



A TAXONOMIC STUDY OF *Vitex* L. (LAMIACEAE MARTINOV) IN PENINSULAR MALAYSIA



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Kampus Sultan Abdul Jalil Shah



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IN PENINSULAR MALAYSIA

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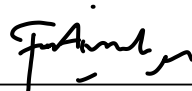
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ABSTRACT

This study was aimed to examine the taxonomy of *Vitex* L. (Lamiaceae Martinov) in Peninsular Malaysia was done. Taxonomic evidences were gained based on morphology, leaf anatomy, micromorphology and distribution of the genus. The morphological and anatomical data were analysed using Multi-Variate Statistical Package (MVSP) and Phylogenetic Analysis Using Parsimony (PAUP) software to obtain of similarity values between species and their evolutionary relationship. Morphological characters which are trichomes were used as the major characters to classify the genus, while leaf anatomical and micromorphological characters were used as supportive evidence. All the data collected were used to construct dichotomous key based on morphological and anatomical characters. Species distribution data were gained from herbarium and field study. A total number of 11 species, one subspecies and two varieties of *Vitex* were identified. The species include *V. gamosepala*, *V. glabrata*, *V. longisepala*, *V. millsii*, *V. negundo*, *V. negundo* var. *bicolor*, *V. negundo* var. *cannabifolia*, *V. pinnata*, *V. quinata*, *V. trifolia*, *V. trifolia* subsp. *litoralis*, *V. vestita*, *V. sp.1* and *V. sp.2*. Cladogram clades show an overall Gower General Similarity Coefficient (GGSc) value at 0.715 to 0.964 which indicate clear separation at genus and species level. Therefore, the morphological and anatomical characters used were highly significant. Most common *Vitex* species distributed throughout Peninsular Malaysia are *V. gamosepala*, *V. vestita*, *V. pinnata* and *V. longisepala*. This study implicate that morphological and anatomical characters of vegetative parts can be used in identification of species, subspecies and variety of this genus.



KAJIAN TAKSONOMI TERHADAP *Vitex* L. (LAMIACEAE MARTINOV) DI SEMENANJUNG MALAYSIA

ABSTRAK

Kajian ini bertujuan untuk mengkaji taksonomi terhadap *Vitex* L. (Lamiaceae Martinov) di Semenanjung Malaysia telah dijalankan. Bukti taksonomi diperolehi berdasarkan data morfologi, anatomi daun, mikromorfologi dan taburan spesies bagi genus ini. Data dianalisis menggunakan perisian *Multi Variate Statistical Package* (MVSP) dan *Phylogenetic Analysis Using Parsimony* (PAUP) untuk mendapatkan nilai persamaan di antara spesies dan hubungan filogenetik. Ciri morfologi iaitu ciri trikom telah digunakan sebagai ciri utama dalam mengelaskan genus, manakala ciri anatomi daun dan mikromorfologi telah digunakan sebagai bukti sokongan. Kesemua data yang dikumpul telah digunakan untuk membina kekunci dikotomi berdasarkan kepada ciri morfologi dan anatomi. Data taburan spesies pula, didapati daripada kajian herbarium dan lapangan. Sejumlah 11 spesies, satu subspesies dan dua varieti *Vitex* dikenal pasti, iaitu *V. gamosepala*, *V. glabrata*, *V. longisepala*, *V. millsii*, *V. negundo*, *V. negundo* var. *bicolor*, *V. negundo* var. *cannabifolia*, *V. pinnata*, *V. quinata*, *V. trifolia*, *V. trifolia* subsp. *litoralis*, *V. vestita*, *V. sp.1* and *V. sp.2*. Klad kladogram menunjukkan nilai *Gower General Similarity Coefficient* (GGSc) keseluruhan pada 0.715 hingga 0.964 membuktikan pengasingan yang jelas pada aras genus dan spesies. Justeru ciri morfologi dan anatomi yang digunakan mempunyai nilai taksonomi sangat signifikan menyokong nilai taksonomi. Spesies yang mempunyai taburan meluas di Semenanjung Malaysia adalah *V. gamosepala*, *V. vestita*, *V. pinnata* dan *V. longisepala*. Kajian ini memberi implikasi ciri morfologi dan anatomi pada bahagian vegetatif boleh digunakan dalam pengecaman spesies, subspecies dan varieti dalam genus ini.





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- G PAUP Analysis – Anatomy
- H PAUP Analysis – Combine





LIST OF ABBREVIATIONS

FeSEM	Field emission Scanning Electron Microscope
FRIM	Forest Research Institute Malaysia
GGSc	Gower's General Similarity Coefficient
GPS	Global Positioning System
MVSP	Multi Variate Statistical Package
OTUs	Operational Taxonomic Units
PAUP	Phylogenetic Analysis Using Parsimony
SEM	Scanning Electron Microscope
UPGMA	Unweighted Pair Group Method with Arithmetic Mean



CHAPTER 1

INTRODUCTION

1.1 General on Lamiaceae

The family Lamiaceae was famously known as the mint family. The named Lamiaceae was derived from a Greek word, *Lamium* which referred for lip-bearing in reference to the obvious floral feature. Most of the plants in this family are used in culinary herbs, such as mint, basil, rosemary, sage, savory, oregano, thyme and lavender (LaFrankie, 2010). The family Lamiaceae is in the major group Angiosperms (The Plant List, 2010) and is denoted as the largest family in the order Lamiales (Stevens, 2001) with 236 genera and 7,173 species which is widely distributed globally (Harley et al., 2004).

Based on the United States Department of Agriculture, the classification for the Kingdom Plantae down to Family Lamiaceae was noted as Figure 1.1.

Kingdom Plantae – Plants
Subkingdom Tracheobionta – Vascular plants
Superdivision Spermatophyta – Seed plants
Division Magnoliophyta – Flowering plants
Class Magnoliopsida – Dicotyledons
Subclass Asteridae
Order Lamiales
Family Lamiaceae – Mint family

Figure 1.1. The classification of Kingdom Plantae down to Family Lamiaceae (USDA, 2017)

In the order Lamiales, Lamiaceae is one of the main families which includes Verbenaceae, Plantaginaceae, Scrophulariaceae, Orobanchaceae, Acanthaceae, Gesneriaceae, Bignoniaceae, Oleoaceae, Pedaliaceae, and the small carnivorous families Lentibulariaceae and Byblidaceae. Based on the phylogeny as shown in Figure 1.2, it stays under the same clade together with Verbenaceae, Acanthaceae, Bignoniaceae, Scrophulariaceae and some other families.

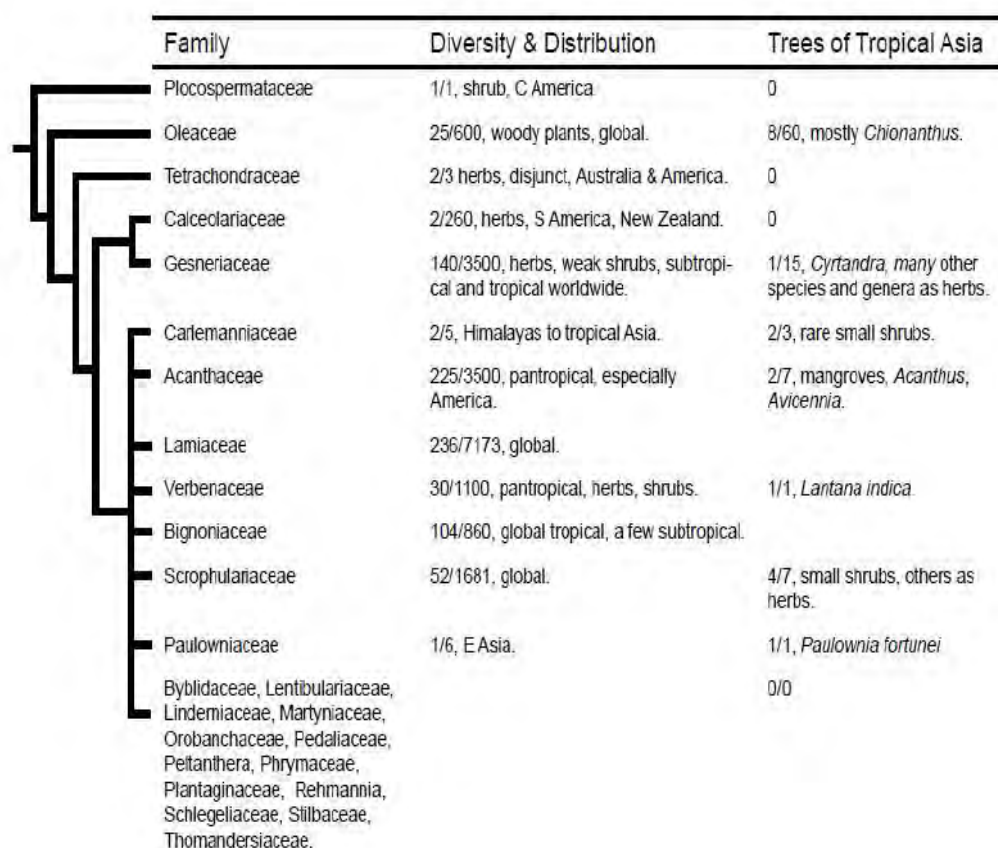


Figure 1.2. The phylogeny of the Lamiales (LaFrankie, 2010)

Among trees of Tropical Asia, the Lamiaceae are represented by about 13 genera and around 120 species. The 13 genera including in the family Lamiaceae are *Lamioideae*, *Nepetoideae*, *Prostantheroideae*, *Scutelleroideae*, *Symphorematoideae*, *Viticoideae* (Vitex-Group), *Ajugoideae* (Clerodendrum-Group) and ten unplaced genera includes *Peronema*, *Callicarpa*, *Gmelina*, *Tectona*, *Hymenopyramis* and *Garrettia* (LaFrankie, 2010).



Lamiaceae is accepted to have simple, opposite-decussate leaves with varied type of margins and hairy glandular surface. These glands contain volatile oil which makes the leaves aromatic (Bhattacharyya & Johri, 1998). They consist of herbs, also shrubs, lianas and rarely trees, that may be recognised by their opposite, usually serrate leaves, more or less square stems, and monosymmetric flowers usually borne in clearly cymose clusters. The plants are often aromatic (Stevens, 2001), hence making this family known as mint family in English.

1.2 The Genus *Vitex*

Vitex is one of the important genus belongs to the Lamiaceae (Corner, 1988). There are 250 known species worldwide, 25 species occurring in Southeast Asia (LaFrankie, 2010) and ten species were recorded in Peninsular Malaysia (Turner, 1995). The genus *Vitex* is named by Pliny, which is possibly refers for caste tree, *Vitex agnus-castus*, a species belongs to this genus (Gledhill, 2008). Linnaeus (1753) described that *Vitex agnus-castus*, together with *Vitex trifolia*, *Vitex negundo* and *Vitex pinnata* as the pioneered species of the genus (Figure 1.3). Commonly, *Vitex* is recognised by having trifoliate or palmate with 3-7 leaflets, where the middle is the largest (Corner, 1988) and *Vitex* in Malaya are nearly all trees or shrubs (Henderson, 1959).

Vitex species is common among Malays with the name Leban, Haleban, Halban, Leban Pachat, Lemuning, Demundi, Muning, Lagundi, Kemuning Hitam and Leban Pelandok. In Peninsular Malaysia, there are some species of *Vitex* which are named based on the states like the Penang *Vitex*. Different states also may refer the same species as different names. Community in Johor for instance identified the Horse-



Chestnut Teak as Kayu Gah, while in Terengganu it is called as Gedebah Lembu. Apart from that, community in Sarawak and Philippines identified *Vitex* species as Lenggundi and Lagundi (LaFrankie, 2010).



Figure 1.3. Pioneered species of *Vitex*, (a) *Vitex trifolia*, (b) *Vitex pinnata* and (c) *Vitex negundo*



The leaves of some *Vitex* species are known for its food value. *V. negundo* or commonly known as Lemuni have been used to cook with rice to make lemuni rice, a Kedah traditional dish. The black coloured rice in the dish was extracted from the leaves of the *V. negundo* which also produces its special aroma as an added value to the rice (Indu Bala Jaganath & Lean, 2000). In addition, the potential of *Vitex* in timber industry also showed that they are used extensively in making of tools, weapons and kitchen utensils. Other than that, it grown for the purpose of ornamentation (de Kok, 2008).

Besides that, *Vitex* is common with its medicinal value as a number of species of *Vitex* have medicinal uses (Kochummen, 1978). Many researches relating to its medicinal value have been proven. A current research done by Zamani et al, (2012) discovered that *V. agnus-castus* has its therapeutic effect towards women who had the Pre-Menstrual Symptoms. Furthermore, a finding by Ong (2004) shows that both of *V. negundo* and *V. trifolia* can be used to treat various disease. This includes high fever, rheumatism, cholera, headache, toothache, flu, gall stone, muscle cramp, rheumatism, mental and physical stress.

Moreover, the leaves extract of *V. negundo* and *V. trifolia* can be used to control the agricultural pesticide and also able to kill the Anopheles and Culex mosquitoes. The dried leaves also able to be kept in the rice container or in the cloth cupboard in order to avoid insects or else is burnt to expel mosquitoes. While the leaves of *V. trifolia* are used as the perfume in the home. As the conclusion, variety of uses in *Vitex* concluded that *Vitex* species is not only important for individual, but also contribute in the country's economic values as well (Indu Bala Jaganath & Lean, 2000).





1.3 Background of Study

The genus *Vitex*, is one of the prominent genus in the family of Lamiaceae. It is the largest genus in the subfamily Viticoideae of Lamiaceae with 250 known species worldwide (Bello et al., 2018). *Vitex* in the world was first described by Linnaeus (1753) while the first revision of the genus *Vitex* in Malayan Archipelago which covers the Peninsular Malaysia was done by Lam (1919), followed by Lam and Bakhuizen (1921), Ridley (1923), Henderson (1930), Steenis (1957), Henderson (1974), Kochummen (1978), (Chin, 1982), Turner (1995) and Bramley (2019). Lam (1919) first described 46 species of *Vitex*, followed by Ridley (1923) with 15 species, Kochummen (1978) and Turner (1995) both recorded ten species and Bramely (2019) recorded 13 species in Peninsular Malaysia.



micromorphological and anatomical characters, including their mapped distribution as an additional data. Both voucher specimens and fresh specimens were examined on the basis of morphological characteristics. 11 species with two varieties and one subspecies of *Vitex* namely *V. pinnata*, *V. vestita*, *V. gamosepala*, *V. longisepala*, *V. glabrata*, *V. negundo*, *V. quinata*, *V. trifolia*, *V. millsii*, *V. trifolia* subsp. *litoralis*, *V. negundo* var. *bicolor*, *V. negundo* var. *cannabifolia*, *V. sp.1* and *V. sp.2* will be examined. Commonly, *Vitex* species are identified based on its opposite, trifoliate or palmate leaves. This research present shows distinct characters among the species therefore, has taxonomic significance.



1.4 Problem Statement

Vitex was currently placed in Lamiaceae which is accepted in Angiosperm Phylogeny Group IV, APG IV (2016). This genus is well known as complex morphologically therefore, contributed to its taxonomic conflict worldwide especially in Southeast Asia including Peninsular Malaysia. Furthermore, the most problematic group in the subfamily Viticoideae is the large genus *Vitex* and its related genera. At present the generic delimitation based on a number of traditionally used morphological characters is confusing and troublesome (Bramley et al., 2009).

The genus *Vitex* in the Peninsular Malaysia, was dealt with in the now largely outdated revision in South-East Asia by Lam (1919) and Lam and Bakhuizen (1921). They discovered the species in the tropics of both the Old and the New World. Even though the species from New Guinea and the Pacific are dealt with in de Kok (2007; 2008), but those species which have been treated in the New Guinea are only cursorily treated (de Kok, 2008).

Literature reviews have indicated that there were various systematic studies have been carried out on *Vitex*, but only a few outdated studies have been done in Peninsular Malaysia. The description of *Vitex* which is focused in Peninsular Malaysia were only done by Ridley (1923), Kochummen (1978) and Turner (1995). Because the genus has never been revised in full, therefore the generic delimitation of *Vitex* and its close relatives still requires proper analysis (de Kok, 2007) so that it can contribute in the solving the paraphyletic relationship in Viticoideae (Bramley, 2009).



Different researchers come out with different outcome of species recorded. But, the exact number of *Vitex* species in Peninsular Malaysia was a confusing. Lam (1919) first described 46 species of *Vitex*, followed by Ridley (1923) with 15 species, Kochummen (1978) and Turner (1995) both recorded ten species. Hence, this has been the most valuable attraction to conduct this study. All of the studies by Ridley (1923), Henderson (1930), Steenis (1957), Henderson (1974), Kochummen (1978) and Corner (1988) were done based on the description of vegetative and reproductive morphology of the species, but there have been no studies which includes anatomical and micromorphological description as the supportive evidence in treating the genus. Therefore, an update and latest study regarding to morphological, anatomical and micromorphological study regarding to the species of *Vitex* in Peninsular Malaysia need to be done.



1.5 Objectives of Study

This study is critically interested in order to examine, with all morphological, micromorphological and leave anatomical characters to solve the generic characteristics. The objectives to be achieved in this study are:

1. To determine the taxonomic significance of *Vitex* by using the morphological and leaf anatomical characters.
2. To construct the key identification based on morphological and anatomical characteristics of leaf.
3. To evaluate numerical data based on morphological and anatomical characters.
4. To map the distribution *Vitex* in Peninsular Malaysia.



1.6 Research Question

This study hopes to solve several broader biological questions such as:

1. What are the morphological and leaf anatomical characters of *Vitex* that shows taxonomic significance?
2. Does the constructed key workable to identify *Vitex* species in Peninsular Malaysia?
3. Are the constructed dendogram, neighbor-joining tree and parsimonious tree support the current classification of the species?
4. What are the distribution of *Vitex* in Peninsular Malaysia? Where it can be found?

The definition of the terms used in this study is defined precisely as below:

1.7.1 Dichotomous Key

Dichotomous key is a tool that can be used to identify organisms (Ed Jensen et al., 2021) which consists of a series of paired statements or clues about features or characteristics to provide a stepwise guide towards identifying certain species. Dichotomous key in this study was done based on morphological, micromorphological and anatomical characters to identify the species.

1.7.2 Numerical Taxonomy in Plant

Numerical taxonomy is a system of plant classification which deals with the grouping by numerical methods of taxonomic unit based on their character states to create a taxonomy by using numeric algorithms like cluster analysis. Numerical taxonomy is important to clarify and illustrate degrees of relationship or similarity (Albert et al., 1974).

1.8 Significance of Study

The findings of this study will contribute to resolve the taxonomic conflicts among the genus in the family Lamiaceae. The transferring of some of the *Vitex* species into the other genus *Teijsmanniodendron* by Lam and Bakhuizen (1921) is still a confusion and the description of *Vitex* species in Peninsular Malaysia by Corner (1988) is still unclear. Through this study, the composition of the genus will be known and a key identification to species by morphology, micromorphology and leave anatomy will be generated.

Furthermore, the use of information from this study will provide an update data to the species which includes the number of species collected, morphological data, micromorphological data and leaves anatomical data. Thus, an outdated study which involves *Vitex* species in Peninsular Malaysia can be updated and improved. This study hopes to establish a knowledge about the genus *Vitex*, not only for the future researchers to be used as reference data in conducting new researches or in testing the validity of other related findings, but also to the society.