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Studies on Leaf Venation in Selected Taxa of the Genus *Ficus* L. (Moraceae) in Peninsular Malaysia

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Abstrak: Kajian variasi corak peruratan daun telah dijalankan terhadap 21 takson daripada genus *Ficus* di Semenanjung Malaysia. Hasil menunjukkan kehadiran lapan corak peruratan daun berdasarkan percabangan urat, peruratan tepi dan tengah lamina daun. Majoriti spesies seperti *F. annulata, F. benghalensis, F. benjamina*, *F. deltoidea* var. *angustifolia*, *F. deltoidea* var. *kunstleri*, *F. depressa*, *F. elastica*, *F. hispida*, *F. microcarpa, F. religiosa, F. tinctoria, F. ucinata* dan *F. vasculosa* menunjukkan urat bercabang tiga. Corak lain hadir seperti berikut: urat bercabang dua pada *F. aurata* dan *F. heteropleura*; urat bercabang satu pada *F. lepicarpa*, *F. schwarzii* dan *F. superba*; dan urat ringkas pada *F. aurantiacea* dan *F. fulva*. *F. sagittata* menunjukkan tiada percabangan yang hadir untuk tengah lamina. Kehadiran trakeid atau urat membengkak pada bahagian tengah lamina dan kehadiran sel sistolit serta trikom merupakan ciri anatomi sepunya yang boleh membantu dalam pengkelasan kumpulan spesies kajian. Variasi corak peruratan daun bukan sahaja mempunyai nilai dalam mengenal pasti kumpulan takson, malah boleh juga digunakan untuk membezakan antara spesies dalam genus *Ficus*.

Kata kunci: Moraceae, *Ficus*, Peruratan Daun, Anatomi Daun

Abstract: A study on the variation of leaf venation patterns was conducted on 21 taxa of the genus *Ficus* in Peninsular Malaysia. The results showed the existence of eight leaf venation patterns based on veinlets, the ultimate marginal and areolar venation. The majority of species, such as *F. annulata, F. benghalensis, F. benjamina, F. deltoidea* var. *angustifolia, F. deltoidea* var. *kunstleri, F. depressa, F. elastica, F. hispida, F. microcarpa, F. religiosa, F. tinctoria, F. ucinata* and *F. vasculosa*, show tri-veinlets. The others exhibit the following: bi-veinlets in *F. aurata* and *F. heteropleura*; uni-veinlets in *F. lepicarpa, F. schwarzii* and *F. superba*; and simple veinlets in *F. aurantiacea* and *F.* fulva. *F. sagittata* presents no veinlets for areolar venation. The presence of tracheid or swollen veins at the centre of the lamina and the presence of cystolith cells and trichomes are common anatomical characteristics that could assist in group classification of the studied species. Variations in leaf venation patterns are not only valuable in identifying a taxon group, but can also be used to differentiate between species in the genus *Ficus.*

Keywords: Moraceae, *Ficus,* Leaf Venation, Leaf Anatomy

INTRODUCTION

Ficus (figs) belongs to the Moraceae family and is one of the largest angiosperm genera, with approximately 1000 species worldwide (Berg 1990) distributed throughout tropical and subtropical areas of Asia, Australia, Africa and America.

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Frodin (2004) has ranked this genus as one of the 21 largest genera of seed plants. The Malaysian forest is extremely rich in *Ficus* species, with approximately 16% (101) of known species (Ng 1978). With regard to growth habit, Harrison (2005) considers this genus as one of the most diverse. *Ficus* includes a large number of indoor ornamental plants and garden and roadside trees, such as *F. religiosa, F. elastica* and *F. microcarpa.* The genus is easy to identify by the highly characteristic fruits, or syconia, and also by the milky juice, the prominent stipules that leave a scar after abscission and the minute unisexual flowers often arranged on variously shaped receptacles (Hutchinson & Dalziel 1958). However, some species do not bear syconia, and their morphological characteristics are similar, contributing to difficulty in species identification, especially in the field.

Anatomical studies of leaf venation have shown that ornamentation of the veins and the course of traces in the lamina are useful additional characters for the identification of species of *Euphorbia* (Sehgal & Paliwal 2008). Dede (1962) also described the foliar venation patterns in Rutaceae, proving them to be useful for the identification of various species. Hickey (1973) stated that leaf venation is correlated with plant evolution and has systematic significance in plant identification and classification. Indeed, leaf venation plays a very important role in the identification of incomplete plants, e.g., sterile specimens, archaeological remains and fragmentary fossils of non-reproductive organs. The objective of this study was to determine the patterns of variation in leaf venation that may have taxonomic value for group identification of this taxon.

MATERIALS AND METHODS

A total of 21 taxa of the genus *Ficus* were used in this study. Details of the species studied are presented in Table 1. The fresh specimens used in this study were obtained from many locations in Malaysia, including several forest reserves in Selangor, Terengganu and Perak. Dried specimens were obtained from the Herbarium of Universiti Kebangsaan Malaysia (UKM). The fresh leaf specimens collected were fixed in AA (70% ethanol:30% acetic acid in ratio of 1:3); the dried herbarium samples were boiled. A 1 x 1 cm sample of the leaf lamina and margin area were cleared using Basic Fuchsin solution (10% Basic Fuchsin and 10% KOH, Bendosen Laboratory, Selangor, Malaysia) in an oven at 60ºC for 1 to 2 days, depending on the thickness of the leaf specimen. The cleared leaf specimens were then dehydrated in an alcohol series, cleared in xylene and mounted on slides using Canada Balsam (R&M Chemical, Essex, UK); the samples were then placed in an oven at 60ºC for nearly 2 weeks. The slides were photographed using a digital camera (Olympus BX43F, Tokyo) mounted on an Olympus microscope (Olympus Soft Imaging Solutions GmbH, Münster, Germany). The leaf venation patterns were observed using Cell B Software (Olympus Soft Imaging Solutions GmbH, Münster, Germany) under 10×, 20×, 40× and 100× magnifications. Details of the analysis and descriptions of the leaf venation types followed the classification of Hickey (1973).

Table 1: List of *Ficus* specimens and taxa studied.

Species	Collector, collection number	Locality	Date of collection
F. annulata Blume	A. Hussin, AH 16	Bukit Lagong, FRIM Kepong, Selangor	04.04.2012
	A. Zainuddin, AZ 04390	Endau, Johor	10.03.1988
	A. Zainuddin, AZ 6794	Kuala Berang, Terengganu	01.06.2000
F. aurantiacea Griff. var. *aurantiacea*	B. Ummu-Hani, UHB 05	Recreational Forest of Sungai Salu, Perak	10.11.2011
	B. Ummu-Hani, UHB 15	Batu Berangkai, Kampar, Perak	13.11.2011
	A. Zainuddin, AZ 4665	Km 87, road to Dungun from Kuantan	15.08.1993
F. aurata Miq.	B. Ummu-Hani, UHB 35	Bukit Bauk, Terengganu	06.03.2012
	B. Ummu-Hani, UHB 64	Bukit Chini, Pahang	31.10.2012
	B. Ummu-Hani, UHB 65	Gumum, Chini, Pahang	31.10.2012
F. benghalensis L.	A. Hussin, AH 24	Road to Rawang, Selangor	04.04.2012
F. benjamina L.	A. Hussin, AH 01	Bukit Rawang, Selangor	03.03.2012
	B. Ummu-Hani, UHB 02	Section 15, Bangi, Selangor	20.10.2011
	B. Ummu-Hani, UHB 30	Section 10, Bangi, Selangor	21.02.2012
F. deltoidea Jack var. *angustifolia* (Miq.) Corner	B. Ummu-Hani, UHB 58	Lata Tembakah, Recreational Forest, Terengganu	12.07.2012
	A. Hussin, AH 07	Teluk Senangin, Perak	31.03.2012
F. deltoidea Jack var. *kunstleri* (King) Corner	B. Ummu-Hani, UHB 01	Herb Garden, UKM, Selangor	20.10.2011
	B. Ummu-Hani, UHB 27	Chemerong, Recreational Forest, Terengganu	18.02.2012
	A. Latiff, ALM 1899	Jeli, Kelantan	28.09.1986
F. depressa Blume	B. Ummu-Hani, UHB 07	Batu Berangkai, Kampar, Perak	11.11.2011
	M. Kassim, MK 315	Batu 20, Kuala Selangor, Selangor	05.10.1972
F. elastica Roxb. ex Hornem	B. Ummu-Hani, UHB 21	Road to PUSANIKA Building, UKM, Selangor	31.12.2012
	B. Ummu-Hani, UHB 24	Herb Garden, UKM, Selangor	21.02.2012
	B. Ummu-Hani, UHB 31	Road to Science Nuclear Building, UKM, Selangor	21.02.2012
F. fulva Reinw. ex Blume	B. Ummu-Hani, UHB 12	Batu Berangkai, Kampar, Perak	13.11.2011
	B. Ummu-Hani, UHB 71	Recreational Forest, Hulu Bendul, Negeri Sembilan	07.11.2012
F. lepicarpa Blume	B. Ummu-Hani, UHB 26	Chemerong, Recreational Forest, Terengganu	18.02.2012
	B. Ummu-Hani, UHB 17	Batu Berangkai, Kampar, Perak	13.11.2011
	A. Zainuddin, AZ 5466	Pulau Tioman, Rompin	28.04.1995

(*continued on next page*)

Table 1: (*continued*)

Species	Collector, collection number	Locality	Date of collection
F. heteropleura Blume	A. Hussin, AH 26	Road of Balau, FRIM, Kepong, Selangor	04.04.2012
	B. Ummu-Hani, UHB 69	Chini, Pahang	07.11.2012
	A. Zainuddin, AZ 4709	Bukit Wang, Jitra, Kedah	23.10.1993
F. hispida L.*f.*	A. Hussin, AH 02	Bukit Rawang, Selangor	03.04.2012
	B. Ummu-Hani, UHB 48	Clinic Desa Matang, Perak	26.04.2012
	B. Ummu-Hani, UHB 50	Hulu Matang, Perak	24.06.2012
F. microcarpa L.*f.*	A. Hussin, AH 23	Road to Bukit Lagong, FRIM Kepong, Selangor	04.04.2012
	B. Ummu-Hani, UHB 25	Rintis Alsophila, Taman Paku-Pakis, FST, UKM, Selangor	21.02.2012
	B. Ummu-Hani, UHB 32	Rintis Cibotium, Taman Paku-Pakis, FST, UKM, Selangor	21.02.2012
F. religiosa L.	A. Hussin, AH 04	Bukit Rawang, Selangor	03.04.2012
	B. Ummu-Hani, UHB 18	Sungai Tangkas, Kajang, Selangor	31.12.2011
	B. Ummu-Hani, UHB 29	Sungai Haji Dorani, Sabak Bernam, Selangor	20.02.2012
F. sagittata Vahl	A. Hussin, AH 19	Road to Bukit Lagong, FRIM Kepong, Selangor	04.04.2012
	B. Ummu-Hani, UHB 38	Bukit Bauk, Terengganu	06.03.2012
	B. Ummu-Hani, UHB 63	Sungai Rumput, Gombak, Selangor	24.12.2012
F. schwarzii Koord.	A. Hussin, AH 18	Road to Bukit Lagong, FRIM, Kepong, Selangor	04.04.2012
	B. Ummu-Hani, UHB 10	Batu Berangkai, Kampar, Perak	13.11.2011
	B. Ummu-Hani, UHB 28	Chemerong Recreational Forest, Terengganu	18.02.2012
F. superba (Miq.) Miq.	A. Hussin, AH 10	Road to Bukit Lagong, FRIM, Kepong, Selangor	04.04.2012
	M. Kassim, MK 524	UKM, Bangi, Selangor	05.10.1989
	A. Latiff, ALM 2658	Pulau Aur, Mersing, Johor	25.01.1988
F. tinctoria G. Forst	A. Hussin, AH 15	FRIM Kepong, Selangor	02.04.2012
	A. Zainuddin, AZ 5901	Pulau Tinggi, Mersing, Johor	08.11.1995
F. ucinata (King) Becc.	A. Hussin, AH 06	Bukit Rawang, Selangor	03.04.2012
F. vasculosa Wall. ex Miq.	A. Hussin, AH 22	Road to Bukit Lagong, FRIM, Kepong, Selangor	04.04.2012
	A. Zainuddin, AZ 5480	Pulau Tioman, Pahang	29.04.1995
	A. Zainuddin, AZ 3886	Bukit Bauk, Terengganu	20.10.1991

RESULTS

The leaf venation patterns are described below with illustrations. The comparison and identification of the studied taxa based on their leaf venation patterns are shown in Tables 2 and 3.

Table 2: Comparison of leaf venation patterns in selected taxa of the genus *Ficus.*

Species	Type of ultimate marginal venation		Type of areolar venation		Types of veinlets				
	Incomplete	Complete	Incomplete	Closed	None veinlets	Simple (linear to curve)	Uni-veinlets	Bi-veinlets	Tri-veinlets
F. annulata	+	–	+	–	–	–	–	–	+
F. aurantiacea var. *aurantiacea*	+	–	–	+	–	+	–	–	–
F. aurata	–	+	+	–	–	–	–	+	–
F. benghalensis	–	+	+	–	–	–	–	–	+
F. benjamina	–	+	+	–	–	–	–	–	+
F. deltoidea var. *angustifolia*	+	–	+	–	–	–	–	–	+
F. deltoidea var. *kunstleri*	–	+	+	–	–	–	-–	–	+
F. depressa	–	+	+	–	–	–	–	–	+
F. elastica	–	+	+	–	–	–	–	–	+
F. fulva	–	+	-	+	–	+	–	–	–
F. heteropleura	–	+	+	–	–	–	–	+	–
F. hispida	+	–	+	–	–	–	–	–	+
F. lepicarpa	+	–	–	+	–	–	+	–	–
F. microcarpa	–	+	+	–	–	–	–	–	+
F. religiosa	–	+	+	–	–	–	–	–	+
F. sagittata	–	+	-	+	+	–	–	–	–
F. schwarzii	+	–	+	–	–	–	+	–	–
F. superba	–	+	+	–	–	–	+	–	–
F. tinctoria	+	–	+	–	–	–	–	–	+
F. ucinata	+	–	+	–	–	–	–	–	+
F. vasculosa	+	–	+	–	–	–	–	–	+

Notes: + present; – absent

Table 3: Identification of taxa studied based on leaf venation.

Patterns of leaf venation	Description	Species
1	Complete ultimate marginal venation Closed areolar venation No veinlets	*F. sagittata*
2	Incomplete ultimate marginal venation Closed areolar venation Simple veinlets	*F. aurantiacea var. aurantiacea* *F. fulva*
3	Incomplete ultimate marginal venation Incomplete areolar venation Uni-veinlets	*F. schwarzii*
4	Complete ultimate marginal venation Closed areolar venation Uni-veinlets	*F. superba*
5	Incomplete ultimate marginal venation Closed areolar venation Uni-veinlets	*F. lepicarpa*
6	Complete ultimate marginal venation Incomplete areolar venation Bi-veinlets	*F. aurata* *F. heteropleura*
7	Incomplete ultimate marginal venation Incomplete areolar venation Tri-veinlets	*F. annulata* *F. deltoidea var. angustifolia* *F. hispida* *F. tinctoria* *F. ucinata* *F. vasculosa*
8	Complete ultimate marginal venation Incomplete areolar venation Tri-veinlets	*F. benghalensis* *F. benjamina* *F. deltoidea var. kunstleri* *F. depressa* *F. elastica* *F. microcarpa* *F. religiosa*

Ultimate marginal venation: Two types of ultimate marginal venation were observed. Type 1: Incomplete venation was present in *F. annulata, F. aurantiacea* var. *aurantiacea, F. deltoidea* var. *angustifolia, F. fulva, F. hispida, F. lepicarpa, F. schwarzii, F. tinctoria, F. ucinata* and *F. vasculosa* [Fig. 1(a–j)]. Type 2: complete venation was observed in *F. aurata, F. benghalensis, F. benjamina, F. deltoidea* var. *kunstleri, F. depressa, F. elastica, F. heteropleura, F. microcarpa, F. religiosa, F. sagittata* and *F. superba,* [Fig. 1(k) and (l), Fig. 2(a–i)].

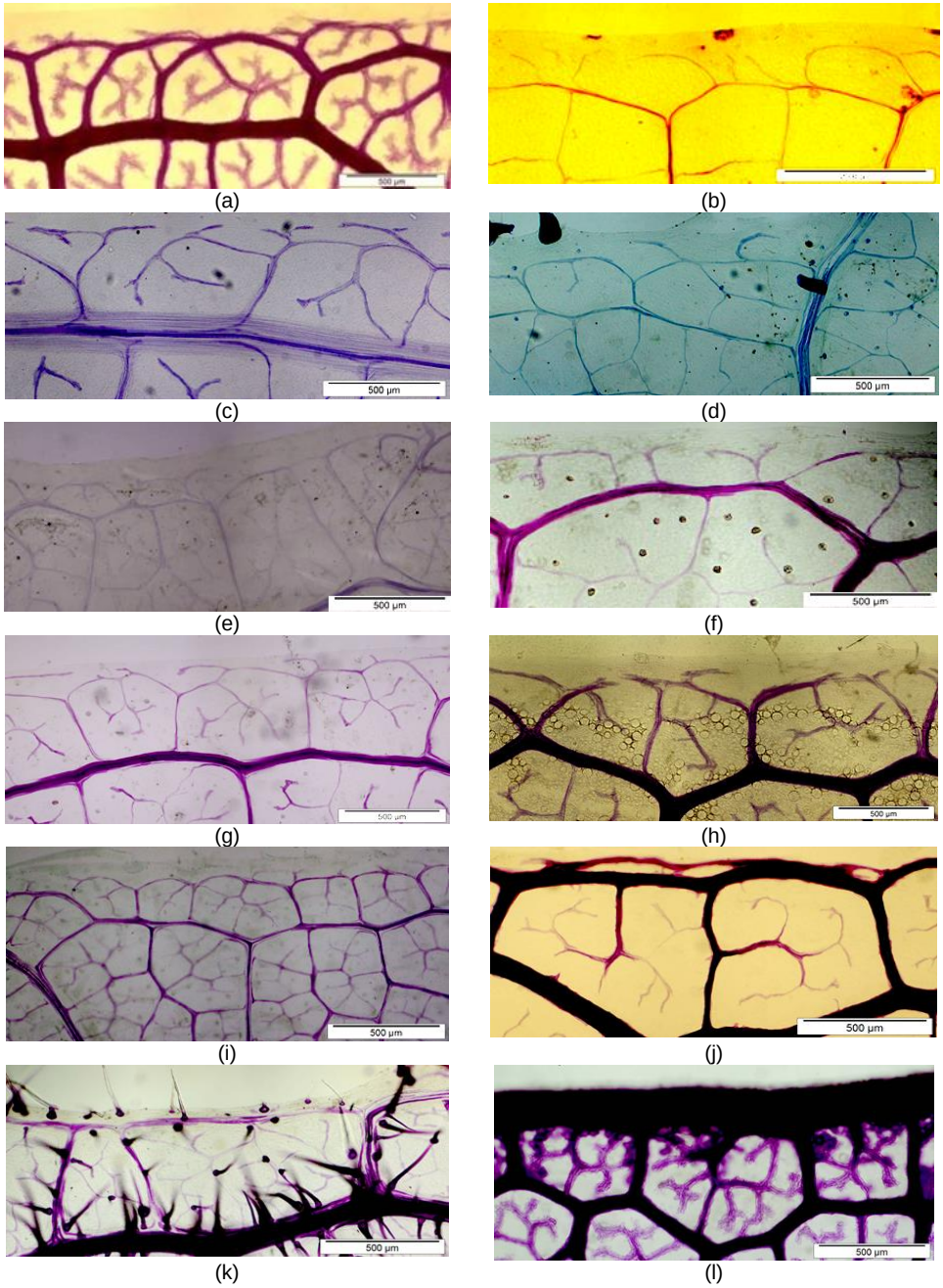


Figure 1: Ultimate marginal venation. In-complete venation; a) *F. annulata*; b) *F. aurantiacea*; c) *F. deltoidea* var. *angustifolia*; d) *F. fulva*; e) *F. hispida*; f) *F. lepicarpa*; g) *F. schwarzii*; h) *F. tinctoria*; i) *F. ucinata*; j) *F. vasculosa*. Complete venation; k) *F. aurata*; l) *F. benghalensis*.

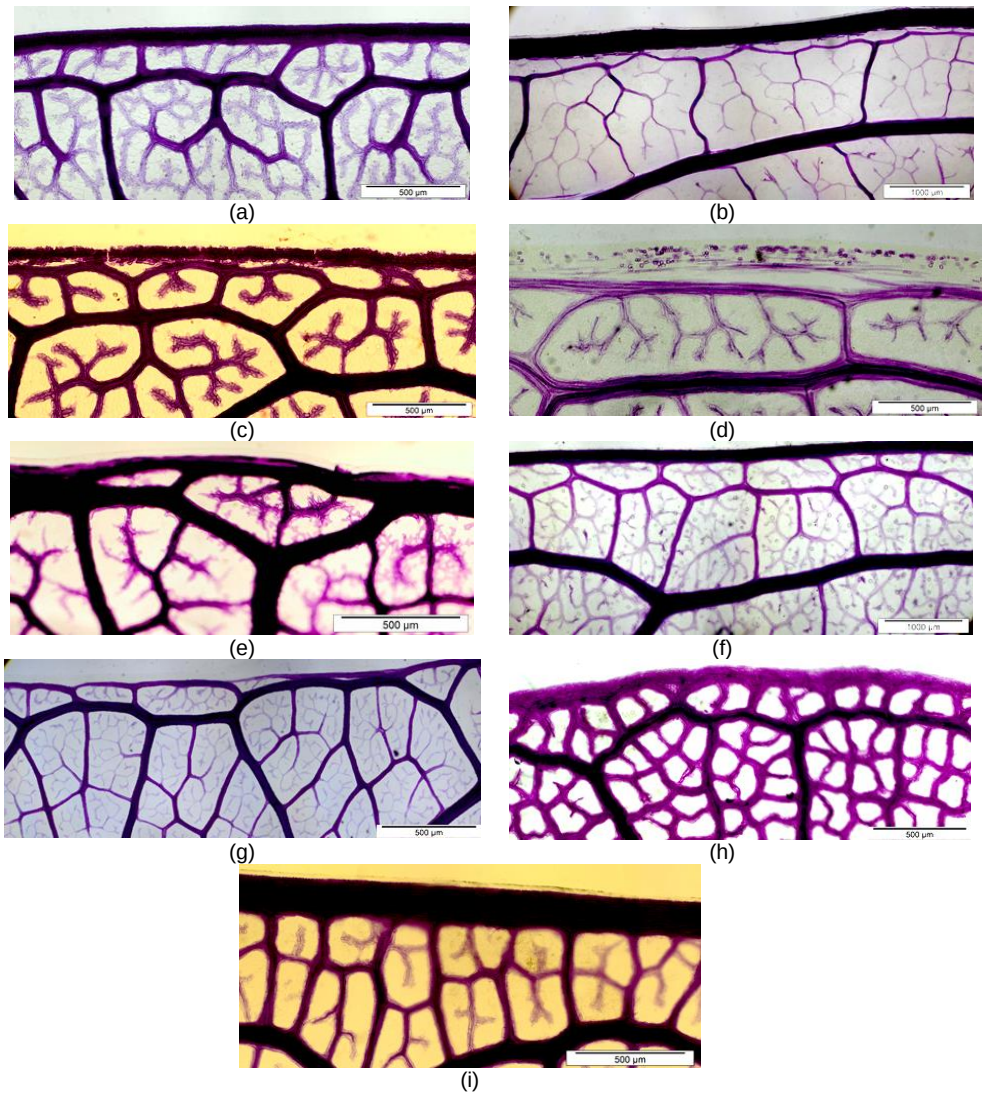


Figure 2: Ultimate marginal venation. Complete venation; a) *F. benjamina;* b) *F. deltoidea* var. *kunstleri*; c) *F. depressa*; d) *F. elastic*; e) *F. heteropleura*; f) *F. microcarpa*; g) *F. religiosa*; h) *F. sagittata*; i) *F. superba*.

Areolar venation: Two types of areolar venation were present. For Type 1, the majority of species showed incomplete-ending veinlets, including *F. annulata, F. aurata, F. benghalensis, F. benjamina, F. deltoidea* var. *angustifolia, F. deltoidea* var. *kunstleri, F. depressa, F. elastica, F. heteropleura, F. hispida, F. microcarpa, F. religiosa, F. schwarzii, F. superba, F. tinctoria, F. ucinata* and *F. vasculosa* [Fig. 3(a–i), Fig. 4(a–h)]. For Type 2, the majority presented closed venation, such as in *F. aurantiacea* var. *aurantiacea, F. fulva, F. lepicarpa* and *F. sagittata* [Fig. 4(i–l)].

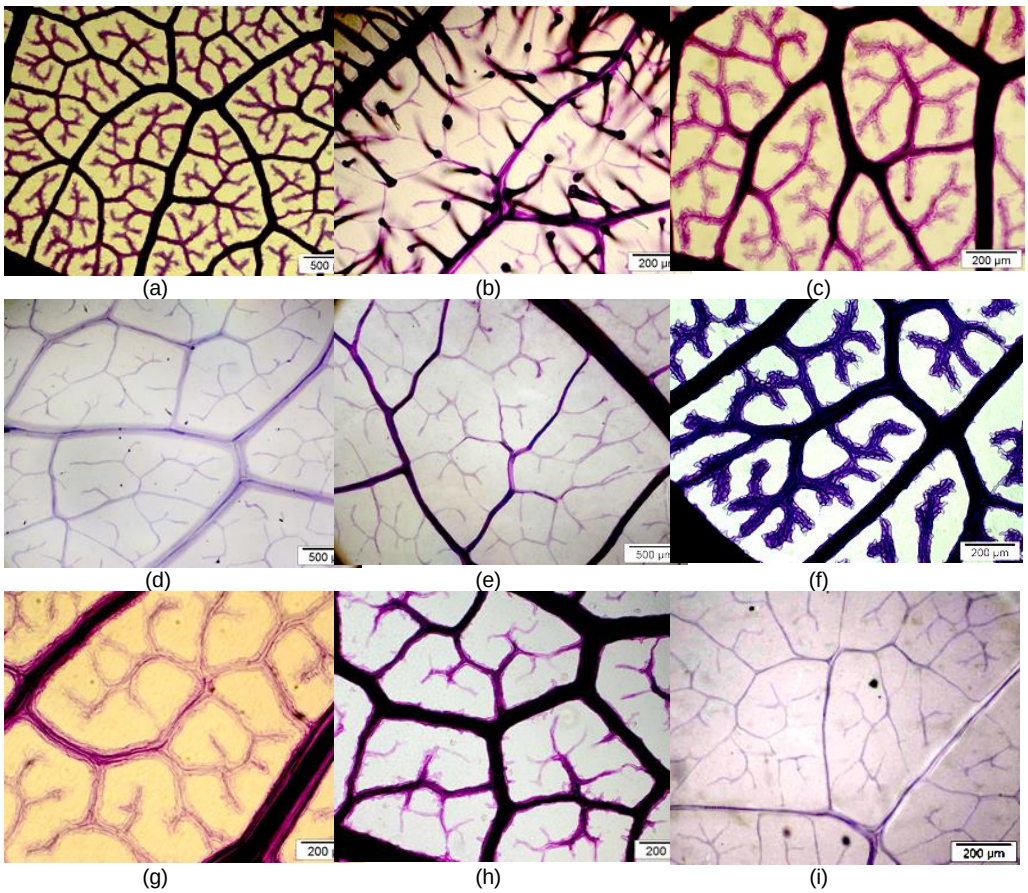
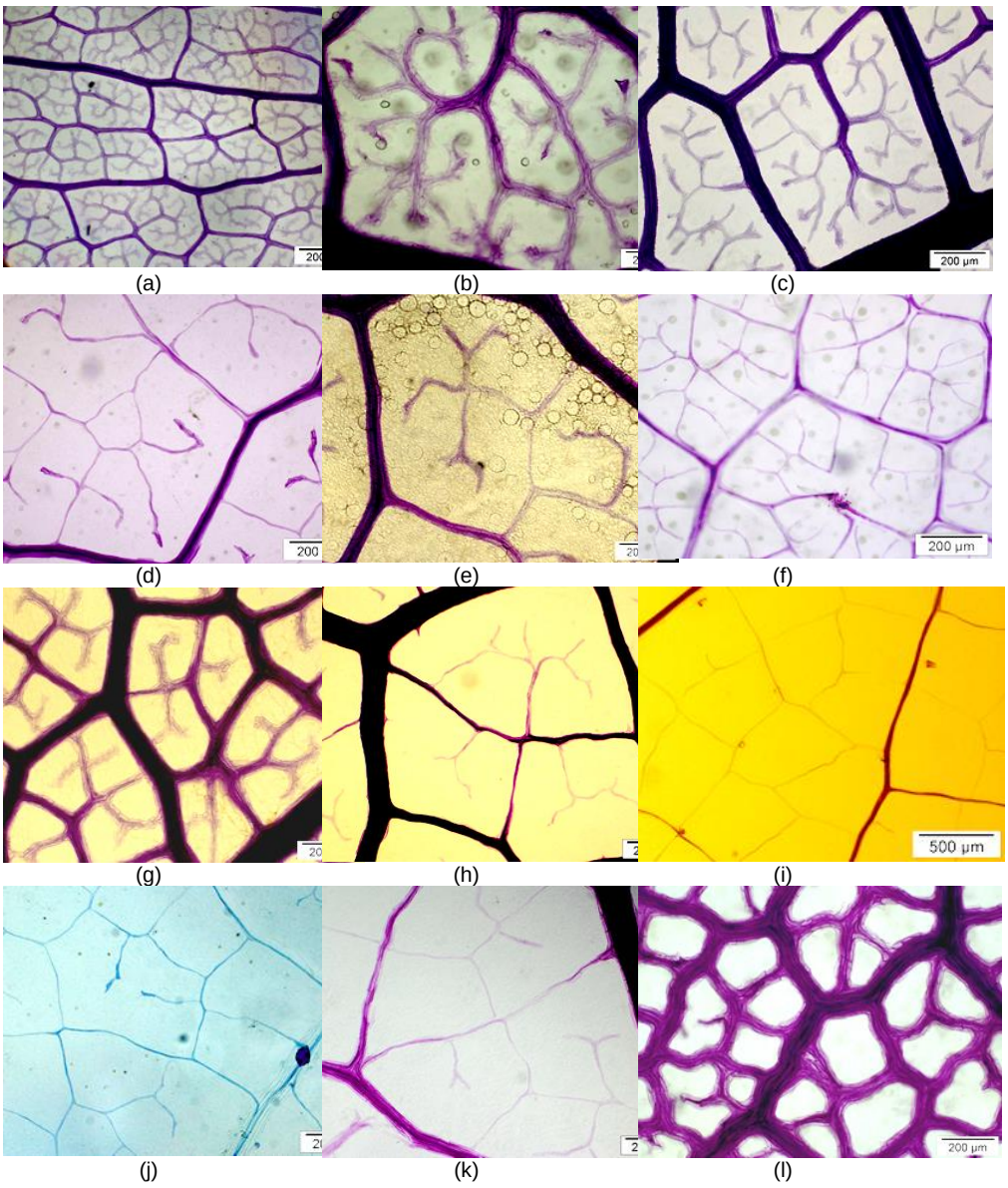


Figure 3: Areolar venation. Incomplete venation; a) *F. annulata*; b) *F. aurata*; c) *F. benghalensis*; d) *F. deltoidea* var. *angustifolia*; e) *F. deltoidea* var. *kunstleri;* f) *F. depressa;* g) *F. elastic;* h) *F. heteropleura;* i) *F. hispida.*

Veinlets: Five types of veinlet ending were observed. Type 1: no veinlets were observed in *F. sagittata* [Fig. 5(a)]. Type 2: Simple veinlets consisting of linear to curved endings, as observed in *F. aurantiacea* var. *aurantiacea* and *F. fulva* [Fig. 5(b) and (c)]. Type 3 comprises uni-veinlets, as in *F. lepicarpa, F. schwarzii* and *F. superba* [Fig. 5(d)]. Type 4 presents bi-veinlets or dichotomous, which was present in *F. aurata* and *F. heteropleura* [Fig. 5(e)]. Type 5, tri-veinlets, was present in *F. annulata, F. benghalensis, F. benjamina, F. deltoidea* var. *angustifolia, F. deltoidea* var. *kunstleri F. depressa, F. elastica, F. hispida, F. microcarpa, F. religiosa, F. tinctoria, F. ucinata* and *F. vasculosa* [Fig. 5(f)].



(a) (b) (c)

(d) (e) (f)

(g) (h) (i)

(j) (k) (l)

Figure 4: Areolar venation. Incomplete venation; a) *F. benjamina;* b) *F. microcarpa*; c) *F. religiosa*; d) *F. schwarzii*; e) *F. tinctoria;* f) *F. ucinata;* g) *F. superba;* h) *F. vasculosa.* Closed venation; i) *F. aurantiacea;* j) *F. fulva;* k) *F. lepicarpa;* l) *F. sagittata.*

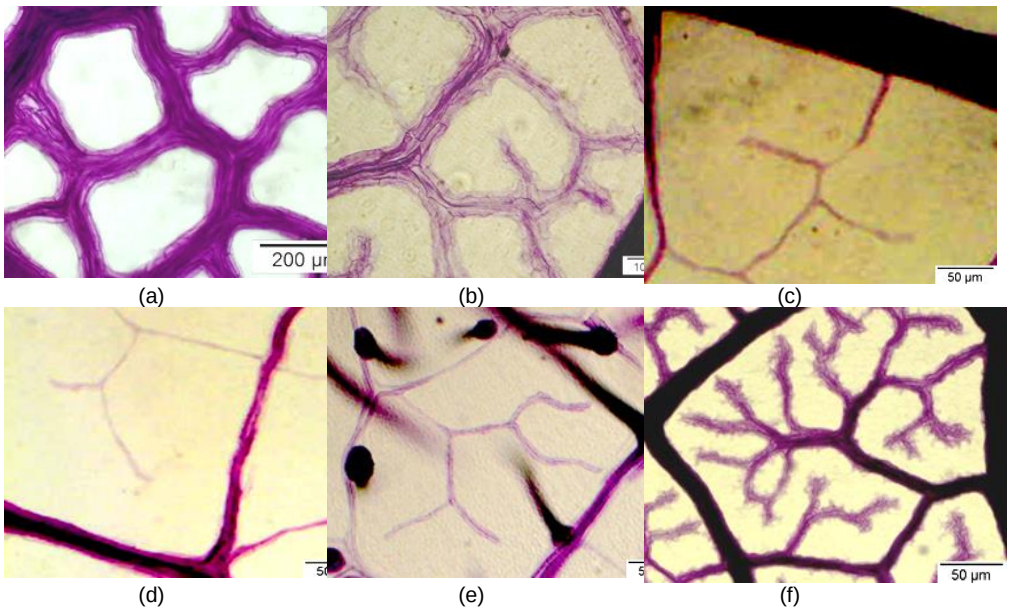


Figure 5: Areolar venation. Veinlet endings; a) nil or no veinlet; b and c) simple veinlets, linear to curve endings; d) uni-veinlets; e) bi-veinlets; f) tri-veinlets.

Swollen-ending veinlets: Swollen veinlet ending was present in some *Ficus* species, such as *F. annulata, F. benghalensis, F. benjamina, F. depressa, F. elastica, F. heteropleura, F. microcarpa, F. sagittata* and *F. superba* [Fig. 6(c)]. Cystolith cell: The majority of the species contain a cystolith cell, except for *F. aurata* and *F. fulva* [Fig. 6(a) and (b)]. Trichomes: The trichomes are simple and unicellular in some taxa, such as *F. aurantiacea* var. *aurantiacea, F. aurata, F. benghalensis, F. fulva, F. hispida, F. lepicarpa, F. sagittata* and *F. superba* [Fig. 6 (d)].

DISCUSSION

Plant leaves are determinate structures responsible for primary productivity and arise as swellings on the flanks of the shoot apex in accordance with a specific phyllotactic pattern (Fosket 1994). All the main functions of the leaf (light harvesting, gas exchange, water transport and distribution of photosynthate) depend upon the architecture, which is defined as the position and form of all the elements that constitute the outward-expressed structure of the organ (Hickey 1988). One such architectural element is the arrangement of the veins of the lamina, which is referred to as the venation pattern (for a recent review, see Nelson & Dengler 1997). Although there are numerous studies on the leaf vasculature of higher plants, very little is known about venation pattern formation. In fact, there is a rich diversity of venation patterns in both monocotyledonous (Inamdar *et al*. 1983) and dicotyledonous plants (Hickey 1973).

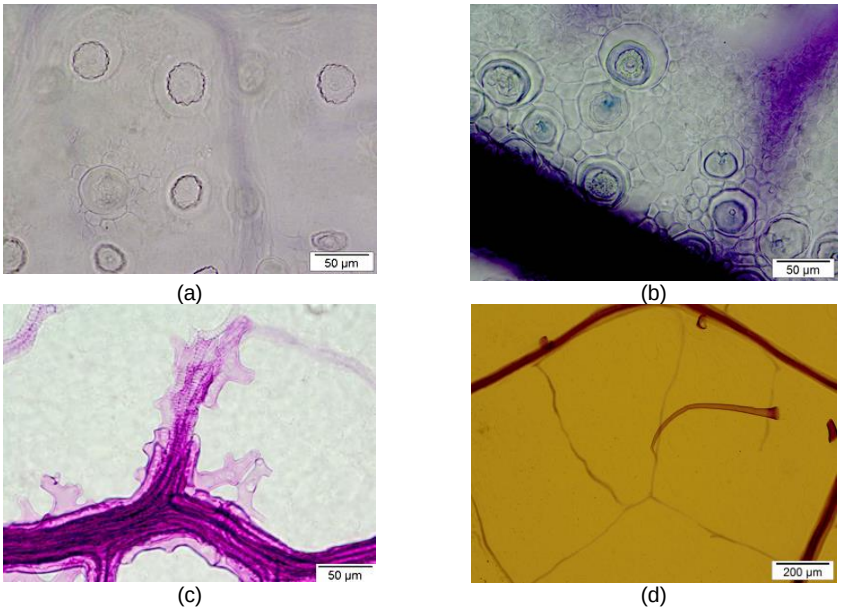


Figure 6: Areolar venation; a and b) cystolith cells; c) swollen veinlets; d) trichome.

Leaf venation can be classified into some characters or patterns that may have taxonomic value for the identification and classification of species, including veinlets, ultimate marginal venation, areolar venation and areolation shape (Hickey 1973; Sehgal & Paliwal 2008). In this study, two types of ultimate marginal venation were observed. Type 1 is incomplete ultimate marginal venation, consisting of freely ending veinlets directly adjacent to the margin (Fig. 1). Type 2 is complete ultimate marginal venation, which refers to higher vein orders fused into a vein running just inside the margin (Figs. 1 and 2). Areolar venation is the smallest area of the leaf tissue surrounded by veins, which taken together forms a contiguous field over most of the area of the leaf. Findings have shown that there are two types of areolar venation: Type 1, for which the majority of the leaf venation consists of incomplete ending veinlets (Figs. 3 and 4); Type 2, largely showing closed venation (Fig. 4).

Veinlets are the freely ending ultimate veins of the leaf and veins of the same order that occasionally cross the aeroles to become connected distally. Hickey (1973) stated that the main characteristics of veinlets are divided into three types, namely, no veinlets, simple without branches and branches giving rise to ramifications by dichotomising, i.e., uni-veinlets, bi-veinlets and tri-veinlets. Based on Hickey's (1973) classification, all 21 taxa of *Ficus* studied can be classified into 8 leaf venation patterns (see Tables 2 and 3). Pattern 1 consists of species with no veinlets, closed areolar venation and complete ultimate marginal venation (*F. sagittata*). Pattern 2 has simple veinlets that are either linear or curved veinlet and closed areolar and incomplete ultimate marginal venation

(*F. aurantiacea* var. *aurantiacea* and *F. fulva*). Patterns 3, 4 and 5 consist of uni-veinlets that are different in areolar and ultimate marginal venation and incomplete in both areolar and ultimate marginal venation, as in *F. schwarzii* (Pattern 3), and incomplete areolar and complete ultimate marginal venation, as in *F. superba* (Pattern 4); Pattern 5 is with closed areolar and incomplete ultimate marginal venation, as in *F. lepicarpa.* Pattern 6 is branched-ending veinlets in two or bi-veinlets and incomplete areolar and complete ultimate marginal venation, as present in *F. aurata* and *F. heteropleura*. Patterns 7 and 8 comprise tri-veinlets and incomplete areolar venation, but both are different in ultimate marginal venation, which is incomplete in *F. annulata, F. deltoidea* var. *angustifolia, F. hispida, F. tinctoria, F. ucinata and F. vasculosa* (Pattern 7) while complete in *F. benghalensis, F. benjamina, F. deltoidea* var. *kunstleri, F. depressa, F. elastica, F. microcarpa* and *F. religiosa* (Pattern 8) (Tables 2 and 3).

Dilcher (1974) stated that a study on the nature and structure of leaf venation has significant implications for the relationship between taxonomy and phylogeny. Levin (1929) also explained that leaf venation patterns have high taxonomic value and suggested that a species has a constant number of veins that can be used for species identification. Studies on leaf texture and secondary venation have taxonomic value and can be used for the identification of some species in the genera *Corchorus* and *Grewia* (Sharma 1991). Therefore, the variations in the patterns of leaf venation represented in this study is not only significant for group identification but can also be used directly to identify some *Ficus* species, such as *F. lepicarpa, F. sagittata, F. schwarzii,* and *F. superba.*

The presence of swollen veinlets or swollen tracheids, cystolith cells and trichomes can also be used as an additional tool for the differentiation of species among groups [Figs. 6(a) and (b)]. For example, swollen veinlets are only present in *F. heteropleura* (Pattern 6) and *F. annulata* (Pattern 7). Pattern 8 swollen veinlets are present in *F. benghalensis, F. depressa, F. elastica* and *F. microcarpa*.

The cystolith (consisting of calcium carbonate) is located in lithocysts; they occur in the form of papillate or hair-like lithocysts, mostly in the epidermis of leaves (Mauseth 1988). Metcalfe and Chalk (1950) noted that “true cystoliths” are known to occur in some genera of Moraceae, such as *Broussonetia, Chlorophora, Conocephalus, Ficus* and *Morus*. Therefore, the presence of cystoliths in this study is a common characteristic of the genus *Ficus*, except for *F. aurata* and *F. fulva* only. Klimko and Truchan (2006) stated that various trichomes, such as straight and long and short and peltate can be found on leaves in *Ficus* taxa. In this study, simple and unicellular trichomes were observed in the leaf venation of some species, such as in *F. aurantiacea* var. *aurantiacea, F. aurata, F. benghalensis, F. fulva, F. hispida, F. lepicarpa, F. sagittata* and *F. superba.*

CONCLUSION

The presence of variable patterns of leaf venation is significant because it can be used as an additional piece of data, especially in the group identification of species and also to directly differentiate some *Ficus* species, such as *F. lepicarpa, F. sagittata, F*. *schwarzii* and *F. superba*. However, other species may require more anatomical characters for differentiation.

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