



***DIVERSITY AND CONSERVATION STATUS OF SELECTED RARE AND ENDEMIC LIMESTONE ORCHID SPECIES IN PADAWAN, SARAWAK***

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ENDEMIC LIMESTONE ORCHID SPECIES IN PADAWAN, SARAWAK**



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**DOCTOR OF PHILOSOPHY  
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**MORPHOLOGY AND CONSERVATION STATUS OF LIMESTONE ORCHIDS  
IN PADAWAN, SARAWAK**



**By**

**KHOR HONG ENG**

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**DIVERSITY AND CONSERVATION STATUS OF SELECTED RARE AND  
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December 2012

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Padawan Limestone Formation is located at the south of Kuching, Sarawak, bordering with Kalimantan, which is the largest outcrop of Sarawak. The favourable unique climate and ecological conditions providing a suitable environment for the plants enhance the rich diversity and high endemism in the limestone hills, especially the orchids. The limestone orchids in Padawan are not only threatened by the over collection by hobbyists and enthusiasts, but the habitat is also threatened with deforestation and quarrying activities. Furthermore, the orchid diversity was poorly studied and the information of rare and endemic species was very limited due to the inaccessibility in the area. Hence, a diversity study was conducted on the Orchidaceae in the limestone hills of Padawan with the objectives to document the macromorphological taxonomic characters of the limestone orchids, to study the diversity of limestone orchids, to determine the diversity indexes for conservation purposes and to evaluate conservation status of rare and endemic species in Padawan, Sarawak. Field sampling collections were done at 42 limestone localities in a sustainable manner. Collection of specimens for living collections and herbarium specimens were prepared. The taxonomic characters of collected specimens were documented and described in details for identification and classification. Quadrant plots of 10 x 10 m were established at 20 selected sites to investigate the diversity indexes. A total of 273 species from 70 genera were recorded from this study. This encompassed 29.7% of Sarawak's orchids in Padawan limestone

area measuring approximately 436.6 km<sup>2</sup> (0.0035% of Sarawak land area). From the study, 57 species were new records in Padawan, 38 species were new records to Sarawak and 15 species were new records to Borneo Island by comparison to the list by Beaman *et al.* (2001), Rusea *et al.* (2007) and World Checklist of Selected Plants (2012). The diversity of the limestone hills was shown to be high with Simpson's Diversity Index (D=0.94), Shannon-Weiner's Diversity Index (H=2.87) and Evenness Index (J=0.92) from the quadrat plots. The diversity richness was very high with a mean of 31 species and plant density of 1.5 plant per m<sup>2</sup> in the plots. Sixteen endemic orchids, which included 2 narrow endemic species in Sarawak limestone, 8 endemic in Borneo, and 6 endemic in Malesia region were identified. From the identified rare and endemic species, 10 species were classified as Endangered species, 2 as Vulnerable species and 4 as Near Threatened in accordance to the IUCN Red List Categories and Criteria Version 3.1.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**KEPELBAGAIAN DAN STATUS KONSERVASI ORKID BATU KAPUR YANG JARANG DAN ENDEMIK TERPILIH DI PADAWAN, SARAWAK**

Oleh

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Formasi Batu Kapur Padawan terletak di selatan Kuching, Sarawak yang bersempadan dengan Kalimantan, merupakan kawasan batu kapur yang terbesar di Sarawak. Keadaan iklim dan ekologi yang unik memberikan suasana yang sesuai untuk memperkayakan kepelbagaian dan endemic di kawasan bukit batu kapur, terutamanya orkid. Orkid batu kapur di Padawan bukan sahaja tergugat dengan pengumpulan tanpa kawalan oleh kalangan pengemar, bahkan juga habitatnya tergugat dengan pembukaan kawasan hutan dan kuari. Tambahan pula, kepelbagaian orkid di Padawan kurang dikaji dan maklumat mengenai spesies yang jarang dan endemik adalah sangat terhad kerana kesukaran untuk memasuki kawasan tersebut. Suatu kajian kepelbagaian telah dijalankan untuk mengkaji famili Orchidaceae di bukit batu kapur di Padawan dengan objektif untuk mendokumenkan ciri-ciri taxonomi makromorfologi orkid batu kapur, mengkaji kepelbagaian orkid batu kapur, memperolehi indeks kepelbagaian untuk tujuan konservasi, menilai status konservasi spesies orkid yang jarang dan endemik di Padawan, Sarawak. Kutipan specimen dijalankan di 42 kawasan batu kapur dengan cara yang mampan. Koleksi orkid hidup dan specimen herbarium telah dilakukan. Ciri-ciri taxonomi specimen didokumenkan secara terperinci untuk pengecaman dan pengelasan. Plot-plot kuadrat 10 x 10 m telah dibina di 20 kawasan terpilih untuk mengkaji indeks kepelbagaian. Sejumlah 273 spesies daripada 70 genera telah direkodkan dalam kajian ini.

Angka ini menunjukkan 29.7% orkid Sarawak terdapat di kawasan batu kapur Padawan yang sebesar 436.6 km<sup>2</sup> (0.0035% daripada kawasan Sarawak). Daripada kajian, perbandingan dengan senarai orkid Beaman *et al.* (2001), Rusea *et al.* (2007) dan World Checklist of Selected Plants (2012) di kawasan kajian, mendapati 57 spesies merupakan rekod baru untuk Padawan, 38 spesies rekod baru untuk Sarawak, dan 15 spesies rekod baru untuk Pulau Borneo. Kepelbagaian orkid di bukit batu kapur terbukti kaya dengan Indeks Kepelbagaian Simpson ( $D=0.94$ ), Indeks Kepelbagaian Shannon-Weiner ( $H=2.87$ ) dan Indeks Keserasian ( $J=0.92$ ) daripada plot-plot kuadrat. Kekayaan kepelbagaian yang tinggi dengan min 31 spesies dan kepadatan 1.5 individu setiap m<sup>2</sup> di setiap plot. Enam belas orkid spesies dikenal pasti sebagai endemik spesies dimana 2 merupakan endemic di kawasan batu kapur Sarawak, 8 endemik in Borneo dan 6 endemik di kawasan Malesia. Daripada spesies yang jarang dan endemic, 10 spesies diklasifikasi sebagai spesies terancam (Endangered), 2 spesies sebagai terdedah (Vulnerable) dan 4 spesies sebagai hampir terancam (Near Threatened) dengan panduan IUCN Red List Categories and Criteria Version 3.1.

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## APPROVAL

I certify that a Thesis Examination Committee has met on 4 December 2012 to conduct the final examination of Khor Hong Eng on his thesis entitled “Diversity and Conservation Status of Selected Rare and Endemic Limestone Orchid Species in Padawan, Sarawak” in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Doctor of Philosophy.

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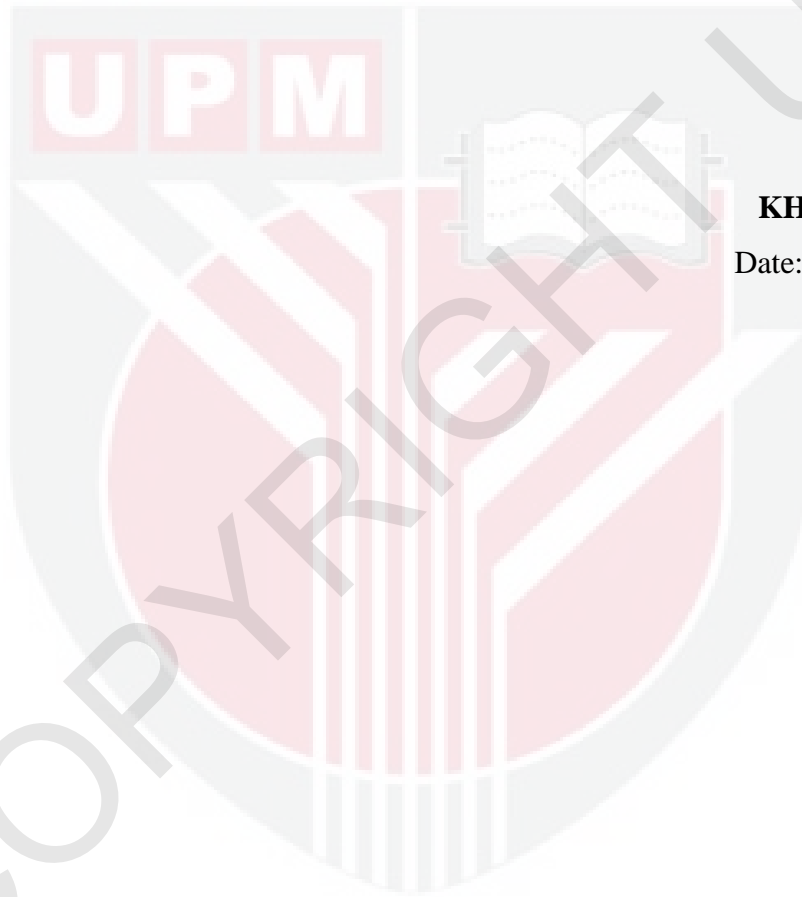
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## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



**KHOR HONG ENG**

Date: 4 December 2012

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## LIST OF ABBREVIATION

a.s.l.	above sea level
Kg.	kampung (Village)
G.	gunung (Hill)
Sg.	sungai (River)
m	meter
km	kilometer
cm	centimeter
mm	millimeter
m <sup>2</sup>	square meter
km <sup>2</sup>	square kilometer
μl	micro liter
M	molar
mM	milimolar
°C	degree Celsius
pers. comm.	personal communication

# CHAPTER 1

## INTRODUCTION

### 1.1. General

Orchids which comprise the Orchidaceae family are the largest and most diverse of the flowering plant kingdom (Hodgson *et al.*, 1991). Orchids belong to the Class of monocotyledon, in which the young plant emerging from the seed has a single juvenile leaf, known as a cotyledon. The Family Orchidaceae is perennial plants with fleshy roots or tubers, and unstalked, undivided leaves which are often long and narrow, with parallel veins. However, there are species that have no proper leaves, these being reduced to scales sheathing the base of the stem (Bandisch, 1998).

Orchids are cosmopolitan in distribution, occurring in every habitat, found all over the world except in the coldest and driest regions (Seidenfaden & Wood, 1992). Orchids are generally found in wetter conditions such as the tropical regions with high annual rainfall and without too much seasonal variation throughout the year. The great majority are to be found in the tropics, mostly Asia, South America and Central America. They are found above the Arctic Circle, in southern Patagonia and even on Macquarie Island, close to the Antarctica. It is considered as one of the largest families among higher

plants. It has been suggested that 10% of the higher plants belongs to this family. Orchids are also the largest flowering plant family in Malaysia (Batygina *et al.*, 2003).

The range of orchid's habitat is very wide. They can grow from sea level up to 4200m. Orchids can be grouped according to the way they retrieve nutrients namely epiphytic, terrestrial and lithophytic (Hodgson *et al.*, 1991).

Limestone hills and mountains are well known for their orchids' diversity. Padawan Formation located in south-west of Kuching District, Sarawak are one of the largest limestone outcrop of Sarawak. The limestone hills experience equatorial climate with high humidity and high annual rainfall providing a favourable climate for the orchids. The existence of various forms of microhabitat further enhances the richness and diversity of the limestone orchids in Padawan, especially the rare and endemic species.

## **1.2. Statements of problem**

1.2.1. Documentation of Orchids in Padawan were previously done by Phoon in 2004 (covering northern and eastern parts of Padawan) and Lim in 2007 (covered northern and central parts of Padawan). The southern and western parts of Padawan have not been covered for its orchids' diversity.

1.2.2. Insufficient information of rare and endemic orchids published or documented in the limestone areas at Padawan. Limestone areas are less studied for its diversity and its prospects. Only random collections were done by Sarawak Forestry Corporation (SFC) and the collection results were not published. The rare and endemic orchids were hard to be found and limited information deposited by previous collectors.

1.2.3. Many of the orchid species are threatened by human activities especially illegal collections and deforestation. The community in the area still practicing shifting cultivation where forest cleared for agriculture purposes. Besides that, illegal collections by both local villagers and outsiders are rapidly done in the neighbouring area as orchids are a very much sought after plant. These bring negative impacts and may lead to the extinction of the existing orchids.

### **1.3. Objectives**

1.3.1. To record all macromorphological taxonomic characteristics of collected limestone orchids in order to compare and revise with existing described specimens for additional taxonomic characteristics of limestone orchids.

1.3.2. To study the diversity of limestone orchids in the Padawan Formation located in Kuching, Sarawak and to determine the diversity indexes for conservation purposes.

1.3.3. To investigate the orchid population of rare and endemic limestone orchids for evaluation of the conservation status based on IUCN Red List criteria.





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## BIODATA OF STUDENT

Khor Hong Eng was born in Melaka, received his early education in S.M.K. St. Francis, Melaka and secondary education in St. Francis' Institution, Melaka. Later, he did his Form 6 (Pre-university study) in Malacca High School. He pursued for his tertiary education in Universiti Putra Malaysia, Serdang, Selangor, majored in Biology. During the years of his study for his Bachelor degree, he frequented the forest due to passion towards the beauty of nature. His interest in plants and herbs were cultivated since young as he loves to grow plants and gardening. Thus, he decided in pursuing his postgraduate study in plant taxonomy. He has over five years' field experience in plant diversity projects, especially orchids.