM content exhibited a significant negative correlation with soil pH ($r = –0.68$, $P = 0.008$). This is true as higher OM (humus, etc.) in the soil contributes to higher soil acidity due to the release of H^+ ions from humus colloids (humic acids) when water is mixed with the soil. Humic acids that are important sources of acidity are formed by the partial decomposition of soil OM.

Table 4: Summary of soil variables data at the National Park at Merapoh, Pahang.

Parameter	mean ± s.e.
pH	3.53 ± 0.02
OM content (%)	5.83 ± 0.30
Available Mg (μg g^{-1})	12.39 ± 0.28
Available P (μg g^{-1})	9.85 ± 0.95
Available K (μg g^{-1})	9.41 ± 1.10
Nitrate-N (μg g^{-1})	11.58 ± 0.98
Ammonium-N (μg g^{-1})	16.03 ± 2.33
Total inorganic-N (μg g^{-1})	27.61 ± 2.45
% clay	60.09 ± 1.62
% silt	33.09 ± 1.65

Available macronutrients, i.e. Mg and K were found in low concentration. It is apparent from Table 5 that Mg content is significantly positively correlated with the OM content ($r = 0.52$, $P = 0.018$). Available P indicated a content of 9.85 ± 0.95 μg g^{-1}, which was considered as medium concentration based on Acres *et al.* (1975) classification. Furthermore, P exhibited a negative correlation with soil pH ($r = –0.47$, $P = 0.031$) which indicates a higher solubility of P compounds under lower pH. The concentrations of soluble nutrients of nitrate-N and ammonium-N showed mean values of 11.58 ± 0.98 μg g^{-1} and

16.03 ± 2.33 µg g^{-1}, respectively; the latter showed a high standard error value reflecting a high variation of concentrations between the subplots. Total available inorganic-N (the sum of available nitrate and ammonium) was used for further analysis to look at relationships between the inorganic-N nutrients and the tree composition, using the ordination technique.

Table 5: Correlation matrix of soil variables measured in the National Park at Merapoh, Pahang.

	pH	OM	Mg	P	K	Inorganic-N	CEC	% clay
pH	1.0000							
OM	–0.6829**	1.0000						
Mg	–0.4246	0.5203*	1.0000					
P	–0.4740*	0.2418	0.3169	1.0000				
K	–0.0301	0.2303	0.5771	–0.0842	1.0000			
Inorganic-N	–0.0709	0.1075	–0.2450	–0.2442	–0.0210	1.0000		
CEC	–0.1842	0.4250	0.0171	0.0906	–0.0525	0.2523	1.0000	
% clay	0.0463	–0.0414	0.1545	0.2740	–0.2375	–0.0780	–0.1328	1.0000
% silt	–0.0177	–0.0066	–0.1310	–0.2612	0.2228	–0.0216	0.1216	–0.9785***

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$. CEC: cation exchange capacity.

Soil-vegetation Relationships

There were 108 species that are represented by only one individual from all 18 subplots, and this would make large number of species with one entry being entered in the data matrix. It was therefore decided that the species with only one entry in the data matrix would be deleted for the CCA (Baruch 2005). From the CCA, subplots were reasonably separated floristically in the ordination space of the first two canonical axes derived from the species-environment data set (Fig. 4). Direct ordination of CCA examines the similarity or dissimilarity of floristic composition of vegetation samples, whereby the distances between the points on the graph are taken as a measurement of their degree of similarity or difference. Points that are close together will represent subplots that are similar in species composition; the further apart any two points the more dissimilar or different the plots will be. For example, it is obvious that subplot A9 is isolated from other points in which the isolation of the subplot is due to having low species scores. The low scores indicate a low species richness of the subplot, whereby the subplot showed the least number of species found (5 species) compared to other subplots (Table 3).

The CCA output showed that the species-environment correlations were high, of which the eigenvalues (a measurement of the strength of an axis or the amount of variation along an axis) were 0.590 for the first axis and 0.583 for the second axis (Table 6). However, the Monte-Carlo permutation test indicates that there is no significant difference of the eigenvalues for the three ordination axes. The percentage variance of 'the species-environment relation' is given cumulatively from the CCA analysis, which can be obtained by a weighted regression (Ter Braak & Šmilauer 1998). The cumulative variation explained by the first three axes of the species-environment relationship in the CCA was 51.3% (Table 7). This indicates that probably other factors that were not measured in this study were also important in determining the floristic pattern of tree communities in all subplots. A thorough examination of the temporal changes in environmental factors may be needed to identify the source of the unexplained variation.

Table 6: Weighted correlation matrix for species axes, environmental axes, and environmental variables of tree species data at the National Park at Merapoh, Pahang.

	SPEC AX1	SPEC AX2	SPEC AX3	ENVI AX1	ENVI AX2	ENVI AX3
SPEC AX1	1.0000					
SPEC AX2	–0.0017	1.0000				
SPEC AX3	0.0165	0.0119	1.0000			
ENVI AX1	0.9839	0.0000	0.0000	1.0000		
ENVI AX2	0.0000	0.9831	0.0000	0.0000	1.0000	
ENVI AX3	0.0000	0.0000	0.9821	0.0000	0.0000	1.0000
pH	–0.8568	0.0545	0.2202	–0.8708	0.0555	0.2242
OM	0.4665	–0.3596	–0.1854	0.4741	–0.3658	–0.1888
Mg	0.1482	–0.5135	–0.2550	0.1506	–0.5223	–0.2597
P	0.4229	0.1064	0.0016	0.4298	0.1083	0.0017
K	–0.0816	–0.5336	0.4150	–0.0829	–0.5427	0.4226
Inorganic-N	0.1519	–0.5134	0.2761	0.1544	–0.5222	0.2811
CEC	0.3443	–0.4520	–0.1544	0.3499	–0.4598	–0.1572
% clay	–0.0689	–0.1434	–0.3738	–0.0700	–0.1459	–0.3806
% silt	0.0971	0.1906	0.3956	0.0987	0.1939	0.4029
Eigenvalues	0.590	0.583	0.424			

SPEC AX: Species Axis; ENVI AX: Environmental Axis.

Table 7: Summary of the CCA of the vegetation and environment data at the National Park, Merapoh, Pahang.

Axes	1	2	3	4	Total inertia
Eigenvalues	0.590	0.583	0.424	0.373	5.790
Species-environment correlations	0.984	0.983	0.982	0.965	
Cumulative percentage variance					
of species data	10.2	20.3	27.6	34.0	
of species-environment relation	18.9	37.6	51.3	63.2	
Sum of all unconstrained eigenvalues					5.790
Sum of all canonical eigenvalues					3.115

From Table 6, the soil pH, OM and P were highly correlated with the first CCA axis with coefficient values of -0.8568, 0.4665 and 0.4229, respectively. Furthermore, K, Mg and inorganic-N were correlated with the second CCA axis with the coefficient values of –0.5336, –0.5135 and –0.5134, respectively. Figure 4 illustrates the influence of the soil variables on canonical axes whereby vectors indicate not only the direction but also the magnitude of influence of each variable. Those edaphic factors that have long arrows are more closely correlated in the ordination than those with short arrows and are much more important in influencing community variation. The location of site scores relative to vectors indicates the environmental characteristics of the sites (Fig. 4) and the location of species scores relative to the vectors indicates the environmental preferences of each species (Fig. 5). For instance, Figure 4 illustrates that subplots A0 and E4 are strongly influenced by the soil pH while subplots T6 and E2 are strongly correlated with available P. However, most of the subplots do not show clear characteristics in relation to the soil variable vectors.

Further analysis to look at species preferences in relation to the environmental variables is illustrated in species-environment biplot of Figure 5. It is apparent that from Figure 5, species such as *Durio griffithii* and *Urophyllum glabrum* are strongly influenced by soil pH where P availability is low. Conversely, *Kayea ferrea* and *M. lowii* showed higher affinity to the available P. Moreover, species such as *D. rostrata*, and *Eurycoma longifolia* are closely correlated with Mg and inorganic-N vectors, while *G. pyrifera* seems closely related with the K vector. However, there are several species that do not show clear preferences to the soil variables.

The study demonstrates that there are associations of species with variation in soil characteristics, within an area that is homogenous in parent rock and elevational range. Similar study by Jose *et al.* (1996) supported this view whereby they reported that the vegetation of understory species and overstory species in their study plots were strongly associated with the soil characteristics, in particular the nutrient availability. However, Newbery *et al.* (1996) argued that in dipterocarp forest (and other rain forest types), topographic variation is a considerably more important determinant of local changes in forest composition than soil chemistry. At this scale, topography is likely to be close correlated with soil moisture availability. Many other studies have highlighted the significant effect of moisture availability in influencing the composition of vegetation community (Ter Steege *et al*. 1993; Becker *et al*. 1988). In addition, several studies that look on differences in species composition related to edaphic factors within a locality have been reported elsewhere such as in Borneo (Newbery *et al*. 1996), Peninsular Malaysia (Ashton 1976), Africa (Newbery *et al*. 1986) and Central America (Clark *et al*. 1998). It can be concluded that edaphic factors have

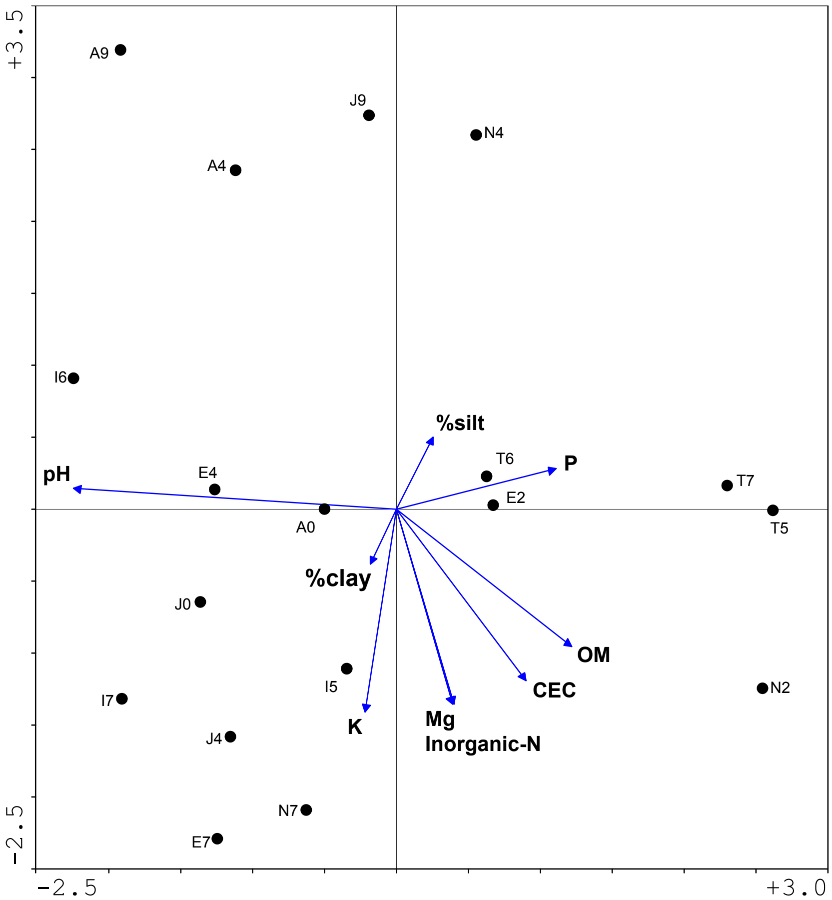

Figure 4: CCA ordination plot showing the approximate locations of sample plots; location, length and direction of edaphic variables. Length and direction of vectors indicate the strength and direction of gradients.

an important influence on distribution patterns of tree species at Merapoh study site. Understanding the relationships between ecological variables and distribution of plant communities is of great importance in conserving and managing the forest ecosystems; and in this sense, the results from this study increase our understanding on distribution patterns of tree species and related major environmental factors in the National Park at Merapoh site.

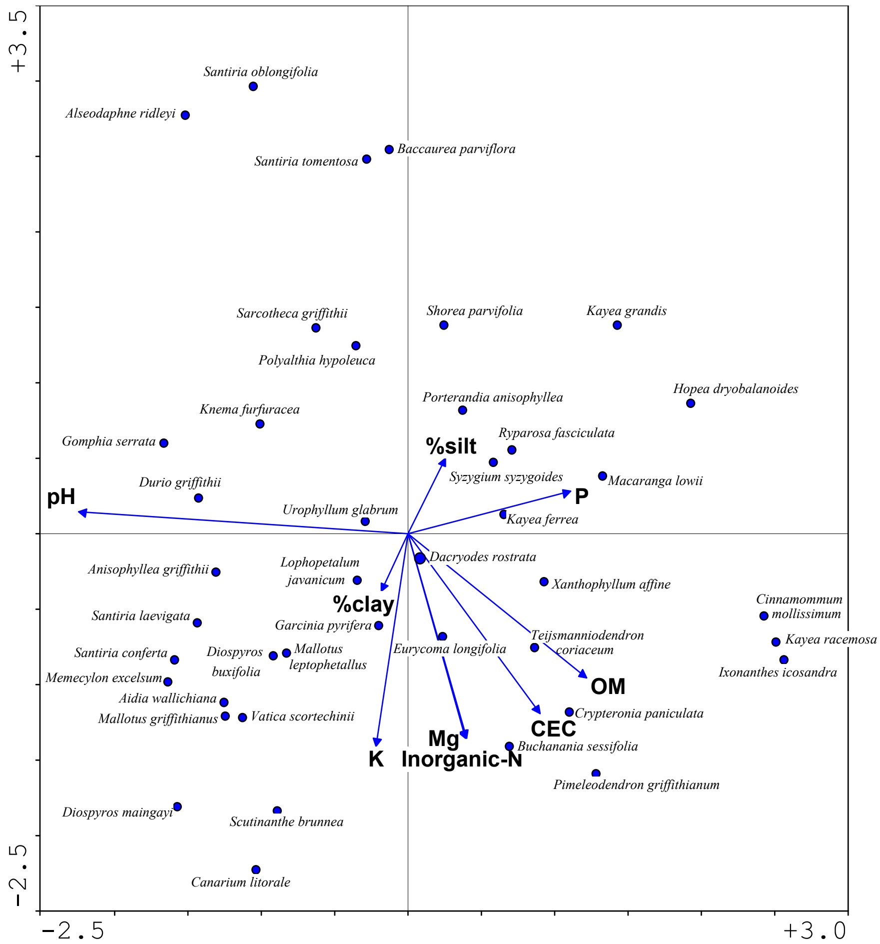

Figure 5: CCA biplot of species and soil variables showing the species occurrence in relation to the edaphic variables. Species with only one entry in the data matrix were deleted from the analysis.

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