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ASSOCIATION OF EDAPHIC FACTORS WITH HERBAL PLANTS ABUNDANCE AND DENSITY IN A RECREATIONAL FOREST, TERENGGANU, PENINSULAR MALAYSIA

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ABSTRACT

Terengganu is one of the states in East Coast Peninsula Malaysia that provides the natural habitat for the herbal plants and non-tree plants. The question of the relationship between herbal and non-tree plants, their abundance and relationship with edaphic factor is still unsolved. This study was conducted at Chemerong Recreational Forest, Dungun, Terengganu to determine the abundance and diversity of herbal and non-tree plants species, and its relationship with the physico-chemical soil properties. Two types of forest were chosen which are riparian forest and inland forest. Two plots with the sizes of 5m x 10 m were built in each forest types and which means the total of area sampling in this study was 200m^2. Result shows that a total of 885 individuals of herbal and non-tree plants were recorded from 68 species, 40 genera and 22 families. Riparian forest plot recorded 558 individuals from 55 species, 37 genera and 21 families while inland plot recorded 327 individuals from 36 species, 27 genera and 15 families. Significant difference was observed in soil physico-chemical properties, phosporus (P), electric conductivity (EC), nitrate (NO_3^-), ammonium nitrate ($NH_4NO_3^+$), moisture content and organic matter (OM) between these two forest types. Based on Cannonical Correspondance Analysis (CCA) there was a strong relationship between species abundance and edaphic factors in the study site. Results from this study could contribute to new information on conserving and preserving the herbal and non-tree plants as the natural green asset of Terengganu and Malaysia.

Key words: herbal plants, non-tree plants, edaphic factor, recreational forest, composition and abundance

ABSTRAK

Terengganu merupakan sebuah negeri di Pantai Timur Semenanjung Malaysia yang menyediakan habitat semulajadi bagi kepelbagaian spesies tumbuhan herba dan bukan pokok. Kajian mengenai kelimpahan dan taburan spesies herba dan bukan pokok serta hubungkaitnya dengan faktor edafik tanah telah dijalankan di hutan lipur terbesar di Terengganu iaitu Hutan Lipur Chemerong, Dungun. Sebanyak dua plot seluas 5 m x 20 m telah dibina di dua jenis hutan berbeza iaitu hutan riparian dan hutan pedalaman. Kesemua spesies herba dan bukan pokok yang terdapat di dalam plot dikenalpasti serta direkodkan bilangan individu dan spesies. Tiga replikasi sampel tanah telah dikutip daripada kedua-dua jenis hutan dengan menggunakan 'auger'. Keputusan menunjukkan sebanyak 885 individu daripada 68 spesies, 40 genus dan 22 famili spesies herba dan bukan pokok telah direkodkan di kedua-dua hutan tersebut. Hutan riparian mencatatkan nilai individu yang tertinggi sebanyak 558 individu, dari 55 spesies, 37 genera dan 21 famili manakala hutan pedalaman merekodkan 327 individu dari 36 species, 26 genera dan 15 famili. Terdapat perbezaan yang signifikan bagi phosporus (P), konduktiviti elektrik (EC), nitrat (NO_3^-), ammonium nitrat ($NH_4NO_3^+$) dan bahan organik tanah (OM) di antara dua jenis hutan. Di dalam kajian ini didapati hubungkait di antara kelimpahan spesies dengan faktor edafik adalah tinggi berdasarkan analisis Canonical Correspondance Analysis (CCA). Maklumat dari kajian ini dapat menyumbang kepada usaha memelihara dan memulihara spesies herba dan bukan pokok sebagai aset hijau untuk Terengganu dan Malaysia.

Kata kunci: Tumbuhan herba, tumbuhan bukan pokok, faktor edafik, kelimpahan dan komposisi spesies

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INTRODUCTION

Malaysia is among the richest country which had highly diverse of plants species in their rainforest. Malaysia has been classified as one of the 12th mega diversity countries of the world, known to support at least 60% of the world's known species (Latiff, 1994) and about 15,000 species of flowering medicinal plants (Faridah Hanum *et al.,* 2001a; Faridah Hanum *et al.,* 2001b). It has been indicated that of the 7,000 species of angiosperms and 600 species of ferns in Malaysia, about 1150 species are reported to have medicinal properties (Latiff, 1994; Hanum *et al.,* 2001a).Tropical forests are the habitat and the main source of medicinal plants, due to high levels of biodiversity and endemism (Norhajar *et al.*, 2010). Medicinal plants are the plants that contain ingredients that can be used for treatment or becoming drug synthesis precursor (Faridah-Hanum & Nurul Huda 1999; Sofowora, 1982). Medicinal plants have become the leading contributor to health to mankind since time immemorial (Setyawan, 2008; Sofowora, 1982).

Malaysia had an extensive of herbal and medicinal plants since few thousand years ago. Based on Burkill (1935), more than 1300 medicinal plant species have been recorded in Peninsular Malaysia alone. In the Malaysian medicine system, herbal products form an important component. The high value of herbal and medicinal plants was estimated to reach RM4.6 billion in the Malaysian Herbal product market with projected growth rate between 15% to 20% annually (Jamal *et al.,* 2006; Khatun *et al.,* 2011).

Research on diversity and composition of herbal plants had been one of the interesting researches to be done since the herbal plants had their own importance and potential value for human. There were several researches done regarding abundance and diversity of the herbal plants species in Malaysia. Norhajar *et al.* (2010) reported a total of 6,788 medicinal trees and non-trees represented by 231 species, 179 genera and 87 families were found at Tekai Tembeling Forest Reserve (TTFR). Abundance and diversity of medicinal plants are well covered in Malaysia (Hanum *et al.,* 2001; Norhajar *et al.,* 2010). The most dominant medicinal tree is *Cinnamomum porrectum* (Lauraceae) while *Lygodium circinnatum* (Schizaeaceae) is for non-tree species. According to Tuan Marina (2007), there was a high species richness, abundance and economic value of medicinal plants at Tranum Forest Reserved, Raub, Pahang. The most popular and high in demand of medicinal plants within this area were *Phyllagathis rotundifolia*, *Labisia pumila*, *Mapania cuspidata*, *Homalomena sagittifolia*, *Peliosanthes teta* and *Tacca integrifolia*. In 1999, Faridah Hanum recorded a total of 98 plant species from 83 genera and 53 families are found in Ayer Hitam Forest with 140 different uses in medicinal purposes and they were grouped into seven methods of application namely drink, eat, chew, poultice, rub, bath and shampoo. Among the plant families present, Zingiberaceae, Euphorbiaceae, Lauraceae, Leguminosae, Melastomataceae and Piperaceae comprised many species with purported medicinal values from their study site.

Soil plays as important roles to the vegetation since they provide nutrients and all elements needed for growth and development of vegetation. Elements such as P, Ca, Mg, K and N are among major nutrients which are important for plants growth (Landon 1991; Shamshuddin & Othman 1982). Research on the edaphic influences to the tree species distribution had been conducted by several researchers (Khairil *et al.,* 2011; Nizam *et al.,* 2007; John *et al.,* 2007; Paoli *et al.,* 2008). Khairil *et al.* (2014) found that several trees in Chini watershed were highly influenced by the soil organic matter contents, pH and cation exchange capacity (CEC). Based on John *et al.* (2007), soil influence almost 36-51% of the tree species distribution in diverse neotropical forest. Based on Paoli *et al.* (2008), soil nutrients play as an important factor which influences the spatial patterns of the aboveground biomass and emergent tree species density in Southwestern Borneo.

The State of Terengganu is still very much endowed with a rich and diverse biodiversity, especially in the riparian zone, lowland and hill dipterocarp forests, limestone hill forests in Taman Negara, fresh water swamp forests along the beach, peat swamp forests and mangrove swamp forests. The rich biological resources have great economic potentials in horticultural and medicinal plants which include various ecosystems; species of plants and animal are natural green asset for the state of Terengganu. All these resources are factors for future sustainable development of the state of Terengganu. It is a common knowledge that biodiversity has important economic, social, agricultural and biotechnological benefits for the local communities, not only for Malaysia but also for the whole tropical region countries (Latiff & Faridah Hanum, 2006). Among the vulnerable forest species are potential source of medicinal plants that may benefit everyone and the values of them could be derived from them either directly or indirectly (Norhajar *et al.,* 2010).

Chemerong Recreational Forest is located in Pasir Raja Forest Reserve in Dungun District. It covers an area of 300 hectares and is located about 30 km from Al-Muktafi Billah Shah town and 100 km from the capital city of Terengganu, Kuala Terengganu. The recreational forest was first developed in 1993 and was the largest recreational forest in Terengganu (Forestry Department of Malaysia, 2006; 2008).

Study on relationship between tree species abundance with physico-chemical of the soil was done by many previous researchers (Nizam *et al.,* 2006; Clark *et al.,* 2009; Alvarez, 2001; Khairil *et al.,* 2014). However, there was lack of research looking on the relationship between soil and the abundance of herbal and non-tree plants. Thus this study was carried out to determine the composition and distribution of herbal plants and non-tree plants and their relation with the physico-chemical of the soil in Chemerong Recreational Forest, Terengganu, Peninsular Malaysia.

METHODOLOGY

Study site

Total population in district of Dungun was 149,851 people. District of Dungun can be divided into 11 parts; Besul, Hulu Paka, Jengai, Jerangau, Kuala Abang, Kuala Dungun, Kuala Paka, Kumpal, Rasau, Sura and Pasir Raja (Jabatan Perhutanan Semenanjung Malaysia, 2008). Chemerong Recreational Forest was situated at Pasir Raja Forest Reserves, Dungun, Terengganu. Traveling distance to the Chemerong Recreational Forest from Al-Muktafibillah Shah city is 30 km, and from Kuala Terengganu city is 100 km (Jabatan Perhutanan Semenanjung Malaysia, 2006) (Figure 1). Chemerong Recreational Forest is the largest Permanent Recreational Forest in Terengganu. This forest was gazetted as a Permanent Forest Reserve in 1960 (Jabatan Perhutanan Semenanjung Malaysia, 2006) and it was controlled by Terengganu Department of Forestry under Recreational Forest Unit.

Plot Establishment

Two forest types were recognized in Chemerong recreational forests which are riparian forest; the forest beside the river and inland forest which is far from the river. The study plots were selected based on stratified sampling method. Two rectangular plots with size of 10 m x 5 m (50 m^2) were established in each riparian (04° 39.414'N, 103° 00.043'E & 04° 39.419'N, 103° 00.197'E) and inland forest (04° 39.423'N, 102° 59.989'E & 04° 39.4141'N, 102° 59.989'E) (Figure 2). Each plot then was divided into five subplots with the size of 5 m x 2 m.

Plants sampling

All herbal and non-tree plants in the plot were collected, counted and identified at UniSZA Herbarium (HUDM), Universiti Kebangsaan Malaysia Herbarium (UKMB) and by referring to other plant taxonomists. The identification also was made by referring to the Alston (1934), Burkill (1935), Edwards (1996), Jabatan Perhutanan Semenanjung Malaysia (2006) and Mat-Salleh & Latiff (2002). The density, important value index (IV_i), composition and diversity of the herbal plants were based on Magurran (1988) and Brower *et al.* (1997). The Sorenson's community similarity index was analyzed to measure the degree of species similarity between the two types of forest using the BIODAP software (Khairil *et al.,* 2011).

Soil sampling

Five soil samples were taken from each plot and total up to 20 samples at the depths of 0 to 15 cm and every sample taken was about 300 g in weight. The samples taken from the field were then air-dried in the lab. The roots, small stones and leaves were separated from the soil. Samples were then sieved through a 2 mm sieve while lump soils were crushed using agate tools. These samples were analyzed for their physico-chemical characteristics, which were soil particle size distribution, organic matter content, exchangeable acid cation Aluminium (Al^+) and Hydrogen (H^+), exchangeable basic cation, cation exchange capacity (CEC) and electrical conductivity. Available nutrients of Phosporus (P), Magnesium (Mg) and Potassium (K) were also determined. Organic matter content was determined by the loss on ignition technique (Black, 1968). The pH of the soil was determined using a soil: water ratio of 1:2.5 (Rowell 1994; Shamshuddin, 1981). The exchangeable acidic cations (Al^+ and H^+) were measured in 1.0 M KCl extract by titration. Exchangeable basic cations of Magnesium (Mg) and Potassium (K) were measured in 1.0 M ammonium acetate extract (Black, 1968; Shamshuddin, 1981) by Atomic Absorption Spectrophotometry. Cation exchange capacity was obtained by summation of acid and basic cations. Electrical conductivity was determined using saturated gypsum extract (Rowell, 1994). Available nutrients of Phosporus (P), Ammonium Nitrate ($NH_4^+NO_3^-$), available Mg and K were extracted using sulphuric acid and determined using a Flame Atomic Absorption Spectrophotometer (FAAS) (Rowell, 1994).

Statistical Analysis

T-test was conducted to compare the mean of the soil parameter of two forest types. The normality test and T-test were conducted by using the MINITAB 16 software. Patterns in herbs species distribution in relation to edaphic variables measurement were analyzed by using canonical correspondence analysis (CCA) (McCune & Grace, 2002; Baruch, 2005). The software of CANOCO version 5.0 was used to carry out the CCA. The occurrences of the species with less than 3 within

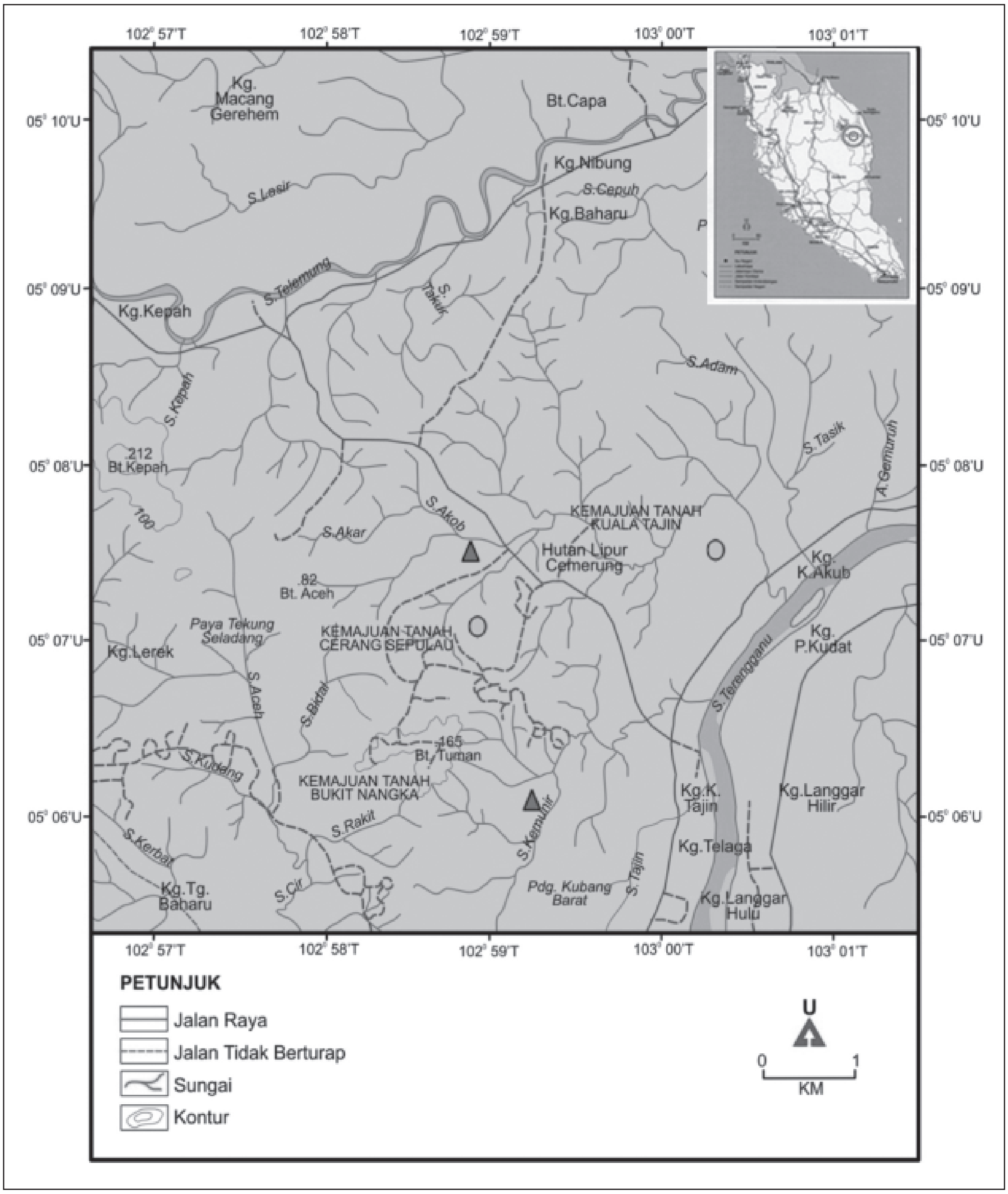

Fig. 1. The location of research plots in two forest types in Chemerong Recreational Forest, Dungun, Terengganu.
Notes: ▲ = riparian plot; ● = inland plot; ◎ = Site study location.

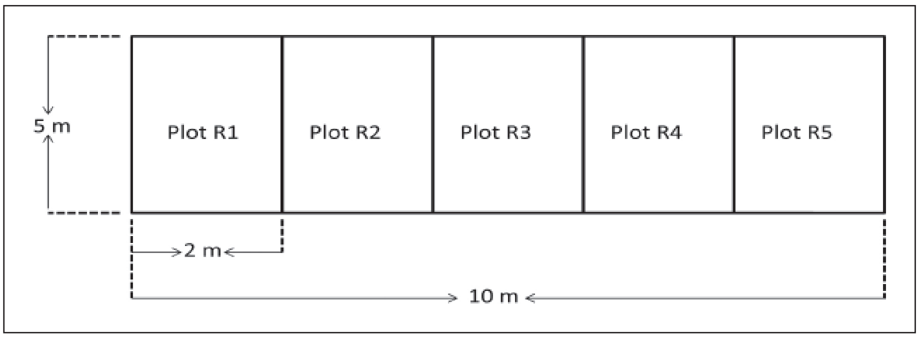

Fig. 2. Layout of the study plot.

the subplots were eliminated to ease the CCA analysis (Baruch, 2005). The CCA method was used to illustrate the relationships between the two set of factors (soil and plants).

RESULTS AND DISCUSSION

Herbal plants composition

A total of 885 individual of herbal plants recorded in both forest types in Chemerong Forest Reserve including 68 species, 40 genera and 22 families. Riparian forest plot recorded 558 individuals from 55 species, 37 genera and 21 families while inland plot recorded 327 individuals from 36 species, 27 genera and 15 families (Table 1). It is clear that species composition and individual abundance of herbals plants were higher in riparian forest than inland forest at Chemerong Forest Reserve.

Species abundance

Based on the density of species level, *Globba patens* (Zingiberaceae) had the highest density at the riparian forest with 520 individuals individuals (ind)/ hectare (ha) (9.32%) followed by *Selaginella velutina* (Selaginellaceae) with 360 ind/ha (6.45%) and *Cyathea latebrosa* (Cyatheaceae) with 310 ind/ha. At inland forest, *Scaphochlamys tenuis* (Zingiberaceae) has the highest density with 510 ind/ha, followed by *Elettariopsis curtisii* (Zingiberaceae) with 34 ind/ha and *Mapania cuspidata* (Cyperaceae) with 320 ind/ ha (9.79%) (Table 2).

Importance Value Index (*IVi*)

Important value (IV_i) of species is a measure of species dominance and family in a community of organisms (Brower *et al.,* 1997). Results from studies conducted in riparian forests showed, *Globba patens* had the highest value (IV_i) of 7.31%, followed by *Zingiber puberulum* with 6.01% and *Selaginella velutina* with 4.74%. In inland forest, *Scaphochlamys tenuis* had the highest IV_i with 12.17%, followed by *Elettariopsis curtisii* with 9.57% and *Mapania cuspidata* with 9.27%.

A species with IV_i of more than 10% can be considered as the dominant species in a particular community (Brower, 1997). Based on the results, only *Scaphochlamys tenuis* had IV_i more than 10%, indicating that it is the most dominant species at inland forest. There was no dominant species recorded in riparian forest since the IV_i of the species were less than 10% (Table 3).

Species diversity and similarity Indices

Shannon Diversity Index calculated for riparian forest is 4.01, higher than inland forest with H' of 3.58. The values obtained showed the diversity of species in riparian forests was higher than inland

Table 1. Taxonomic composition of herbal species in two forest types in Chemerong Recreational Forest, Terengganu

Number	Family	Inland			Riparian		
		Genera	Species	Ind	Genera	Species	Ind
1	Adiantaceae	nil	nil	nil	1	1	3
2	Araceae	3	5	30	7	11	65
3	Arecaceae	1	2	18	nil	nil	nil
4	Commelinaceae	1	1	4	1	1	9
5	Cyatheaceae	1	1	32	1	2	46
6	Cyperaceae	1	1	1	1	1	20
7	Dioscoreaceae	nil	nil	nil	1	1	9
8	Dracaenaceae	1	1	2	1	2	9
9	Gesneriaceae	nil	nil	nil	1	2	31
10	Hanguanaceae	nil	nil	nil	1	1	8
11	Hypoxidaceae	1	1	3	1	1	2
12	Marantaceae	2	2	10	1	1	8
13	Myrsinaceae	1	1	2	1	1	4
14	Ochnaceae	5	9	71	1	1	7
15	Palmae	2	2	22	5	8	43
16	Pandanaceae	nil	nil	nil	1	1	12
17	Pentaphragmataceae	1	2	6	1	1	2
18	Piperaceae	2	2	31	1	2	30
19	Rubiaceae	1	1	1	3	4	49
20	Selaginellaceae	nil	nil	nil	1	4	71
21	Vitaceae	nil	nil	nil	1	1	1
22	Zingiberaceae	4	5	94	5	8	129
	Total	27	36	327	37	55	558

Table 2. Density of the five most dense herbal species in riparian and inland forest of Chemerong Recreational Forest, Terengganu

Types of forest	Species	Family	Individual/ha	%
Riparian forest (N=558)	*Globba patens*	Zingiberaceae	520	9.32
	Selaginella velutina	Selaginellaceae	360	6.45
	Cyathea latebrosa	Cyatheaceae	310	5.56
	Zingiber puberulum	Zingiberaceae	290	5.20
	Didymocarpus corneri	Gesneriaceae	290	5.20
Inland forest (N=327)	*Scaphochlamys tenuis*	Zingiberaceae	510	15.60
	Elettariopsis curtisii	Zingiberaceae	340	10.40
	Mapania cuspidata	Cyperaceae	320	9.79
	Iguanura humilis	Palmae	290	8.87
	Argostemma longistipulum	Rubiaceae	260	7.95

Table 3. The highest importance value (IV_i) of five species in riparian and inland forest at Chemerong Recreational Forest, Dungun, Terengganu

Types of forest	Species	Families	IV_i(%)
Riparian forest	*Globba patens*	Zingiberaceae	7.31
	Zingiber puberulum	Zingiberaceae	6.01
	Selaginella velutina	Selaginellaceae	4.74
	Psychotria obovata	Rubiaceae	4.69
	Piper stylosum	Piperaceae	4.33
Inland forest	*Scaphochlamys tenuis*	Zingiberaceae	12.17
	Elettariopsis curtisii	Zingiberaceae	9.57
	Mapania cuspidata	Cyperaceae	9.27
	Iguanura humilis	Palmae	8.18
	Pinanga cleistantha	Palmae	5.88

Table 5. Soil physico-chemical mean ± SE parameters recorded in two forest types in Chemerong Recreational Forest, Terengganu

Soil content	Riparian forest	Inland forest	P value
pH	4.04 ± 0.2	3.90 ± 0.2	0.188
Available P (µg/g)	2.91 ± 1.1	1.59 ± 0.3	0.002***
Available K (µg/g)	100.95 ± 35.1	121.25 ± 12.4	0.626
Available Mg (µg/g)	26.46 ± 11.1	32.31 ± 3.1	0.587
Electric conductivity (mS/cm)	1.92 ± 0.2	2.30 ± 0.3	0.017*
Ammonium nitrate ($NH_4NO_3^+$) (µg/g)	5.55 ± 2.3	12.41 ± 2.8	0.000***
Nitrate (NO_3^-) (µg/g)	6.85 ± 5.3	17.15 ± 4.4	0.000***
CEC (meq/100g)	7.98 ± 0.9	8.12 ± 0.6	0.673
Cation acid (meq/100g)	3.93 ± 0.8	3.75 ± 0.6	0.575
Cation base (meq/100g)	4.05 ± 0.3	4.37 ± 0.6	0.111
Moisture content (%)	5.27 ± 4.3	8.91 ± 2.1	0.027*
Organic matter (OM) (%)	4.84 ± 1.3	7.77 ± 1.5	0.000***

Notes: *p<0.05, **p<0.005, ***p<0.001 (T-Test) CEC = Cation exchange capacity

forests. Usually, this index only gives value at 1.5 to 3.5 and rarely reaches 4.5 (Magurran, 1988). Based on the obtained value of the index shows the plot of the two communities of herbal plants had a low similarity value of 0.4, indicating only 40% of the herbal plants occurring at forest types.

Soil characteristics

Soils from both forest types were acidic with pH less than 5 (Table 5). Based on Othman and Shamshuddin (1982), most of the soil in tropical forest area in Malaysia was acidic with pH less than 6 and most of the previous research in Malaysia such as Nizam *et al.* (2006); Adzmi *et al.* (2010); Khairil *et al.* (2014a; 2014b); Paoli *et al.* (2008) found that most of the pH was between 4-6. Riparian forest soil has a higher mean value of available phosphorus compared to inland forest. The mean of available K, Mg, organic matter (OM) and moisture content recorded in soil of inland forest were slightly higher than riparian forest (Table 5).

This result was similar to Khairil *et al.* (2014a; 2014b) where they found the OM in inland forest was higher than in the seasonal flood and riverine forest. There are significant differences in available phosphorus (P) ($p<0.01$), electric conductivity (EC) ($p<0.05$), nitrate (NO_3^-) ($p< 0.001$), ammonium nitrate ($NH_4^+NO_3^-$) ($p<0.001$), moisture content ($p<0.05$) and organic matter (OM) ($p<0.001$) between the two types of forest (Table 5). Throughout, the correlation between the chemical content of soil in this study was moderate. Available Mg, for instance, had a positive correlation with the available K ($p<0.001$) (Table 6). This indicated the soil content which had high available K and Mg available. There were also positive correlations between clay and available P ($p<0.001$), silt with OM ($p<0.01$), but negative correlation between clay with silt ($p<0.05$), clay with OM ($p<0.01$) and silt with sand ($p<0.05$) (Table 6). Soil with high percentage of clay will have less percentage of silt and OM.

Soil-plant relationship

A total of 34 species of herbal plants were selected for the Canonical Correspondence Analysis (CCA) (Table 7). The selection of the plants species was based on their occurrence within the subplots where the occurrences which less than three were eliminated to ease the CCA. Direct ordination of CCA examines the strength of floristic abundance with edaphic factors (Nizam *et al.,* 2006; *Khairil et al.,* 2014). Species-environment correlation can be considered high as indicated by eigenvalues which is 0.72 for the first axes and 0.59 for the second axes. The eigenvalues is a measurement of the strength of an axis or the amount of variation along an axis. The strength for axis 1 and axis 2 are 72% and 59%, respectively. However based on the Monte-Carlo permutation test, there is no significant difference of the eigenvalues for the three ordination axes ($p>0.05$).

The percentage variance of the species-environment relation given cumulatively from the CCA, which can be obtained by weighted regression (Nizam *et al.*, 2006; Khairil *et al.,* 2014). The first and second axes showed the species-environment variance were 52.3% and 88.1%, respectively. This results indicated that the physico-chemical of soil were highly affected the herbal plants abundance at this area. Further analysis to look at species preferences in relation to environmental variables is illustrated in the species-environment biplot in Figure 3. It is apparent that a few herbal species were strongly influenced by soil parameters, for instance by soil pH, EC, air dry moisture, available Mg, K, P, base cation, OM and $NH_4^+NO3^-$. The list of species that highly influenced by the edaphic factors is shown in Table 9. Besides soil, other elements such as topography, soil water content, and forest gap

Table 6. Matrix correlation of soil attributes in Chemerong Recreational Forest, Terengganu

	pH	OM	CEC	Mg	K	P	% Clay	% Silt
OM	-0.442 0.051							
CEC	-0.221 0.348	0.164 0.490						
Mg	-0.002 0.995	-0.093 0.697	-0.034 0.887					
K	0.005 0.985	-0.081 0.736	-0.080 0.736	0.986*** 0.000				
P	0.386 0.093	-0.465 0.039	-0.166 0.484	-0.136 0.567	-0.087 0.717			
% Clay	0.379 0.099	-0.565** 0.009	0.019 0.936	-0.230 0.329	-0.211 0.373	0.707*** 0.000		
% Silt	-0.0023 0.924	0.574** 0.008	0.045 0.849	0.128 0.591	0.123 0.605	-0.369 0.110	-0.469* 0.037	
% Sand	-0.344 0.138	0.001 0.998	-0.046 0.848	0.093 0.697	0.079 0.740	-0.342 0.140	-0.528 0.017	-0.501* 0.024

Note: *p<0.05, **p<0.01, ***p<0.001
OM = organic matter content; CEC = Cation exchange capacity

Table 7. The list of 34 herbal species in Canonical Correspondence Analysis (CCA) at Chemerong Recreational Forest, Terengganu

Species code	Species	Species code	Species
1	*Acranthera didymocarpa*	18	*Cyrtandra pendula*
2	*Aglaonema griffithii*	19	*Daemonorops micracantha*
3	*Aglaonema nitidum*	20	*Daemonorops verticillaris*
4	*Aglaonema simplex*	21	*Didymocarpus corneri*
5	*Alpinia corneri*	22	*Didymocarpus crinitus*
6	*Alpinia javanica*	23	*Donax grandis*
7	*Amischotolype griffithii*	24	*Dracaena elliptica*
8	*Ampelocissus cinnamomea*	25	*Dracaena umbratica*
9	*Anadendrum montanum*	26	*Elettariopsis curtisii*
10	*Ardisia metallica*	27	*Freycinetia javanica*
11	*Arenga hastata*	28	*Globba patens*
12	*Argostemma longistipulum*	29	*Globba pendula*
13	*Calamus castaneus*	30	*Globba unifolia*
14	*Calamus densiflorus*	31	*Hanguana malayana*
15	*Calamus luridus*	32	*Homalomena kiahii*
16	*Cyathea latebrosa*	33	*Homalomena propinqua*
17	*Cyathea moluccana*	34	*Iguanura humilis*

Table 8. Summary of the Canonical Correspondence Analysis (CCA) of the vegetation and environmental data at Chemerong Recreational Forest, Terengganu

Axes	1	2	3	4	Total inertia
Eigenvalues:	0.72	0.59	0.46	0.26	2.03
Species-environment correlations:	91.0	88.0	93.0	1.000	
Cumulative percentage variance					
of species data:	52.3	88.1	100.0	0.0	
of species-environment variance:	52.3	88.1	100.0	0.0	
Sum of all *eigenvalues:*					2.03
Sum of all canonical *eigenvalues:*					2.03

Table 9. The list of herbal and non-tree plants species which were influenced by the soil parameters

Soil parameter	Species code	Species
OM	28, 29	*Globba patens* Miq. var. *costulata* S.N. Lim, *Globba pendula* Roxb.
Moist	29	*Globba pendula* Roxb.
pH	21, 24, 32	*Didymocarpus crinitus* Jack var. *crinitus* Kunth *Dracaena elliptica* Thunb. *Homalomena kiahii* Furtado
Available P	2, 25	*Aglaonema nitidum* (Jack) Kunth, *Dracaena umbratica* Ridl.
Availabe Mg	7, 8, 22	*Amischotolype griffithii* (C.B. Clarke) I.M. Turner, *Ampelocissus cinnamomea* (Wall.) Planch. *Didymocarpus crinitus* Jack var. *crinitus*
Availabe K	7, 8, 22	*Amischotolype griffithii* (C.B. Clarke) I.M. Turner, *Ampelocissus cinnamomea* (Wall.) Planch. *Didymocarpus crinitus* Jack var. *crinitus*
Cation base	15	*Calamus luridus* Becc.
Ammonium Nitrate	29	*Globba pendula* Roxb.
EC	7, 8	*Amischotolype griffithii* (C.B. Clarke) I.M. Turner, *Ampelocissus cinnamomea* (Wall.) Planch.

Notes: OM = Organic matter, EC = Electric conductivity

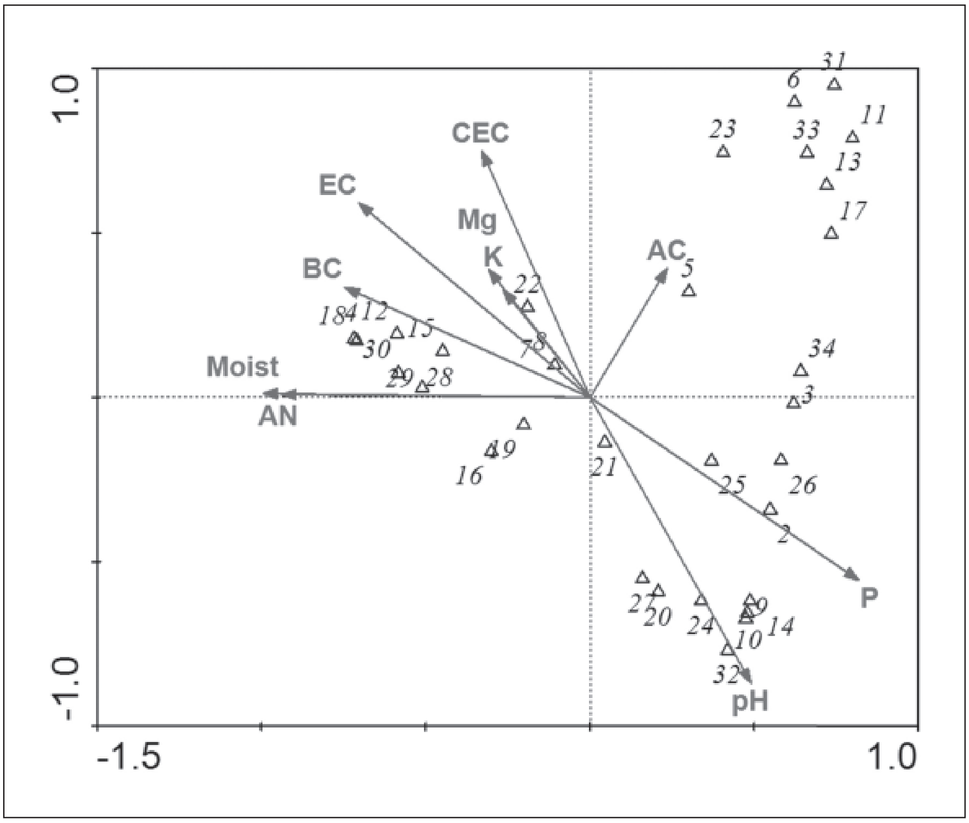

Fig. 3. Canonical Correspondence Analysis (CCA) bi-plot for the species and variables of soil which show the relationship of herbs species with edaphic factor.
(Notes: AC = Acidic Cation; AN = Ammonium Nitrate; CEC = Cation Exchange Capacity; BC = Bases Cation; EC = Electrical conductivity).

should be taken into consideration in order to see the pattern of distribution of herbal plants in this area. Based on Whitmore, 1990; Itoh *et al.,* 1995; John *et al.*, 2007 besides the physico-chemical of soil, topography is also one of the important factor influenced the distribution of several tropical plants species.

CONCLUSIONS

Edaphic factor plays as an important role in controlling the species abundance in the particular area. This study shows that the abundance of the herbal plant species is highly influenced by the physico-chemical of the soil. Since many herbal plants were beneficial to the society in terms of their medicinal purposes, this study brought a new knowledge in highlighting the relationship between herbal plants with physico-chemical of the soil. A thorough study should be taken in the glasshouse to see the influences of each soil parameters to the growth and development of the herbal plants. As a one of the permanent reserve forest, Chemerong Recreational Forest deserves attention from the state government to preserve this area and other reserve forests to ensure the natural green asset and other biotas in the state will still remain.

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