



UNIVERSITI PUTRA MALAYSIA

**A SYSTEMATIC STUDY ON VITEX TOURN. (VERBENACEAE)
IN SABAH AND SARAWAK, MALAYSIA**

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**A SYSTEMATIC STUDY ON *VITEX TOURN.* (VERBENACEAE)
IN SABAH AND SARAWAK, MALAYSIA**

By

CHANHSAMONE PHONGOUDOME

**Thesis Submitted in Fulfilment of the Requirements for the
Degree of Master of Science in the Faculty of Forestry
Universiti Putra Malaysia**

May 2000



**DEDICATED
TO
PHONGOUDOME FAMILY
AND
LAO FORESTRY SECTOR
IN THE
NEW MILLENNIUM**



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science.

**A SYSTEMATIC STUDY ON *VITEX* TOURN. (VERBENACEAE)
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May 2000

Chairman: Assoc. Prof. Faridah Hanum Ibrahim, Ph.D.

Faculty: Forestry

This thesis comprised a systematic study of the genus *Vitex* Tourn. (Verbenaceae) in Sabah and Sarawak, Borneo. The study was mainly based on 1,064 herbarium specimens obtained from seven herbaria. Additional information on the species was also gathered from some field observations of natural populations, with the incorporation of new characters such as inflorescence architecture and its degree of hairiness, epidermal structures of leaves through the scanning electron microscopy. The genus *Vitex* comprises 12 species i.e. *V. trifolia*, *V. ovata*, *V. negundo*, *V. cannabifolia*, *V. pinnata*, *V. quinata*, *V. parviflora*, *V. gamosepala*, *V. vestita*, *V. secundiflora*, *V. longipes* and *V. flava*; the latter three species are endemic to Borneo. Taxonomic evidences were obtained based on the morphology, anatomy, palynology, ecology and distribution of the taxa, which were finally subjected to numerical methods. The vegetative morphological characters found to be diagnostic where growth form, habit and buttress formation; leaf characteristics such as arrangement, shape, apex, base, margin, number of secondary nerves, petiole and petiolule length, texture, the adaxial and abaxial surface, size length and width; reproductive characters includes inflorescence characteristics such as position, architecture, length and width; flower

characteristics such as perianth and colour of petals, and of calyx, fruiting calyx; and, fruit features such as size and seeds. The anatomical structures, which proved to be diagnostically significant were petiole, midrib, lamina, margin, venation, stomata type and size, and trichomes. Five types of vascular system, which were mostly U-shape patterns, were found in the petiole vascular system. The vascular system of the midribs were mostly U-shaped, the abaxial surface convex-flattened; adaxial grooved, flattened and humped; the leaf thickness ranges from 0.075 mm to 0.93 mm. Four types of leaf margin were observed; recurved, slightly curved, acute and rounded. The venation system with areoles varies from pentagonal to quadrangular; the end of veinlets varies from simple linear to simple curved, branched once and branched twice. The distribution pattern of stomata was random, commonly anomocytic but diacytic to actinocytic were also present, and rarely anisocytic or paracytic. Eight trichome types which appear to be very specific in type and distribution among the species were found; four sessile glandular and four non-glandular. Palynological assessment showed that the size of the pollen which ranges from 17.1 μm to 29.9 μm in the polar and 12.3 μm to 39.9 μm in the equatorial view, is also diagnostic. The taxonomic treatment includes a key to the species, and a full list and description of all species and specimens studied together with their respective collectors, collection number, locality, date and where these were deposited. The distributions of the taxa were mapped.



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

**KAJIAN SISTEMATIK TERHADAP *VITEX* TOURN. (VERBENACEAE)
DI SABAH DAN SARAWAK, MALAYSIA**

Oleh

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Tesis ini merangkumi kajian sistematik terhadap genus *Vitex* Tourn. (Verbenaceae) di Sabah dan Sarawak, Borneo. Pada amnya kajian ini berdasarkan spesimen herbarium dan sejumlah 1,064 spesimen telah dicerap daripada tujuh herbarium dan beberapa pemerhatian lapangan terhadap populasi liar, dengan menggabungkan ciri-ciri baru seperti bentuk infloresens dan kelebatan bulu, struktur luaran daun melalui penelitian mikroskop elektron. Genus *Vitex* terdiri daripada 12 spesies seperti *V. trifolia*, *V. ovata*, *V. negundo*, *V. cannabifolia*, *V. pinnata*, *V. quinata*, *V. secundiflora*, *V. longipes*, *V. parviflora*, *V. gamosepala*, *V. flava* dan *V. vestita*. Tiga spesies seperti *V. secundiflora*, *V. longipes* dan *V. flava* adalah endemik di Borneo. Bukti-bukti taksonomi telah diperolehi berdasarkan morfologi, anatomi, palinologi, ekologi dan taburan dan data ini telah dimasukkan ke dalam perisian komputer untuk di analisis dan keputusan diperolehi menggunakan kaedah taksonomi numerik. Sifat-sifat morfologi yang didapati diagnostik adalah tabiat, bentuk pertumbuhan, pembentukan banir, susunan sifat daun, bentuk apeks, pangkal, tepi, bilangan urat kedua, petiol dan panjang petiolul, tekstur, permukaan adaksial dan abaksial,

panjang dan lebar, sifat bunga seperti perian dan warna petal, warna kaliks, kaliks buah, dan sifat buah seperti saiz dan biji. Struktur anatomi yang terbukti signifikan secara diagnostik adalah petiol, urat tengah lamina, peruratan, stomata dan trikrom. Lima jenis sistem vaskular corak berbentuk-U dijumpai didalam sistem vaskular petiol. Sistem vascular urat tengah kebanyakannya adalah berbentuk-U, permukaan abaksial adalah cembung-rata; adaksial berlurah, rata, berbonggol dan bertimbun; tebal daun adalah dari 0.075 mm sehingga 0.93 mm. Empat jenis tepi daun telah kerap; melengkung, melengkung sedikit, akut dan bulat. Sistem peruratan dengan areol berbeza daripada pentagonal kepada empat segi; hujung peruratan adalah berbeza daripada selari mudah sehingga ke melengkung mudah, berdahan sekali dan berdahan dua kali. Taburan stomata adalah rawak, selalunya anomositik tetapi terdapat juga diasitik kepada aktinositik dan jarang anisositik kepada parasitik. Lapan jenis trikrom yang mana lebih khusus dalam jenis dan taburan di kalangan spesies telah ditemui; empat adalah subsesil berkelenjar dan empat bukan berkelenjar. Kajian palinologi menunjukkan saiz debunga, dari 17.1 μm 29.9 μm pada kutub dan 12.3 μm kepada 39.9 μm pada pandangan garis lintang, juga adalah diagnostik. Perlakuan taksonomi termasuk kekunci kepada takson, senarai penuh dan huraian semua spesies dan spesimen yang dikaji termasuk nama orang yang mengumpul, nombor kutipan, tempat, tarikh dan di mana ia disimpan. Taburan takson juga dipetakan.

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LIST OF ABBREVIATIONS

BEBP	Bibliographic Enumeration of Bornean Plants
BJBB	Bull. Jard. Bot. Buitenz.
BO	Herbarium Bogor Botanical Garden
Bkt.	Hill
CLTS	Check List Tree of Sarawak
DBH	Dimeter at breast height (1.30 m)
DEPMP	Dictionary of the Economic Products of the Malay Peninsular
DOF	Department of Forestry
EPB	Enumeratio Phanerogamarum Bornean
FFBB	Forest Flora British Burma
FBI	Flora British India
FM	Flora Malesiana
FMP	Flora of the Malay Peninsula
FR	Forest Reserve
FRC	Forest Research Centre
FRIM	Forestry Research Institute Malaysia
FTSB	Forest Trees of Sarawak & Brunei
GoL	Government of Lao
Gn.	Mountain
Herb.	Herbarium
H. E.	His Excellency
K	Royal Botanic Gardens Kew
Kg.	Kampong (Village)
KEP	Herbarium Forestry Research Institute Malaysia
KLU	Herbarium University of Malaya
LM	Light Microscope
LSFP	Lao-Swedish Forestry Programme
MAF	Ministry of Agriculture and Forestry
MFR	Malayan Forest Record
MT	Medium Tree
NOFIP	National Office of Forest Inventory and Planning
NP.	National Park
OTUs	Operational Taxonomic Units
PNH	Philippines National Herbarium
S	Herbarium, Forestry Department Sarawak, Kuching.
SAN	Herbarium, Forestry Department Sabah, Sandakan.
SEM	Scanning Electron Microscope
Sg.	Sungai (River)
SH	Shrub
SING	Herbarium, Singapore Botanical Gardens
Spp	> 2 species unidentified
ST	Small tree
T	Tree
TFIC	Tree Flora of Indonesia Checklist
TFM	Tree Flora of Malaya
TFSS	Tree Flora of Sabah & Sarawak
UKM	Herbarium, Universiti Kebangsaan Malaysia



UM
UPM
Var.
WTM

Universiti Malaya
Universiti Putra Malaysia
Variety
Wayside Tree of Malaya



CHAPTER I

INTRODUCTION

South-East Asia is richly endowed with natural forest resources. The countries in this region account for a total forest area of about 212 million ha (FAO, 1999) in which 193 million ha are found in Lao PDR, Vietnam, Cambodia, Myanmar (Burma), Thailand, Philippines, Indonesia, Brunei and Singapore. Malaysia alone, which comprises of Peninsular Malaysia, Sabah and Sarawak, occupies 19 million ha.

Estimates show that 25,000 to 30,000 species of the flowering plants are found in South-East Asia (Whitmore, 1992). Peninsular Malaysia has at least 8,000 plant species and possibly, as many as 15,000 species of flowering plants are found in Borneo (Ashton, 1964, 1977; Poore, 1968; Turner, 1995).

The Verbenaceae family comprises a very large number of species world-wide. Schauer (1847) recorded 670 species, Lawrence (1951) 2,614 species, Rendle (1959) 800 species, Melchior (1964), Dutta (1970) 2,600 species, Nguyen Tich and Tran Hop (1971) 2,800 species, Good (1974) 3,000 species, Kochummen (1978) 1,000 species, Cronquist (1981) 3,000 species, Hickey and King (1981)

3,000, Samuel and Arlene (1986) 2,600 species, Radford (1986) 3,151 species, Corner (1988) 1,000 species and Bhattacharyya and Johri (1998) 2,614 species.

Saint-Hilaire (1805) noted that Verbenaceae comprises of 27 genera whereas other authors recorded the following: Schauer (1847) 42 genera; Lawrence (1951) 98 genera; Rendle (1959) 80 genera; Allan (1961), Melchior (1964), Dutta (1970), Nguyen Tich and Tran Hop (1971), Corner (1988), Cronquist (1981) and Samuel and Arlene (1986) 100 genera; Good (1974) and Hickey and King (1981) 75 genera; Moldenke (1980) 78 genera; Radford (1986), Sharma (1993) 99 genera and Bhattacharyya and Johri (1998) 98 genera. The largest genera included *Clerodendrum* comprising 90-400 species, *Vitex* has 100-380 species, *Verbena* 80-250 species, *Lippia* 200 species, *Premna* 200 species and *Lantana* has 50-155 species.

Most members of the genus *Vitex* are small to medium and large trees (rarely shrub or creeping shrubs), yet some of the *Vitex* and *Clerodendrum* species are handsome shrubs (Loudon, 1973). *Vitex* is widely distributed throughout the world, mostly tropical and subtropical regions and only a few species are found in the temperate regions (Fig. 1). In South East Asia the genus *Vitex* is distributed from Indo-China through Indo-Malaya, Java, Sumatra and Borneo.

In Peninsular Malaysia there are 11-15 genera and 70 species which are distributed chiefly in the lowland areas (Corner, 1988; Kochummen, 1978; Keng, 1969) while 15 genera are native or endemic in Malaya (Keng, 1969). In Merrill's (1921) and Masamune's (1942) enumeration of species, they revealed a total of 17 genera and 83 species in Borneo. Thus from these records cited by the

previous authors, the family Verbenaceae has a range of 15-17 genera and 70-83 species in Malaysia at present.

Economic Uses

Vitex is known economically for its timber use. Woods of some *Vitex* species that are hard equivalent has been used earlier in India, Burma, Vietnam, Malaya, Philippines and other countries before the 18th century. The timber is used for building bridges and railway sleepers, agriculture tools, construction, furniture, sport instruments, machine accessories, cart-wheels, house building, ruler, piano sharps, small turnery, fencing posts, flooring, chisel handles, scantling, hydraulic engineering, ships and boats, wattle-work and general implements like fire wood (Burkill, 1935; Howard, 1951; Uphof, 1968, Tanaka & Nacao, 1976, etc). Likewise, it is used in traditional medicine and as food.

The roots, fruits and flowers of some species are known for its food value (Appendix. H). The leaves and bark of some species such as *V. trifolia*, *V. negundo*, *V. quinata* and *V. pinnata* can be used as medicines for human consumption and insecticide (Burkill, 1935; Uphof, 1968; Kirtikar *et al.*, 1975; Tanaka & Nacao, 1976; Kunkel, 1984, etc).

Moreover, Taylor (1961), Whitehead (1970), Hellyer (1971) and Loudon (1973) pointed out that some *Vitex* like *V. agnus-castus* has its aesthetic value and are used for landscape architecture, gardens, marshy places, roadside, urban forest trees, and forestland rehabilitation, and related uses. In Sarawak particularly *V. pinnata* is cited as a good ornamental species for the roadside (Chai, 1984). The

details of economic uses of each species are presented in taxonomic treatment in Chapter VII.

Justification of Study

With the increasing rate of environmental degradation and current issues on biodiversity, the documentation of the country's flora is deemed important before they disappear or become totally unknown to science. Basic data on flora, which especially employs systematic studies, is useful and fundamental to many fields. This systematic study of the genus *Vitex* in Borneo is significant to the on-going project of the Tree Flora of Sabah and Sarawak as it may provide some vital information particularly on the morphological characteristics of the species.

Limitation of the Study

In this study, herbarium specimens had to be used in the majority of the cases and this obviously restricted the amount of the material available for study, which called for critical sectioning. Limited time and finance also restricted some attempts, such as survey for all the species investigated.

Objectives of Study

The primary objective of this study is to conduct a systematic study on the genus *Vitex* in Borneo specially Sabah and Sarawak, by employing some taxonomic evidences such as:

- (i) Morphology,
- (ii) Anatomy,
- (iii) Palynology,
- (iv) Ecology and distribution, and
- (v) Numerical taxonomy.

Specifically, this study attempts to update the species record in Borneo and generate a key to species identification.