



Faculty of Resource Science and Technology

**Systematic Study of the Genus *Hopea* Roxb.
(Dipterocarpaceae): Leaf Morphological and Anatomical
Aspects in Sarawak.**

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(45293)**

Bachelor of Science with Honours
(Plant Resource Science and Management)

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**Systematic Study of the Genus *Hopea* Roxb. (Dipterocarpaceae): Leaf
Morphological and Anatomical Aspects in Sarawak.**

Gloria Rinya ak Brikie

This project is submitted in partial fulfilment of the requirements for The Degree of
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LIST OF ABBREVIATIONS

FAO	:	Food and Agriculture Organization
CO ₂	:	Carbon dioxide
HUMS	:	Prefix for Herbarium of Universiti Malaysia Sarawak
SEM	:	Scanning Electron Microscopy
KeV	:	Kiloelectron Volt

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ABSTRACT

Dipterocarpaceae is a family of tropical trees species and most well-known in Southeast Asia, Dipterocarpaceae divided into three subfamilies, Monotoideae which found in Africa, Pakaraimoideae from South America and Dipterocarpoideae is found in forests of Asia that produce high quality of timber. In this study, the genus *Hopea* (Luis) is selected for the study. This preliminary study of five species were selected namely *Hopea sphaerocarpa* (Heim) Ashton, *Hopea dryobalanoides* Miq, *Hopea* sp.3, *Hopea kerangasensis* Ashton and *Hopea beccariana* Burck for study the leaf morphological, micro-morphological and anatomy studies. The morphological characteristics for the five species scored were the leaf shape, apex, base, margin and the venation. The measurement of leaf lamina and the petiole were also recorded. The micro-morphological studies through the Scanning Electron Microscope (SEM) and through the epidermal peel showed that the five species possessed distinct characteristics which could be used as additional evidence to support the species identification. Two type of stomata and trichomes were found which were anomocytic and cyclocytic while, trichomes were peltate and simple trichomes. The cross-section of the leaf petiole anatomical studies also showed distinct patterns of vascular bundles such as outer vascular bundles arrangement in O-shaped and V-shaped, while medullary in O-shaped ring and U-shaped. Anatomical studied of leaf epidermal and petiole cross section were observed under compound microscope by various magnifications. Therefore, this study provides crucial taxonomic value either in morphology and anatomy aspects for further references.

Keywords: *Hopea*, Dipterocarpaceae, leaf morphology, micromorphology, anatomy

ABSTRAK

Dipterocarpaceae adalah keluarga pokok spesies tropika dan paling terkenal di Asia Tenggara, *Dipterocarpaceae* dibahagikan kepada tiga subfamili, *Monotoideae* yang ditemui di Afrika, *Pakaraimoideae* dari Amerika Selatan dan *Dipterocarpoideae* ditemui dalam hutan di Asia yang menghasilkan kayu yang berkualiti tinggi. Dalam kajian ini, *Hopea* genus (Luis) dipilih untuk dikaji. Kajian awal lima spesies telah dipilih iaitu *Hopea sphaerocarpa* (Heim) Ashton., *Hopea dryobalanoides* Miq, *Hopea* sp.3, *Hopea kerangasensis* Ashton dan *Hopea beccariana* Burck untuk mengkaji morfologi daun, mikro-morfologi dan anatomi. Ciri-ciri morfologi untuk lima spesies adalah bentuk daun, puncak, asas, margin dan urat daun. Pengukuran lamina daun dan tangkai daun juga telah direkodkan. Kajian mikro morfologi dibuat melalui Imbasan Elektron Mikroskopik (IEM) dan melalui kulit epidermis menunjukkan bahawa lima spesies memiliki ciri-ciri yang berbeza yang boleh digunakan sebagai bukti tambahan untuk menyokong pengenalan spesies. Dua jenis stomata dan trikom telah ditemui iaitu anomocytic dan cyclocytic, trikom yang ditemui seperti trikom peltat dan trikom jenis mudah. Keratan rentas daun dan kajian anatomi juga menunjukkan pola berkas vaskular yang berbeza seperti luar berkas vaskular dalam bentuk O dan berbentuk V, manakala bentuk tengah berkas vascular dalam bentuk O dan berbentuk U. Anatomi epidermis daun dan keratan rentas tangkai daun diperhatikan di bawah mikroskop kompaun dengan pelbagai pembesaran. Oleh itu, kajian ini memberikan nilai taksonomi penting sama ada dalam aspek morfologi dan anatomi untuk rujukan lanjut.

Kata kunci: *Hopea*, Dipterocarpaceae, Morfologi daun, mikromorfologi, Anatomi.

CHAPTER 1

INTRODUCTION

Borneo is one of the most richness forest that contains lot and high number of species in dipterocarp forest. Dipterocarp can compose family of Tropical Sub-canopy and canopy trees. Most of trees are dicotyledons and come from Dipterocarpaceae family (Ashton & Kettle, 2012). Dipterocarpaceae family members attain more than 50 cm or up-to 1m in diameter at breast height and can form dense canopies (Sasaki, 2006).

The survey by Boy (2015) showed that dipterocarps can grow very tall and large, they form a very large proportion of the rainforest canopy in Peninsular Malaysia. An extensive study showed that up to 57% of the emergent layer of the lowland forest in Peninsular Malaysia composed of dipterocarp. In Sarawak, mixed dipterocarps forest comprise even more of the emergent and canopy layer at 75%, while in Sabah can be as high 90%. Sabah has tallest tropical trees in the world.

The Dipterocarps in general have distinct fruits characteristics such as the fruit has wing-like sepal (Ashton, 1988). The wings characteristics are important characteristics to distinguish the different genera within the family. Some of the Dipterocarps species do not have wings. Besides that, Dipterocarpaceae comprise high value sources of timber. According to Appanah & Turnbull, (1988), timber contributes one of the important role in the economic sector nowadays. Dipterocarpaceae is considered as an important timbers of Asia.

Hopea is the second largest genus after *Shorea* in the family Dipterocarpaceae. *Hopea* has wings that allow it to spin and helping in dispersal. Species of the Dipterocarps produces resin which also known as dammar and take place in peninsular, Indonesia and the East Indies. (Mills & Werner, 1955). *Hopea* was known as one of the important timber species in lowland and hill dipterocarp forest include in Laos, Myanmar and Cambodia. Apart from that, *Hopea* species was the most valuable dipterocarp tree that present a hard durable timber and generally for construction, boat building and canoes (Phothisat, 1998).

Systematic studies include, study in both morphology and anatomy characteristics in plant species. Morphology is a study about the external part of plant. The most important part of plant that used to identify are flower, fruit, leaves and wood. Among the three part of plant the most crucial part was flower whereas we can identify until species level. It is difficult to collect due to the season. Anatomy was studies about internal part of plant. Anatomical studies more difficult to conduct due to various step that should apply to leaves compared to morphology.

There is still lack of information to conduct the studies of leaf morphological and anatomical of *Hopea* selected species. The latest review of the genus *Hopea* was done by Ashton, 2004 focused on the gross morphology. It is crucial to obtain more taxonomic on the morphological and anatomical data which could be used for identification and conservation in the future. Therefore, the objectives of this studies are:

1. To produce botanical characteristics of selected species of *Hopea* leaf.
2. To obtain and compare leaf anatomical characteristics of selected *Hopea* species.

3. To compare and identify the micro morphological of selected *Hopea* species using Scanning Electron Microscope (SEM).
4. To produce identification key of the species based on the morphological characteristics.

CHAPTER 2

LITERATURE REVIEW

2.1 Mixed Dipterocarp Forest/Tropical Rainforest

The dipterocarp forest known as dominant trees across a large of lowland area in Southeast Asia. Dipterocarp forest provide high valued sources of timber since before 1970, higher number of biodiversity and crucial for terrestrial carbon sinks (Asthon & Kettle, 2012). According to FAO as cited in (Ashton & Kettle, 2012) lowland dipterocarp forest contributes more than half of hardwood timber over past few decades causes the logging and degradation of forest while, according to (Maury-Lechon & Curtet, 1998) the dipterocarp forest were known to be sources of wild products.

During the flowering years of Seasonal Evergreen dipterocarp forests, each of the mature dipterocarp forest may set up to 4 million flowers, this result in as many 100,000 mature fruits and not include the flowers that lost to insects, birds and mammals. The ripe fruit fall and winged fruit are not dispersed far away from the mother trees. While the dipterocarp forest is lack of seed dormancy, and will be germinate after falling (Appanah & Turnbull, 1998).

2.2 Family of Dipterocarpaceae

Distribution of family Dipterocarpaceae is in Asia and the Pacific, South America and Africa consists 17 genera with 523 species (Joshi, 2003). The family Dipterocarpaceae represent 40% emergent trees and 30% of basal area in land of hill forest. The family

Dipterocarpaceae are harvesting for making timber due to their strength and stability (Mustaffa *et al.*, 2012).

Three main genus in Dipterocarpaceae family are *Shorea* (Meranti) consist of 150 species, while *Hopea* with 100 species and *Dipterocarpus* (Keruing) around 75 species. This trees are used by local people for construction materials and also used in plywood industry. 'Minyak keruing' produces from *Dipterocarpus* trees and have been used by local for caulking boats, torch and medicinal purposes. While, *Shorea* and *Hopea* produce resin for varnishes. (Zuraida *et al.*, 2010).

2.3 Subfamily Dipterocarpaceae

Dipterocarpaceae are divided into three subfamily, there are Monotoideae, Pakaraimoideae and Dipterocarpatoidae. Monotoideae distributed Across Africa, Madagascar and South America with three genera and about 30 species. While, Pakaraimoideae found in the Guaianan Higlands of South America with single species *Pakaraimaea roraimae*. (Gamage, 2006) and Dipterocarpatoidae consists of biggest subfamily with 470 species in 13 genera, include *Anisoptera*, *Cotylelobium*, *Dipterocarpus*, *Dryobalanops*, *Dryobalanoides*, *Hopea*, *Neobalanocarpus*, *Parashorea*, *Shorea*, *Upuna*, *Vateria*, *Vateriopsis* and *Vatica*. (Meekiong, 2015).

Dipterocarpoideae was divided into two tribes which are Dipterocarpeae and Shoreae. Dipterocarpeae consist of genera *Anisoptera*, *Cotylelobium*, *Dipterocarpus*, *Stemonoporus*, *Upuna*, *Vateria* and *Vateriopsis*. Shoreae on the other hand consist of *Dryobalanops*,

Hopea, *Neobalanocarpus*, *Parashorea* and *Shorea*. Tribe Shoreae is a most valuable timber in Dipterocarpaceae family (Essy, 2013).

Dipterocarpoideae grow in wide areas from the Seychelles in the west to the Louisiade, Arch of Papua New Guinea at its eastern limit, India, Sri Lanka, Myanmar, Laos, Vietnam, Hainan, South China, Philippines, Thailand, Malaysia, Indonesia and Papua New Guinea. This species is adapted to any climate either high temperature and abundant of rainfalls throughout the year. (Sasaki, 2006)

2.4 *Hopea* Roxb

Genus *Hopea* was named after Dr. John Hope, a Scottish Botanist (1725-1786) Regius keeper of the Royal Botanic Garden, Edinburgh from 1761 until his death in 1786 (Lirio & Freitas, 2014). *Hopea* has their synonyms such as *Balanocarpus* Beddome, *Diotocarpus* Dunn, *Hancea* Pierre, *Peirrea* F. Heim and *Petalandra* Hasskarl (Xi-Wen *et al.*, 2007).

Hopea is one of the genera that contains over 100 species. While in Malesian region there are 84 *Hopea* species that has been identified. *Hopea* has been subdivided into different group such as bark, pattern, and present or absence of resin and silt root. These four characteristics was used by Desh as cited in Choong *et al.*, (2008) to divide species into four different group. While, Symington as cited in Choong *et al.*, (2008) has divided *Hopea* into four groups there are Euhopea, Pierra, Dryobalanoides and Bracteata.

In family Dipterocarpaceae the genera that closely related to *Hopea* is *Shorea*. *Hopea* and *Shorea* has similar morphological characteristics. However, *Hopea* and *Shorea* have

different in development of fruit calyx. *Hopea* characterized by two long and three short fruit calyx wings, while *Shorea* have three long and two short wing of fruit calyx (Yulita, 2012). Both of this species are economically important source of timber, several of the species yield useful wood oil, balsam or resin.

According to Symington as cited in Yulita (2012), *Shorea* timber characteristic has divided into four main groups: Balau, Dammar hitam (yellow meranti) Red meranti and meranti pa'ang (white meranti)

Hopea growth from small to large tree, the buttressed or stilt rooted trees function in supporting the growth of trees, the twig slender, stipules small (size) fugacious, the leaves small to large, while the venation are variable and the petiole is never geniculate. Section in *Hopea* (Dipterocarpaceae): Leaf veneration of scalariform, panicles irregularly branches, present of many- flowered and pale in color, the wood markedly heterogenous rays, without chambered parenchyma strands. (Kubitzki & Bayer, 2013).

2.5 Morphology

In plant taxonomic system, morphology is a studies of external form of any organism. Morphology can help people gives much of information character for basic identification for flower, fruits, seed, genera and families of the species (Fatin, 2013). A morphological aspect is most important thing that we must identify first before study the anatomical aspects.

Leaf morphology help us to study about external characteristics of the leaves. Leaves are important as it can be used in identification and classification. The leaf part such as blade, petiole and stipules are the parameters that are always used. Other part such as leaf structure, attachment, shapes, margins and their venation are important in description of plant (Miraadila, 2013).

2.6 Scanning Electron Microscopy (SEM)

Scanning Electron Microscope (SEM) widely used in taxonomic studies. Scanning Electron Microscope (SEM) not only can be used to obtain image but also to obtain qualitative information in two dimension or three dimension, about the microstructure, the chemistry, the crystallography and the electronic properties of the materials of interest (Joy, 1997). Micro morphological study using Scanning Electron Microscope (SEM) in general is used for describing the leaf surface: leaf epidermis, venation systems, trichome, structure of epicuticular, waxes and stomata (Joshi, 2009).

Scanning Electron Microscope (SEM) has high resolution to examine the surface of plants. Plant tissue must be dehydrated so that we can observe it use Scanning Electron Microscope (SEM). Due to high vacuum in coating system and microscope, specimen cannot resist the vacuum system without having distortion (Pathan *et al.*, 2009).

2.7 Stomata and Epidermal cell

Stomata in Greek refer to “mouth”. Stoma is defined as microscopic pore or hole over the surface of plant organ that allow connection between interior and exterior environments and presence of functional pair of guard cell surround the the pore. The guard cell control

the size of or movement of stomata depends on the environment. Role of stomata in plant adaptation can be determine by doing the analysis on the dispersal of stomata in leaves that grow in environment with different water level in that area (Zeiger, 1987). Complexes of stomata include the epidermal cells correlate with guard cells (Croxdale, 2001)

2.8 Trichome

Trichome are hairs and papillae (scales) that present with leaf epidermal cell of leaf. In taxonomic studies, the occurrence and cellular structure of trichome usually used for identification because there is many form of trichome. Every plant species, the hairs and papillae may range from glabrous (hairless) to very hirsute (hairy). However, many form of hair, only few type that can be used for diagnosis of family. Individual species in some families can be defined based on form of their hair alone. Two major categories of hairs are glandular and non-glandular or covering hairs. The hair serve important function in water relationship of leaf. There are less rate of transpiration if the hair on the surface of leaf become dense (Cutler *et al.*, 2008).

2.9 Petiole

Petiole is the plant part that connects the blade of leaf to its stem and considered as taxonomic importance. To study and compare the petiole among species, tranverse section must be done. Transverse sections of dicotyledonous petioles in Figure 1 shown the principal type of vascular system. Different species may have single strand of vascular or divided in number of bundles type of vascular system. Family such as Dipterocarpaceae have more complex petiolar vascular.