THE MORPHOLOGY OF MATURED BARK OF NON-DIPTEROCARP TREE SPECIES IN DERAMAKOT FOREST RESERVE, SABAH

DISSERTATION SUBMITTED TO UNIVERSITI MALAYSIA SABAH IN FULFILMENT OF REQUIREMENT FOR THE BACHELOR SCIENCE OF FORESTRY

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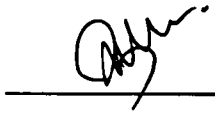
DECLARATION

The materials in this thesis are original except for quotations, excerpts, summaries and references, which have been duly acknowledged.



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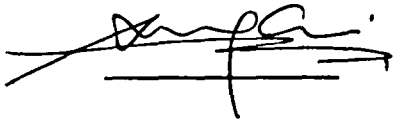

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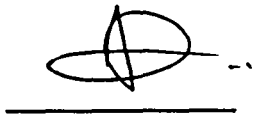

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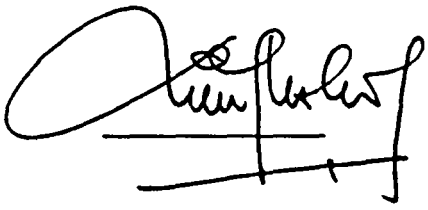

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ABSTRACT

THE MORPHOLOGY OF MATURED BARK OF NON-DIPTEROCARP TREE SPECIES IN DERAMAKOT FOREST RESERVE, SABAH

Bark morphology was found useful in distinguishing between some tropical tree species, especially during inventory for stock mapping in the tropical rain forest reserve. The present study was to determine the variety of the morphology of matured bark while producing a bark morphology description that allows the identification of non-dipterocarp tree species in the field. From these, some useful taxonomic characters to distinguish non-dipterocarp species could reach a better approach. The investigated non-dipterocarp bark samples consisted of 64 species from 29 families. The materials for this study were by field note, bark samples and photographs taken from both felled and standing tree from Compartment 40, Deramakot Forest Reserve. The field examination on bark was done macroscopically. Further microscopic identification was done in the laboratory by using the stereomicroscope for detail characteristics descriptions writing. The data combination of colours and all the three main parts of the analysed bark descriptions: bark texture, bark patterns and exudation characters or smell gave a fully description of bark morphology for each species. A large number of macroscopic bark terms listed in Junikka's (1994) study used to describe the investigated barks. The comparison between obtained results and the existing studies, a revealed that profound distinct characteristics of slash of the tree bark showed more variety of living bark patterns. These visible bark patterns on living bark were mainly related with the growth structure of bark. The outer bark surface patterns also showed the unique feature for certain species. The results also showed that some of the species exhibited similar features within their genus or family. In conclusion, matured barks of tropical non-dipterocarp tree species showed the variety of bark morphology.

ABSTRAK

MORFOLOGI KULIT POKOK MATANG BAGI SPESIES BUKAN DIPTEROKARP DI HUTAN SIMPAN DERAMAKOT, SABAH

Ciri-ciri morfologi kulit pokok adalah berguna untuk pengecaman beberapa jenis spesies pokok di hutan hujan tropika, terutamanya semasa membuat inventori untuk pelan stok di hutan hujan tropika simpanan. Kajian ini adalah untuk menentukan kepelbagaian morfologi pada kulit pokok yang matang serta menghasilkan satu penerangan ciri-ciri morfologi spesies pokok bukan Dipterokarp yang boleh membantu dalam pengecaman pokok di lapangan. Dari penerangan ini, sesetengah ciri-ciri taksonomi didapati bersesuaian dan menunjukkan satu pendekatan yang lebih baik untuk membezakan spesies bukan Dipterokarp. Kajian ini telah merangkumi sampel kulit pokok sebanyak 64 spesies dari 29 famili. Bahan kajian melibatkan nota lapangan, sampel kulit pokok dan gambor foto yang diambil dari pokok berdiri atau pokok tumbang dari Kompatmen 40, Hutan Simpan Deramakot. Kajian di lapangan dibuat secara makroskopik dan kajian menggunakan stereo-mikroskop dilakukan di makmal. Kombinasi data iaitu warna dan ketiga-tiga bahagian kajian bagi penerangan kulit pokok: tekstur kulit pokok, corak kulit pokok dan ciri-ciri luahan dari takikan atau bau memberikan penerangan lengkap morfologi kulit pokok untuk setiap spesies. Kebanyakan istilah kulit pokok makroskopik yang disenaraikan dalam kajian Junikka (1994) digunakan untuk menerangkan kulit pokok yang dikaji. Perbandingan keputusan yang dicapai dengan kajian terdahulu menunjukkan bahawa ciri-ciri mendalam takikan yang dibuat pada kulit pokok menunjukkan lebih banyak kepelbagaian pada bahagian kulit dalam. Ciri-ciri ini adalah berkaitrapat dengan struktur perkembangan kulit. Corak kulit luar pokok juga menunjukkan ciri keunikan bagi sesetengah spesies. Keputusan menunjukkan bahawa kebanyakan spesies menunjukkan ciri morfologi kulit pokok yang berbeza dan sesetengah spesies menunjukkan ciri yang sama dengan spesies lain di antara genus atau famili. Kesimpulannya, kulit pokok yang matang bagi spesies pokok bukan Dipterokarp tropika menunjukkan kepelbagaian morfologi kulit pokok.

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ABBREVIATIONS

cm	centimetre
DBH	Diameter at Breast Height
DFR	Deramakot Forest Reserve
ed.	editor
Fig.	Figure
FRC	Forest Research Centre, Sepilok, Sandakan
LB	Living bark
m	metre
mm	milimetre
No.	Number
PP	Primary Phloem
R	rhytidome
Sc	Sclereid
SP	Secondary Phloem
SW	Sapwood
trans.	translator
VC	vascular cambium
Vol.	Volume

CHAPTER 1

INTRODUCTION

Bark, is what we see when we first glance at a tree in the forest. Bark protects the tree. Nonetheless, bark is always interpreted as an obstruction, since tree feller only aim to reach the wood.

The bark surface patterns are important for the identification of tropical tree species. They are used for identification in the field by forest dwellers, tree finders, and botanists. In temperate forest, where a limited number of species exist, forester can easily identify trees by observing the bark features. However, difficulties arise in identification of tropical trees when a genus is very rich in species or when species occur very infrequent or belong to families still incompletely known, such as Sapotaceae, Lauraceae and Myrtaceae (Roth, 1981).

The varieties of bark surface patterns are well known and described. Bark patterns may show unique characteristics for a single genus or even species. For example, most of the *Sindora* spp. and *Vatica* spp. have hooped bole, and large lenticels are covering the bole surface of *Parartocarpus bracteatus* (Wyatt-Smith, 1999).

Tree bark also gives a useful indication for the wood quality. It shows of faults or peculiarities of tree growth. A wavy pattern in the bark is the best outward indication of wavy grain in the wood. This feature fetches very high price, because such trees yield a valuable decorative veneer (Schwankl, 1956).

During bark development, progressive of inner and outer bark might change the bark surface smoothness, the brightness of the bark colour and produce varied

bark surface patterns. The bark surface patterns likewise reveal varied appearance within tree or between trees of different ages.

Foresters often cannot reach the crown canopy of the rain forest emergent to obtain flower or fruit samples, or they can hardly observe the leaves arrangement either. Instead of just following the labels of herbarium sheets for tree identification, careful description of mature bark morphology offers an alternative approach for reliable and quick tree identification in the tropics.

There is no doubt that bark has many characteristics, which aid identification in field. Nevertheless, it is very difficult for a scientist or tree identifier to capture consistent words for the exclusive characteristics of odour, colour and bark surface quality for a single species descriptions. Unfortunately, little is known about bark characteristics in botanical samples, because bark is rarely used as a part of botanical collections.

1.1. Justification

Although, the rich variety of bark surface patterns indicate the value of bark characters for tree identification, the systematic study of bark morphology using a uniform terminology has been neglected.

The morphology of bark changes with growth and tree height. This can be seen from simple observation of some bark characters such as bark surface patterns. However, the maturity and tree height level where the observation is made was often overlooked in previous tree bark morphology studies. Therefore, a consistent guideline for description has to be established before a scientific taxonomic system for bark morphology can be developed successfully.

Detailed bark morphology studies were undertaken for some softwood and hardwood tree species of the temperate countries (Schwankl, 1956; Nanko and Côté, 1980; Samuelson and Hogan, 2003). The general bark morphology for tropical tree species have been outlined by Foxworthy (1927, 1932), Wyatt-Smith (1999), Wood

(1957), Whitmore (1972), Cockburn (1976, 1980), Ng (1978, 1989), Soepadmo and Wong (1995), Soepadmo, Wong and Saw (1996), Soepadmo and Saw (2000), Soepadmo, Saw and Chung (2002). Whitmore (1962a, b, c) has completed one extensive study on bark surface pattern on Dipterocarp in the 60s. Since then is not much research on tropical tree bark morphology has been conducted. The present study aims to extend the knowledge on detailed bark morphology to some non-dipterocarp species. Furthermore, this study tries to find useful taxonomic characters to distinguish non-dipterocarp species.

1.2. Objective

1) To determine the variety of the morphology of matured bark in selected tropical non-dipterocarp tree species.

2) To produce a bark morphology description that allows the identification of these species in the field.

CHAPTER 2

LITERATURE REVIEW

A wide range of literature of the tree identification guide based on tree features has been established. Although flower and fruit structure give the best feature for accurately identification of tree species, certainly, branch structure with leaves arrangement is also a useful tool for accurately tree identification, the crown canopy of the rain forest emergent is thick yet overlapping, somehow it is hard to visualise the leaf shape and leaves arrangement. In fact, the outer bark morphology and characteristics on bark slash may be a suitable tool to assist quick tree identification in tropical forest, especially during forest inventory before harvesting operation in commercial forest reserve.

2.1. Bark

Bark mainly determines the appearance of a tall tropical tree when one first looks at it. In 1957, the committee on nomenclature of the International Association of Wood Anatomists defined bark as a non-technical term used to cover all the tissues outside the xylem cylinder. In older trees usually divisible into inner (living) versus phloem, and outer (dead) versus rhytidome (Tropical Woods, 1957). According to Jensen, Fremer, Sierilä and Wartiovaara, generally, bark means the outer part of the stem and branches, which surrounds the wood (Jensen *et al.*, 1975). Trockenbrodt (1990) in his studies of terminology used in bark anatomy, mentioned bark as all tissue outside the vascular cambium, regardless of its specific structure. However, he found that Metcalfe (1979 b) uses the term bark for "all secondary tissues external to the

xylem" and thereby excludes all tissue of primary origin. In general, bark is the outer most layers that protect the tree.

2.2. Bark Growth and Anatomical Structures

To describe the changes of bark appearance during tree growth, it is appropriate to commence with a brief reference to how a tree grows.

Like all living things, trees are made up of cells. The tree growth occurs by means of cell divisions. Basically, a tree grows in three directions: stem and branches grow upward; roots grow downward. It is called vertical growth. At the same time, all tree grow laterally, for example, the branches, roots and the stem increase in diameter (Spencer & Luv, 1975).

Lateral growth in diameter is also named secondary growth. The vascular cambium of tree is only a few cells thick. It produces the different types of cells including phloem and xylem in both the bark and the wood. When the divided cells are matured, the cells form a new region at each side of the vascular cambium, which contains living cells in various stages of development (Spencer & Luy, 1975).

After a period of time, the matured wood cell is procedurally dead, for it contains no nucleus or protoplasm. Thus, the dead wood made up the heartwood, and certain kinds of cells in the sapwood remain alive longer than others cells. Since the vascular cambium is a sheath surrounding the sapwood and heartwood, every layer of dead wood produced is added around the ones underneath (Spencer & Luy, 1975).

Similarly in bark, a layer of dead bark is also added at the most outer layer of secondary phloem during each growing season. These two directional growth processes cause a tree enlarge in diameter each year. The outer layers of bark are stretched and have to widen to accommodate the increased circumference. Soon, the outer layers of bark become dry and brittle, instead of stretching, they crack and

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