UNIVERSITI PUTRA MALAYSIA

VEGETATION AND SELECTED ENVIRONMENTAL FACTORS OF BUKIT CHARAS LIMESTONE

SOH WUU KUANG

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By

SOH WUU KUANG

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TO MOM AND DAD WITH LOVE

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

VEGETATION AND SELECTED ENVIRONMENTAL FACTORS OF BUKIT CHARAS LIMESTONE

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SOH WUU KUANG

November 2002

Chairperson: **Rusea Go, Ph.D.**

Faculty: **Science and Environmental Studies**

The Limestone flora of Peninsular Malaysia is exceptionally rich in diversity and endemism but is under extreme threat. Moreover, the ecology of limestone plants is little understood. Bukit Charas stands out as one of the last sanctuaries for the flora of the Panching Limestone Formation. Therefore a floristic and ecological study were undertaken to document and conserve the hill. The flora in this study stood at 249 species in 175 genera and 82 families. The largest family is the Euphorbiaceae (19) followed by the Rubiaceae (18), Araceae (13), Annonaceae (10) and Lauraceae (7). Six rare species; (*Suregada multiflora* var *lamellata*, *Ardisia suffruticosa*, *Tectaria cherasica*, *Emarhendia bettiana, Monophyllaea hendersonii* and *Polyalthia* sp.) are recognised from Bukit Charas. Cluster analysis has identified four types of vegetation groups at the base of the hill (BASE), at the slope of the hill (SLOPE), at the talus slope (TALUS) and at the cave (CAVE). Plants, characteristic to the limestone habitat are found in the TALUS and CAVE groups. Twelve environmental variables have been used for ordination. Unrotated principal component analysis has reduced these variables to two components, i.e. calcium and magnesium; and kalium and carbonate. Two primary environmental gradients were identified with

the Varimax-rotated principal component analysis of environmental data: topographic situation and soil fertility. The TALUS and CAVE groups were significantly associated with high level of soil exchangeable calcium and magnesium. The TALUS group is also associated with high organic matter and the CAVE group with high carbonate content. The results of the species and quadrat ordination of the detrended correspondence analysis were similar to the principal component analysis. Three hypotheses are proposed: Firstly, the plant endemism in limestone habitat is greatly driven by edaphic factor and not by the need to avoid competition. Secondly, the high level of exchangeable calcium and magnesium, and high soil pH in the limestone soil act as important limiting factors for limestone endemics. These conditions are important requirements for limestone habitats. Thirdly, there exist limiting factors within a limestone habitat that create a niche partition among the limestone endemic species. The current threat to Bukit Charas flora is agricultural activities at the surrounding base of the hill. A buffer zone that stretched 50 m from the forest margin is proposed as a strategy to conserve Bukit Charas. Future study should be expanded to other hills for comparison and green house experiment should be undertaken to test the hypotheses.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

VEGETASI DAN FAKTOR ALAM PERSEKITARAN TERPILIH BATU KAPUR BUKIT CHARAS

Oleh

SOH WUU KUANG

November 2002

Pengerusi: Rusea Go, Ph.D.

Fakulti: Sains and Pengajian Alam Sekitar

Flora batu kapur di Semenanjung Malaysia adalah kaya dengan diversiti and tumbuhan endemik, walaubagaimanapun ia sedang diancam kepupusan. Tambahan pula pengetahuan kita tentang ekologi flora batu kapur adalah cetek. Bukit Charas adalah salah satunya kawasan perlindungan terakhir bagi flora batu kapur Panching. Oleh itu, satu kajian flora dan ekologi untuk mendokumentasi dan memulihara Bukit Charas telah dijalankan. Jumlah flora dalam kajian ini adalah sebanyak 249 spesies, 175 genera and 82 famili. Famili terbesar adalah Euphorbiaceae (19), ini diikuti oleh Rubiaceae (18), Araceae (13), Annonaceae (10) dan Lauraceae (7). Sebanyak enam spesies di Bukit Charas adalah nadir (*Suregada multiflora* var *lamellata*, *Ardisia suffruticosa*, *Tectaria cherasica*, *Emarhendia bettiana, Monophyllaea hendersonii* dan *Polyalthia* sp.). Analisis kluster telah mengenal pasti empat jenis kumpulan vegetasi, iaitu vegetasi di dasar bukit (BASE), lereng bukit (SLOPE), lereng batu-batuan (TALUS) and gua (CAVE). Tumbuhan yang mencirikan habitat batu kapur didapati di dalam kumpulan TALUS dan CAVE. Sebanyak dua belas faktor persekitaran telah digunakan untuk ordinasi. Analisis komponen prinsipal 'Unrotated' telah mengurangkan faktor-faktor ini

kepada dua komponen, iaitu kalsium dan magnesium; dan potasium dan karbonat. Dua kecerunan persekitaran telah dikenalpasti melalui analisis komponen prinsipal 'Varimax-rotated': keadaan topografi dan kesuburan tanah. Kumpulan TALUS dan CAVE berkait rapat dengan kandungan kalsium and magnesium tanah yang tinggi. Kumpulan TALUS berkait rapat dengan kandungan organik tanah yang tinggi manakala, kumpulan CAVE berkait rapat dengan kandungan karbonat yang tinggi. Keputusan ordinasi spesies dan kuadrat 'detrended correspondance analysis' adalah sama dengan keputusan analisis komponen prinsipal. Tiga hipotesis telah dicadangkan: Pertama, taburan tumbuhan yang endemik kepada habitat batu kapur adalah dipengaruhi oleh faktor edafik dan bukan oleh faktor untuk mengelak daripada persaingan. Kedua, kandungan kalsium and magnesium, dan pH yang tinggi adalah ciri penting yang menghadkan taburan tumbuhan endemik kepada habitat batu kapur. Ketiga, di dalam habitat batu kapur itu sendiri, terdapat faktor penghad yang mewujudkan pemisahan 'niche' di kalangan tumbuhan endemik batu kapur. Ancaman utama Bukit Charas kini adalah daripada aktiviti pertanian yang dijalankan di dasar bukit. Oleh itu, satu saranan untuk mewujudkan satu zon mampan sejauh 50 m dari gigi hutan dicadangkan sebagai strategi untuk pemuliharaan Bukit Charas. Pada masa yang akan datang, kajian yang melibatkan bukit batu kapur lain dicadangkan supaya dapat dibuat perbandingan and selain daripada itu, eksperimen rumah hijau juga patut dibuat untuk mengesahkan hipotesis yang dibuat.

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I certify that an Examination Committee met on 11th November 2002 to conduct the final examination of Soh Wuu Kuang on his Master of Science thesis entitled "Vegetation and Selected Environmental Factors of Bukit Charas Limestone" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Univeristi Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Umi Kalsom Yusuf, Ph.D.
Associate Professor
Department of Biology
Faculty of Science and Environmental Studies,
Univeristi Putra Malaysia
(Chairperson)

Rusea Go, Ph.D.
Department of Biology
Faculty of Science and Environmental Studies,
Univeristi Putra Malaysia
(Member)

Japar Sidik Bujang, Ph.D.
Associate Professor,
Department of Biology
Faculty of Science and Environmental Studies,
Univeristi Putra Malaysia
(Member)

Saberi Othman, Ph.D.
Associate Professor,
Department of Biology
Faculty of Science and Environmental Studies,
Univeristi Putra Malaysia
(Member)

SHAMSHER MOHAMAD RAMADILI, Ph.D.
Professor / Deputy Dean,
School of Graduate Studies,
Universiti Putra Malaysia

Date: 25 NOV 2002

This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

Rusea Go, Ph.D.
Department of Biology
Faculty of Science and Environmental Studies,
Univeristi Putra Malaysia
(Chairperson)

Japar Sidik Bujang, Ph.D.
Associate Professor,
Department of Biology
Faculty of Science and Environmental Studies,
Univeristi Putra Malaysia
(Member)

Saberi Othman, Ph.D.
Associate Professor,
Department of Biology
Faculty of Science and Environmental Studies,
Univeristi Putra Malaysia
(Member)

AINI IDERIS, Ph.D.
Professor / Dean,
School of Graduate Studies,
Universiti Putra Malaysia.

Date: 9 JAN 2003

DECLARATION

I hereby declare that the thesis is based on my original work except for equations and citations which have been duly acknowledge. I also declare that it has not been previously or concurrently submitted for any other degrees at UPM or other institutions.

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(SOH WUU KUANG)

Date:

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LIST OF ABBREVIATIONS

DCA Detrended correspondence analysis

G.P.S. Global Positioning System

KEP The herbarium of the Forest Research Institute Malaysia

KLU The herbarium of Rimba Ilmu

PCA Principal component analysis

Species acronyms:

Agl *Agloanema simplex*

Alo *Alocasia denudata*

Ami *Amischotolype monosperma*

Amo *Amorphaphallus prainii*

Ana *Anadendrum montanum*

Ard *Ardisia suffruticosa*

Ari *Arisaema laminatum*

Beg *Begonia ignorata*

Chl *Chloranthus erectus*

Cyt *Cyrtandra pendula*

Dio *Dioscorea* sp.

Dra *Draceana pendula*

Ela *Elatostema subscabrum*

Ema *Emarhendia bettiana*

Epi *Epithema saxatile*

Ery *Erythrospermum candidum*

Gym *Gymnostachyum decurrens*

Imp *Impatiens albo-flava*

Mon *Monophyllaea hendersonii*

Myx *Myxopyrum nervosum*

Pas *Passiflora* sp.

Peli *Peliosanthes teta*

Phy *Phryhium pubinerve*

Pil *Pilea fruticosa*

Rap *Rhaphidophora maingayi*

Rin *Rinorea honeri*

Sch *Schismatoglottis calyptrata*

Tyl *Tylophora* sp

Ven *Ventilago oblongifolia*

1 Sapling 1

4 Sapling 4

5 Sapling 5

6 Sapling 6

10 Sapling 10

Adi *Adiantum latifolium*

Nid *Asplenium nidus*

Pel *Asplenium pellucidum*

Bol *Bolbitis sinuate*

Het *Heterogonium pinnatum*

Lgy *Lygodium salicifolium*

Nep *Nephrolepis falcata*

Phy *Phymatosorus nigrescens*

Del *Selaginella delicatula*

Min *Selaginella minutifolia*

Kec *Tectaria keckii*

CHAPTER 1

INTRODUCTION

Limestone flora of Peninsular Malaysia is a vegetation type that is exceptionally rich in diversity and endemism, while being under extreme threat. In this situation, it is often only practical or possible to conserve part of the target area. Usually detailed information on individual species may be lacking but botanists are often confident that those areas are rich in diversity (Given, 1994).

To date, studies on the limestone flora in Peninsular Malaysia has been in three major categories. They are the floristics, the ecology, and the conservation of limestone flora.

In the early days the emphasis was on the documentation of the general flora. The first comprehensive study on the limestone flora of the Peninsular Malaysia was undertaken by Henderson (1939). The account on the limestone flora is based entirely on vast botanical collections and observations on plants growing on limestone derived soil. The limestone hills in Peninsular Malaysia were classified into two broad groups, 'dry hills' and 'wet hills', and a brief description on the microhabitat of limestone flora was given. The plants collected from limestone hills were also enumerated with a total of 745 species recorded (Henderson, 1939).

The same attempt was made by Anderson (1965) to describe and record the limestone flora of Sarawak based on field observation. However, the study was a preliminary one and still awaits detailed investigation. Over 600 species of plant growing on limestone hill have been recorded in this study. The vegetation of Sarawak's limestone hills has been classified into eight broad subdivisions and the microhabitats of limestone flora were generally described. It is interesting to note that for the first time, the calcifuge and calcicole habitats of plants in relation to the soil properties was mentioned and discussed briefly, however, many of the findings were mere speculations.

The floristic study of limestone flora in Peninsular Malaysia has been amplified by Chin's work (Chin, 1977, 1979, 1983a, 1983b), which provided a revision of Henderson's account. As a result, a regional floristic key was constructed and 1216 species of vascular plants was enumerated and grouped into four degree of affinity towards limestone habitat. Chin (1977) subdivided the Peninsular Malaysia limestone habitat into nine groups and described the flora in each distinct habitat. Pteridophytes were included in the study for the first time in limestone flora research. The plants on the limestone hills have been grouped into four degree of fidelity (Braun-Blanquet, 1932).

In the late 70s investigations on the forest ecology over limestone was undertaken. Studies on the limestone vegetation in Peninsular Malaysia have been studied by Crowther (1982; 1986) and in Sarawak, particularly in Mulu National Park have been studied by Vallack (Proctor *et al.*, 1983). Both studies looked into