LEAF VENATION PATTERNS IN *FICUS* L. SPECIES OF THE WESTERN GHATS: A TAXONOMIC PERSPECTIVE

Dissertation is submitted in partial fulfilment of requirement for the

awarding of the degree of "Masters of Science" in

Botany

By

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DEPARTMENT OF BOTANY AND CENTRE FOR RESEARCH

ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM

2024-25

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DECLARATION

I hereby declare that the dissertation entitled "**Leaf Venation Patterns in *Ficus* L. Species of the Western Ghats: A Taxonomic Perspective** " submitted to Mahatma Gandhi University, Kottayam in partial fulfilment of the requirements for the award of the degree of Master of Science is a bonafide record of the original project work done by me under the supervision and guidance of Dr. Sreehari S. Nair, Department of Botany, St. Teresa's College (Autonomous), Ernakulam and that has not previously formed the basis for the award of any degree, diploma or other similar title or recognition to any candidate of the university.

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ACKNOWLEDGEMENT

I wholeheartedly express my gratitude to Dr. Sreehari S. Nair, Assistant Professor, St. Teresa's College, Department of Botany, for suggesting the topic, guiding and inspiring me through the period of this work.

I wish to express my sincere gratitude to Smt. I.K. Nishitha, Head of the Department of Botany and Centre for Research, St. Teresa's College (Autonomous), Ernakulam, for the guidance and intellectual support extended to me.

I gratefully acknowledge Dr. Alphonsa Vijaya Joseph, Principal, St. Teresa's College (Autonomous), Ernakulam, for providing me with the opportunity and support to undertake this project.

I am thankful to all the faculty members of the Department of Botany for their extended support and constant upliftment throughout my study.

I thank all the non-teaching staff, the Department of Botany and the workers of the science block for all the help rendered during our work.

I record my sincere gratitude to the Directorate of Collegiate Education, Government of Kerala, for financial support through the ASPIRE Scholarship.

I am grateful to my classmates who played an excellent role in showering their love, friendship and generosity.

I convey my ardent gratitude to my parents for their reckless support and guidance directly and indirectly.

Finally, I thank God almighty for guiding me through the right path.

DEVIKA T.B.

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Leaf Venation Patterns in Ficus species of the Western Ghats: A Taxonomic Perspective

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INDRODUCTION

The Moraceae family, also known as the fig family or mulberry family, is one of the most abundant and diverse families of angiosperms. The mulberry family consist of 53 genera and more than 1000 species. *Ficus* L. is the most abundant genus in the family. The genus *Ficus* is found mostly distributed in tropical and subtropical areas of the world (Corner, 1965; Berg, 1989; Berg & Corner, 2005). With over 500 species, approximately 60% of all species worldwide, they are primarily found in the Asian-Australian region (Chaudhary *et al*., 2012). Simple, frequently alternating leaves, milky latex, and unisexual blooms that are frequently carried in dense inflorescences are characteristics of the Moraceae family. One of the major traits of the family is the production of multiple or complex fruits, such as the sorosis in *Morus* or the synconium in *Ficus*. Moraceae include both ecological and economically important genera such as *Morus* (mulberries), *Artocarpus* (breadfruit & jackfruit) and *Ficus* (figs) (Naira *et al*., 2013). Among the Moraceae genera, *Ficus* is notable for its ecological importance as well as its intricate taxonomy and distinctive biological traits.

Ficus L. is one of the largest genera of flowering plants in the Moraceae family. The genus contains 881 species (POWO, 2025) most of which are found in tropical and subtropical regions of Asia, Australia, Africa, and America (Berg & Corner, 2005). There are now 115 recognized taxa in India (Chaudhary *et al*., 2012). There are currently 37 identified taxa of *Ficus* in the Western Ghats region (Nair, 2024). Simple, alternating leaves, milky latex, three basal lateral nerves, cystolith, and the hypanthodium inflorescence are major characteristics of the genus *Ficus*. One of the most specialized and coevolved pollination systems in the plant kingdom is the mutualistic association with fig and fig wasps (Agaonidae) (Datwyler & Eiblen, 2004). They can be seen at low to high elevations. They are thought to be one of the oldest and most prosperous species of higher plants, and their habitat pattern is also varied, encompassing shrubs, trees, climbers, epiphytes, and hemi epiphytes (Lansky & Paavilainen, 2011). Because of its year-round fruit consumption by birds, insects, and mammals, *Ficus* plays a vital role in ecosystems (Siti-Khaulah & Noraini, 2016). Despite the ecological importance and long-standing scientific interest in the genus, the taxonomy and identification of *Ficus* remain complex and challenging.

Taxonomists and botanists have significant challenges when it comes to the identification and classification of *Ficus* species. One of the main problems in the identification and classification of the genera is the remarkable morphological plasticity of the genus. The distinctive stipules that leave a scar after abscission, the milky juice, the tiny unisexual flowers that are frequently grouped on a variety of shaped receptacles, and the highly distinctive fruits, or syconia, are some features that make the genus easy to identify. Certain species, particularly in the wild, are challenging to identify due to their identical morphology and lack of syconia (Badron *et al*., 2014).

A leaf venation is an essential feature that supports and aids in the movement of water and minerals, aids in plant evolution, and is consistently important for plant identification (Hickey, 1973). Venation patterns are crucial characteristics for the categorization and evolution of angiosperms, due to the relative stability of their orientation and quantitative characteristics at the species level (Fang *et al*., 2002; Haung *et al*., 2004). Levin (1929) proposed that a species has a fixed number of veins that can be used to identify it and indicated that leaf venation patterns have great taxonomic value. A study of the nature and structure of leaf venation has important ramifications for the connection between taxonomy and phylogeny, according to Dilcher (1974).

The study of leaf architecture was first investigated by paleobotanists in the 1950s, whose main source of data were leaf impressions and compressions (Foster, 1936). The leaf venations have applications in systematic and evolutionary biology, the evolution of leaf form and function (Boyce & Knoll, 2002), genetic and other mechanisms in the ontogeny of leaf venations (Candella *et al*., 1999), and taxonomy (Ellis *et al*., 2009). According to anatomical research on leaf venation, ornamentation of the veins and the course of traces in the lamina are helpful extra characteristics for identifying Euphorbia species (Sehgal & Paliwal, 2008). Dede (1962) also provided a description of the Rutaceae foliar venation patterns, which demonstrated their utility in species identification. The size and shape of leaves frequently correspond with temperature and soil moisture on both a local and global scale, according to numerous paleoclimatic and common garden studies (Hightower *et al*., 2024). However, leaf venation features are comparatively stable over environmental gradients, which makes them reliable characters for herbarium work and field identification. Venation investigations are therefore an essential addition to conventional morphological and molecular taxonomy.

Ficus exhibits high level of morphological complexity and are considered as a "Taxonomically Complex Group". The presence of minute flowers arranged within the closed receptacle and morphological variations among the species and within the species causes the identification of the taxa highly problematic. The identification keys currently in use are relayed on vegetative and floral features and seems to be inadequate for the identification of the taxa, especially when any of the part (vegetative or floral) is unavailable. Leaf venation pattern seems to be a constant character among the species and is poorly studied in the genus. The aim of this study is to investigate the venation pattern among members of *Ficus* in the Western Ghats region and to provide a key for the identification of the taxa based on the venation pattern.

OBJECTIVES:

- To study the leaf venation pattern among all the taxa of *Ficus* in the Western Ghats region.
- To provide a key for the identification of the taxa of *Ficus* based on leaf venation pattern.

REVIEW OF LITERATURE

Simola (1968) performed a comparative study on the endemic *Lathyrus* species based on the number of leaflets, venation, and epidermal structure that was collected from different contents. They noticed that all of the endemic species from North America and some species from Eurasia had leaflets with pinnate venation and epidermal cells with undulated walls. While majority of the species from Eurasian and North African region had only one pair of leaflets with parallel venation, and epidermal cells with undulate walls. While endemic species from North American and Eurasian species were connected to both South American and North American species, the endemic species of South America varied significantly from those of North America due to the South American species' two leaflets with parallel venation and epidermal cells with straight lateral walls.

A study of the leaf venation patterns of 150 species in the genus *Euphorbia* was conducted by Sehgal & Paliwal (1974). The species were categorized as uni-, bi-, tri-, and other species. Additional features, such as vein ornamentation and the course of traces in the lamina, were also employed. The vast majority of the taxa under study were classified as triveined. They concluded that characteristics such as areole size, the quantity of vein ends, and their branching patterns do not adhere to a rigid, predictable pattern in the same or different leaves of the species. Some species contain noticeable globular chloroplasts in their sheath cells, while 40 species have a parenchymatous vein sheath. Additional characteristics of xerophytic species include dilated tracheidal components, which are present at the tips of vein endings or on venules.

A study of leaf venation was carried out by Rury & Dickison (1977) on the genus *Hibbertia*, which is a member of the Dilleniaceae family. They stated that the genus *Hibbertia* showed a high degree of variability in leaf venation patterns. They divided it into three primary classes and nine subclasses. Classification was done on the basis of leaf size, nodal structure, fundamental venation pattern features, and high order venation pattern. The size of the leaves and the marginal configuration were also observed.

Inamdar & Murthy (1978) examined the venation patterns of some members of the Solanaceae family and found that approximately 12 species of the family had pinnate camptodromous veins. They also noted that the number of secondaries, free vein endings, and areole size varied from species to species, in spite of the type of leaf. Some species had looped marginal ultimate veins, while others had marginal fibriate veins. All vein types were covered by a parenchymatous bundle sheath, and they noticed both uni and biseriate tracheids. Two species of Cestrum also had isolated veins, and some species had extension cells.

The leaf architecture of 19 genera and 29 species in the Apocynaceae family was studied by Mohan & Inamdar (1982). The majority of the species exhibited brochidodromous secondaries and a pinnate camptodromous venation pattern. Other characteristics were also examined, such as the size of the leaves, the size of the areoles, the number of vein terminals that enter the areoles, etc. Vein order was studied up to 70.

An extensive examination of venation patterns in 25 Polypodiaceae genera, with an emphasis on both juvenile and adult leaf development, was reported by Mitsuta (1984) in order to support taxonomic classification. Excurrent, recurrent, and reticulate venation types were distinguished, and evolutionary insights were provided by contrasting them with patterns seen in allied fern families. Venation was highlighted as a crucial, but frequently disregarded, aspect of fern systematics is well-illustrated in this study. The research offered a strong morphological foundation, despite its high level of technicality and lack of ecological or molecular integration.

Venation investigations of Indian *Sida* L., a member of the Malvaceae family, were carried out by Saibaba & Rao (1990). Some of the species they studied were *S. rhombifolia* var. *rhombifolia, S. rhombifolia* var. *retura, S. grewioides, S. acuta, S.spinosa, S. schimperima, S.cordidolia, S. mysorensis*, and *S. cordata* in particular. Simple, serrated-edged leaves are characteristic of these species. They observed that the venation was either actinodromous or pinnate. Other characteristics that differ between species include the number of areoles, their form, base, apex, and the vein ends that enter the areoles.Vein orders up to 50 were examined. Both brachytracheoids and tracheoids-in- aggragates were seen in vein ends.

The leaf venation patterns of 42 species and four genera in the Chloranthaceae family were studied by Todza & Keating (1991). Up to 15 characters were analysed, including leaf rank, tooth type, secondary vein type, and intramarginal veins. Craspedodromous, semicraspedodromous, brochidodromous, and eucamptodromous secondary venation patterns were investigated. They compared the leaf architecture of the Lauraceae, Annonaceae, and Chloranthaceae families. They came to the conclusion that these two families and the Chloranthaceae shared similar features.

The open dichotomous leaf venation of *Circaeaster agrestis* and *Kingdonia uniflora* was studied by Yi *et al*., (1998). The authors came to the conclusion that the venation is a degraded trait, most likely an evolutionary adaptation to moist high-altitude conditions, in contrast to previous opinions that viewed it as primitive. They discovered significant variety in vein architecture, including blind veins and reduced anastomoses, based on a thorough morphological investigation, which supported their theory of reduction rather than primitiveness. They believed that the significance of the venation in the larger angiosperm phylogeny has been overemphasized even though it aids in elucidating these taxa' position within Ranunculales.

The creation of leaf venation patterns on the vegetative leaves of the model organism *Arabidopsis thaliana* was the subject of research by Candella *et al*., (1999). They described three primary developmental characteristics, including length, the number of vein network branching points on the lamina surface, and the number of hydathodes per leaf. Out of the 266 ecotypes whose first vegetative leaves were analysed for natural variation, only two had a venation pattern that differed from the others; the latter displayed a very basic pattern known as hemivenata. Additionally, they looked for mutants with aberrant venation patterns, but they found that this phenotype is uncommon because just one recessive mutation, the presence of extrahydathodes with more hydathodes per leaf was found.

The hydraulic architecture of *Laurus nobilis* L. leaf venation was studied by Zwieniecki *et al*., (2002). They found that first and second order veins had a relatively low radial permeability and a high axial conductance, which permits water to reach the leaf's distal regions with minimal water loss. Higher order veins were more radial leakage-permitting and hydraulically resistant. They found that this design enables a fair representation of the venation's ability to provide a uniform water supply throughout the leaf lamina.

The efficiency of supervised pattern recognition methods—LVQ-ANN, DAN2, and SVM—for categorizing 93 *Camellia* species based on leaf morphology and venation from five sections was evaluated in this study by Lu *et al*., (2012). The two techniques with the best classification accuracy were DAN2 and RBF-SVM; on the testing dataset, RBF-SVM achieved up to 97.78%. Existing morphological categories were further reinforced by a dendrogram based on leaf architecture. The findings highlight the potential of combining leaf architecture with modern recognition techniques, particularly DAN2 and SVM, to accurately identify *Camellia* species.

Five species of the genus *Vernonia* SCHREB (Asteraceae) in Nigeria were compared by Aworinde *et al*., (2013) using traits such lamina symmetry, leaf shape, margin, texture, petiole, venation, and areolation patterns. They used taxonomically significant traits to identify and differentiate each species. The presence of craspedodiomous venation is the distinguishing characteristic that set *Vernonia galamensis* apart from lanceolate leaves.

Taxonomically significant traits like *V. ambigua's* wavy anticlinal wall and polygonal cell form set it apart from *V. amygdalina* and *V. cinerea*, which had straight anticlinal walls and irregular cell shapes. With the rare to sporadic occurrence of other stomatal kinds with anomalies, all leaves are amphistomatic and have paracytic types.

In order to evaluate the taxonomic significance of leaf anatomical features, particularly venation patterns, Nurshahidah *et al*., (2013) studied five species from the genera *Byttneria* and *Pterocymbium* (Malvaceae s.l.). *B. curtisii, B. jackiana, B. maingayi, P. tinctorium*, and *P. tubulatum* were among the species that were chosen. Clearing the leaves and examining them under a microscope showed that all species had the same characteristics, such as complete marginal venation and a closed venation system with few free-ending veinlets. On the other hand, *B. jackiana, P. tinctorium*, and *P. tubulatum* showed bent or incomplete venation, whereas *B. curtisii* and *B. maingayi* showed entire ultimate marginal venation. Veinlet-associated crystals and other trichome types were also helpful in identifying species. The study showed that leaf anatomy is useful for classifying and identifying species.

Bardon *et al*. (2014) reported about the existence of eight leaf venation patterns on genus *Ficus* based on the veinlets, marginal, and areolar venation. The study was conducted in 21 taxa of genus *Ficus* of Peninsular Malaysia. Majority of the species such as *F. annulata, F. bengalensis, F. benjamina, F. deltoidea var. augustifolia, F. deltoidea* var. *kunstleri, F. depressa, F. elastica, F. hispida, F. macrocarpa, F. religiosa, F. tinctora, F. ucinata, F. vasculosa* exhibited tri-veinlets, while *F. aurata and F. heteropleura* exhibited bi- veinlet, *F. lepicarpa, F. schwarzii* and *F. superba* showed univeinlet; *F. aurantiacea* and *F. fulva* showed simple veinlets. But, *F. sagittata* does not show any kind of venation.

Nur Fatihah *et al*. (2014) assessed the morphology and anatomy of leaf in 7 varieties of *F. deltoidea*, namely var. *deltoidea*, var. *angustifolia*, var. *trengganuensis*, var. *bilobata*, var. *intermedia*, var. *kunstleri*, and var. *motleyana*. The study revealed the variations in morphological characters like leaf shape, size, surface texture, margin, midrib dichotomous and petiole length. Variations in anatomical characteristics like structure of midrib, leaf epidermis, and lamina structures were also demonstrated in this study.

Buechler (2014) studied the high variability in leaf venation patterns seen in the genus *Salix*, he also noted that venation can vary among species, individual plants, and even within a single leaf. Usually eucamptodromous, the secondary vein framework has a tendency for brochoid arches, particularly in hot, dry climates where certain species develop intramarginal veins or lengthy brochoid chains. A leaf may have more than one form of venation, hence the term "brochoid" is used to refer to these variants. Five morphotype groups established by the venation are used in the study to classify *Salix* leaves. The absence of these patterns in fossilized *Salix* leaves from the Miocene is probably the result of fossilization biases or more humid historical conditions. Despite the lack of these characteristics in the fossil record, *Salix* is nevertheless a viable genus since leaf variability can cause categorization errors. When characterizing fossil *Salix* species, the study highlights the importance of taking venation pattern variety into account in order to prevent making false species assumptions and to differentiate *Salix* from other fossil taxa.

Zhang *et al*., (2015) examined the venation of leaves in 13 sections of 150 species of *Saxifrage* L. Three primary venation patterns were identified by them: The patterns of species with entire leaves are acrodromous or camptodromous, while those with lobed leaves are palinactinodromous. *Heterisia, Irregulares, Cymbalaria, Cotylea*, and *Mesogyne* species are palinactinodromous; *Saxifraga, Ciliatae*, *Bronchiales*, and *Trachyphyllum* species are either palinactinodromous or acrodromous, depending on the leaf margin; and *Ligulatae* and *Porphyrion* species have camptodromous venation, with their hydathodes secreting calcium bicarbonate. In sections *Gymnopera*, *Porphyrion*, subsection *Oppositifoliae*, and *Xanthizoon*, intermediate states can be observed. They concluded that the most primitive kind of venation was palinactinodromous.

Siti-Khaulah & Noraini (2016) worked on the leaf venation anatomical characteristics on 8 chosen *Ficus* L. species from Peninsular Malaysia. They observed the veinlets, the ultimate marginal and areolar venation as the main leaf venation anatomical characters. Majority of the species such as *F. callosa, F. pubigera, F. celebensis, F. pendens* exhibited complex veinlets in areolar venation; while *F. apiocarpa, F. caulocarpa* and *F. mollissima* showed simple or uni-veinlets. Free ending veinlet was absence in *F. drupacea. F. callosa, F. caulocarpa, F. pendends, F. mollissima* and *F. drupacea* exhibit complete ultimate marginal venation while species such as *F. callosa, F. pubigera, F. pendens, F. mollissima,* and *F. celebensis* displayed opened areolar venation. Cystolith cells were the diagnostic leaf venation anatomical characteristic in *F. pubigera* and trichomes were present on venation in *F. mollissima* only.

Sharma *et al*. (2016) studied the venation characteristics for identification of 30 *Mangifera indica* L. varieties. They reported that *Kaju, Totapuri, Badshahpasand* varieties are characterized by pinnate type of thick primary veins; whereas secondary veins were camptodromous type. Minor venation was assessed up to five orders, and all kinds were studied demonstrated fimbriate venation. Additional qualitative characteristics of the secondary vein (angle of divergence, course, and intersecondary vein), tertiary vein pattern, higher order venation, veinlet branching, areole development, areole arrangement, and areole form were also investigated. Cluster analysis was used to investigate the relationships between the variations. Depending on their hierarchy, closely similar kinds were clustered in the dendrogram. Five clusters, each representing a different vein pattern parameter, were created.

A study on the genus *Psidium* from the Brazilian savanna biome was carried out by Oliveira *et al*. (2017). The study was based on the morphology and leaf venation patterns of four selected Psidium species: *Psidium firmum, P. myrsinites, P. laruot-teanum,* and *P. guineense*. The findings demonstrated that *P. firmum* has a rounded base, an abaxial surface with a grooved midrib, flat secondary veins on both sides, an apex that is obtuse to mucronate, and brochidodromous secondary veins with marginal final venation of the fimbrial type. *P. guineense* varies from every other Myrtaceae species analyzed in this study due to its trichomes on both surfaces, a pronounced midrib on the abaxial surface, and a grooved midrib on the adaxial surface. In the morphological identification key, the species *P. guineense* and *P. firmum* were distinguished from the other members of the genus by a set of distinct leaf traits.

Lima *et al*., (2019) examined the characteristics of leaf venation patterns of the family Rubiaceae from Caatinga forest in Brazil. They identified and delineated the leaves of 14 species from 8 genera within the family Rubiaceae. The purpose of this study was to evaluate the use of leaf architecture as a taxonomic tool that can provide vegetative and diagnostic characteristics between species. By characterizing secondary vein patterns, third vein patterns, fourth and fifth order vein patterns, and areole conformation, this work helped to define taxa.

Muazaz Azeez AL-Hadeethi *et al*., (2019) conducted an analysis of the venation pattern of *Cordia myxa* L. species. Venation systems has been classified according to their design for each order. In the current study, the venation was pinnate, and the first-order veins were of the brochidodromous type, the second-order veins were of the cascade type, and the third-order veins were lattice and percurrent. The areoles are either polygonal or triangular in shape and vary in size.

An extensive investigation across the venation patterns of ten species of the genus *Ficus* was conducted by Oladipo & Akinlabi (2021). Ten *Ficus* species—*F. lutea, F. thonningii,* *F. exasperata, F. mucuso, F. recurvata, F. leprieurii, F. polita, F. sur, F. elastica,* and *F. benjamina*—were examined for their veinlet endings, areole form, breadth, and length. They suggested that venation patterns were important characteristics for identifying *Ficus* species. They also suggested that these traits may be added to the current taxonomic key of the genus as further information.

A comparative analysis of the various clearing techniques used to prepare the leaf venation was carried out by Mir *et al*., (2021). The purpose of the study was to identify the best technique for clearing *Ficus religiosa* leaves. They observed that venation acquired using NaOH and C2H3Cl3O2 was less damaging and as effective as alternative approaches.

The leaf venation patterns of thirty species of *Saxifraga* L. found in the Western Himalayas of India were investigated by Unigal *et al*., (2021). Information about 20 unknown species were added. Four subtypes and five major types of venation patterns were identified. Five major leaf venation pattern types were identified: acrodomous, camptodromous, campylodromous, hyphodromous, and palinactinodromous. The venation types in the sections Micranthes, Ciliatae, Mesogyne, and Porphyrion were acrodromous, eucamptodromous, and hyphodromous, respectively. However, the section Micranthes displayed palinactinodromous veins. It was discovered that the ancestral form of venation was palinactinodromous.

Lindera, a member of the Lauraceae family, is challenging to categorize solely based on morphological characteristics because current classifications mostly depend on floral characteristics. The leaf venation patterns of eight *Lindera* species—*L. assamica, L. bifaria, L. caudata, L. griffithii, L. latifolia, L. melastomacea, L. nessiana,* and *L. pulcherrima*—were examined by Chodankar (2021), in order to facilitate species identification. Three primary venation types were distinguished: acrodromous with perfect basal secondaries, acrodromous with perfect supra-basal secondaries, and pinnate camptodromous with festooned brochidodromous secondaries. Additionally, variations were seen in the highest vein orders (ranging from 40 to 60), tertiary vein patterns, and secondary vein angle of divergence. Additional distinguishing characteristics include the angle of tertiary vein origin and the existence or absence of tracheoids. The identification of species is greatly aided by these anatomical characteristics.

In a study by Chodankar & Vaidya (2021), the venation patterns in the Lauraceae family's genus *Machilus* were studied. A total of ten *Machilus* species—*M. bombycina, M. clarkeana, M. dutheii, M. gamblei, M. globosa, M. khasyana, M. kingii, M. odoratissima, M.*

parviflora, and *M. villosa*—were examined. Pinnate camptodromous veins with festooned brochidodromous secondary veins were the type of venation observed. On the basis of tertiary vein patterns, highest vein order, and the angles at which secondary and tertiary veins diverged, the species were further separated. A diagnostic key was therefore created. Determining the nomenclatural kinds of the species was frequently challenging due to their strong resemblance in leaf morphological characteristics. Thus, an effort was made to acknowledge laminar architecture's taxonomic significance.

Peng *et al*. (2022) examined vein traits and leaf shape in 39 broad-leaved woody species that thrive in subtropical forests of China. They evaluated scaling relationships using the standard major axis approach and ordinary least squares, then compared the results with data from across the world. They found that whereas evergreen and deciduous species did not vary, palmate-veined species had higher major vein densities and a higher major to minor vein density ratio at the given leaf size than pinnate-veined species. They came to the conclusion that, for all vein types and leaf habits, major vein density and the ratio of major (1 and 2) to minor (3 and above) vein density both geometrically declined with leaf size.

The inconsistent leaf shape variation on *Capsella bursa-pastoris* in relation to climate was investigated by Hightower *et al.,* (2024). They concluded that temperature is the primary environmental factor linked to variations in leaf shape, and they displayed that species with irregular variations in leaf shape can be determined using geometric morphometric modelling techniques. They also identified that the shape of the leaves remained constant over a century.

MATERIALS AND METHODS

Collection of samples

A total of 37 *Ficus* L. taxa in Western Ghats region were chosen for the investigation. For the purpose of the research, dry leaves from herbarium specimens were taken into account. The specimens were collected by Dr. Sreehari S. Nair were used for the study. The specimens were recognized correctly, authenticated and previously deposited at University of Calicut (CALI), Blatter Herbarium, Mumbai (BLAT). A list of the taxa of *Ficus* studied is provided in table 1.

Sl No	Species
1	*Ficus amplissima* Smith.
2	*Ficus amplocarpa* Govind. & Masil
3	*Ficus anamalayana* Sudhakar & G.V.S.Murthy
4	*Ficus arnottiana* (Miq.) Miq.
5	*Ficus auriculata* Lour.
6	*Ficus beddomei* King.
7	*Ficus benghalensis* L.
8	*Ficus benjamina* L.
9	*Ficus binnendijkii* (Miq.) Miq.
10	*Ficus callosa* Wild.
11	*Ficus caulocarpa* (Miq.) Miq.
12	*Ficus costata* (Miq.) Miq.
13	*Ficus dalhousiae* Miq.
14	*Ficus drupacea* Thumb.
15	*Ficus elastica* Roxb ex Hornem.
16	*Ficus exasperata* Vahl.
17	*Ficus fergusonii* (King) T.B. Worth ex Corner
18	*Ficus guttata* (Wight) Wight ex King
19	*Ficus heterophylla* L.f.
20	*Ficus hispida* L.f.
21	*Ficus krishnae* C. DC.
22	*Ficus microcarpa* L.f.
23	*Ficus middletonii* Chantaras.
24	*Ficus mollis* Vahl.
25	*Ficus nervosa* B. Heyne ex Roth

26	*Ficus pumila* L.
27	*Ficus racemosa* L.
28	*Ficus religiosa* L.
29	*Ficus superba* (Miq.) Miq.
30	*Ficus talbotii* King.
31	*Ficus tinctoria*. ssp. *gibbosa* (Blume) Corner.
32	*Ficus tinctoria*. ssp. *parasitica* (J. Koenig ex wild.) Corner.
33	*Ficus travancorica* King
34	*Ficus tsjahela* Burm. f.
35	*Ficus virens* var. *virens* Aiton.
36	*Ficus virens* Aiton var. *dispersa* Chantaras.
37	*Ficus virens* Aiton var. *matthewii* Chantaras.

Leaf venation study

Data sheets were prepared using 18 characters and 66 character states of the leaf architecture. The data sheet prepared for the research work attached as Appendix 1. The collected samples were used for studying the venation patterns of *Ficus* taxa according to Manual of Leaf Architecture (Ellis *et al*., 2009). Leaf venation patterns were observed and the photographs were taken using Microware 1000X 8 LED USB Digital Microscope. The variations in leaf venation pattern among the taxa were analysed and identification of the taxa based on leaf pattern were carried out.

Phenetic Analysis

A total of 18 characters and 66 character states were analysed for each taxa of *Ficus* based on the leaf venation pattern. Based on the range of each observed character, the character states were developed. A standardized numerical format was then created from the character states (Sneath & Sokal, 1973) and the data were entered into a numerical matrix, where 1 denoted the presence of the character states under study and 0 denoted their absence (Nair *et al.,* 2021a, 2021b).

The numerical data matrix was analysed using PAST Ver 4.03 software (Hammer *et al*., 2001). Single lineage, paired group algorithm (UPGMA), and Wards method—were used to perform similarity-based hierarchical clustering on the data using Bray-Curtis similarity index, which assigned equal weight to each character state considered. The best model for analysis was selected based on the high cophenetic corelation value. The most suitable representation of the data matrix was determined based on a co-phenetic correlation value between 0.8 and 0.9. (Sneath & Sokal, 1973; Mahima, 2020). The phenogram was analysed to determine the clustering pattern, and morphological similarities within each group was discovered. The similarity index was used to determine the species' correlation value. The phenogram that was produced was examined using the software Figtree version 1.4.4 (Rambaut, 2018).

RESULT

A total of 37 taxa of *Ficus* were used in the phenetic analysis. A total of 18 characters and 66 character states were studied for each taxa of *Ficus*. The leaf venation pattern of all the 37 taxa of *Ficus* from the Western Ghats were observed and the images of the venation pattern from 2^{o} to 5^{0} level is provided (Fig……). The characters and the character states recorded for each taxa is provided as Appendix 2. The observed morphological characters were converted into the standard numerical format and the data is provided as Appendix 3. The multivariate cluster analysis was done for all the three different algorithms single lineage, UPGMA, and Wards methods to find the best fit model. The cophenetic correlation value obtained for single lineage, UPGMA, and Wards methods were 0.76, 0.80 and 0.38. UPGMA method yielded the best fit model and phenogram with highest cophenetic correlation. The similarity between each taxa were recorded and is provided as Appendix 4. Based on the venation patterns of the leaves, 37 taxa under investigation were categorized into 3 clades (Fig. ……).

Clade 1: The sole species in the first group was *F. benjamina*. They are 50% different from other species. Their leaves are simple and alternating, with pinnate veins as the primary vein category, brochidodromous veins as the secondary vein category, and dichotomizing veins at the fourth and fifth levels.

Clade 2: This clade comprises of *F. elastica*, *F. talbotii*, *F. drupacea*, and *F. dalhousiae*. Regular polygonal reticulate quaternary venation patterns and pinnate primary venation are the commonly exhibited by each member. This clade is 32% similar to other clades.

Subclade 1: This include *F. elastica* which is 50% similar to the other members in the subclade. This species differs from other species in this group due to traits like convex leaf apex shape, uniform secondary vein spacing, and uniform secondary vein angle.

Subclade 2: *F. talbotii*, *F. drupacea* and *F. dalhousiae* belong to this subclade. *F. drupacea* and *F. talbotii* share 72% of their similarities within this subclade. Its leaves are entire, with an acuminate apex, pinnate primary veins, increasing secondary vein spacing toward the base, and examidially ramified. *F. dalhosuiae* is 55% similar to other species.

Clade 3: The majority of the species were represented in this clade. Clade 1 contained 32 taxa of *Ficus* and 8 subclades were included. The majority of individuals exhibited regular polygonal reticulate quinary and quaternary venation pattern. The leaf shapes are oblong, cordate, elliptic, and ovate. This shows 48% similarity to the other two clades.

Subclade 1: *Ficus tinctoria*. ssp. *gibbosa* is the only species in this subclade. It shows 54% similarity to other subclades.

Subclade 2: Six taxa of *Ficus* were grouped together in subclade 2. These included *F. guttata, F. amplocarpa, F. exasperata, F. anamalayana, F. auriculata,* and *F. beddomei*. This subclade is 42% similar to other groups overall. All species in this group shows entire leaves, pinnate primary venation, weak brochidodromous secondary venation patterns, obtuse base angles and acute apex angles. The quaternary and quinary venation patterns of all species are regular polygonal reticulate patterns.

Subclade 3: There is only one taxon in this subclade, *F. amplissima*. They are 59% similar to other subclades. It exhibits a variety of venation patterns, including dichotomizing quinary, regular polygonal reticulate quaternary, random reticulate tertiary, brochidodromous secondary and pinnate primary venation.

Subclade 4: the sole taxa in this subclade is *F. binnendijkii*. It exhibits 74% similarity to other subclades. The leaves are entire with pinnate primary, brochidodromous secondary, alternate percurrent tertiary, and regular polygonal reticulate quaternary and quinary venation patterns.

Subclade 5*:* *F. racemosa, F. travancorica, F. pumila, F. virens* var. *virens, F. fergusonii, F. virens* var. *dispersa, F. nervosa, F. costata, F. superba, F. callosa, F. heterophylla* and *F. tsjakela* are the 12 species belong to subclade 5. All of them have whole leaves, pinnate primary veins, regular polygonal reticulate quaternary and quinary venation (except *F. heterophylla* and *F. tsjakela*), and alternate reticulate secondary venation patterns. There is 88% similarity between the taxa *F. racemosa* and *F. travancorica*, 87% between *F. virens* var. *virens* and *F. fergusonii*, and 84% between *F. virens var. dispersa* and *F. nervosa*. Additionally, there is 92% similarity between *F. superba* and *F. callosa*, and 84% between *F. heterophylla* and *F. tsjakela*.

Subclade 6: This subclade contains 8 species including *F. tinctoria* ssp. *parasitica*, *F. middletonii*, *F. virens* var. *Matthewii*, *F. arnottiana*, *F. caulocarpa*, *F. religiosa*, *F. krishnae* and *F. mollis*. They show 64% similarity to other subclades. All the leaf margins are entire, with regular polygonal reticulate quaternary and quinary venation patterns, pinnate primary venation, brochidodromous secondary venation (except from *F. middletonii*), and alternate percurrent (apart from *F. middletonii*). In comparison, they are 81% similar to *Ficus tinctoria.* ssp. *parasitica* and *F. middletonii*, 75% similar to *F. virens* var. *matthewii* and *F. arnottiana*, and 78% similar to *F. krishnae* and *F. mollis.*

Subclade 7: This subclade includes only 2 taxa of *Ficus*, *F. microcarpa* and *F. bengalensis*. There is a 66% similarity between them. *F. microcarpa* has pinnate primary, brochidodromous secondary venation, while *F. bengalensis* exhibits weak brochidodromous secondary venation. While *F. bengalensis* has an alternate percurrent tertiary venation pattern, *F. microcarpa* has a random reticulate. Both exhibits dichotomizing quinary venation and regular polygonal reticulate quaternary venation.

Subclade 8: This subclade includes sole taxa, *F. hispida*. This is 55% similar to other species in this clade. It's venation patterns are pinnate primary, mixed opposite or alternate tertiary, alternating percurrent quaternary, weak brochidodromous secondary, and regular polygonal reticulate quinary.

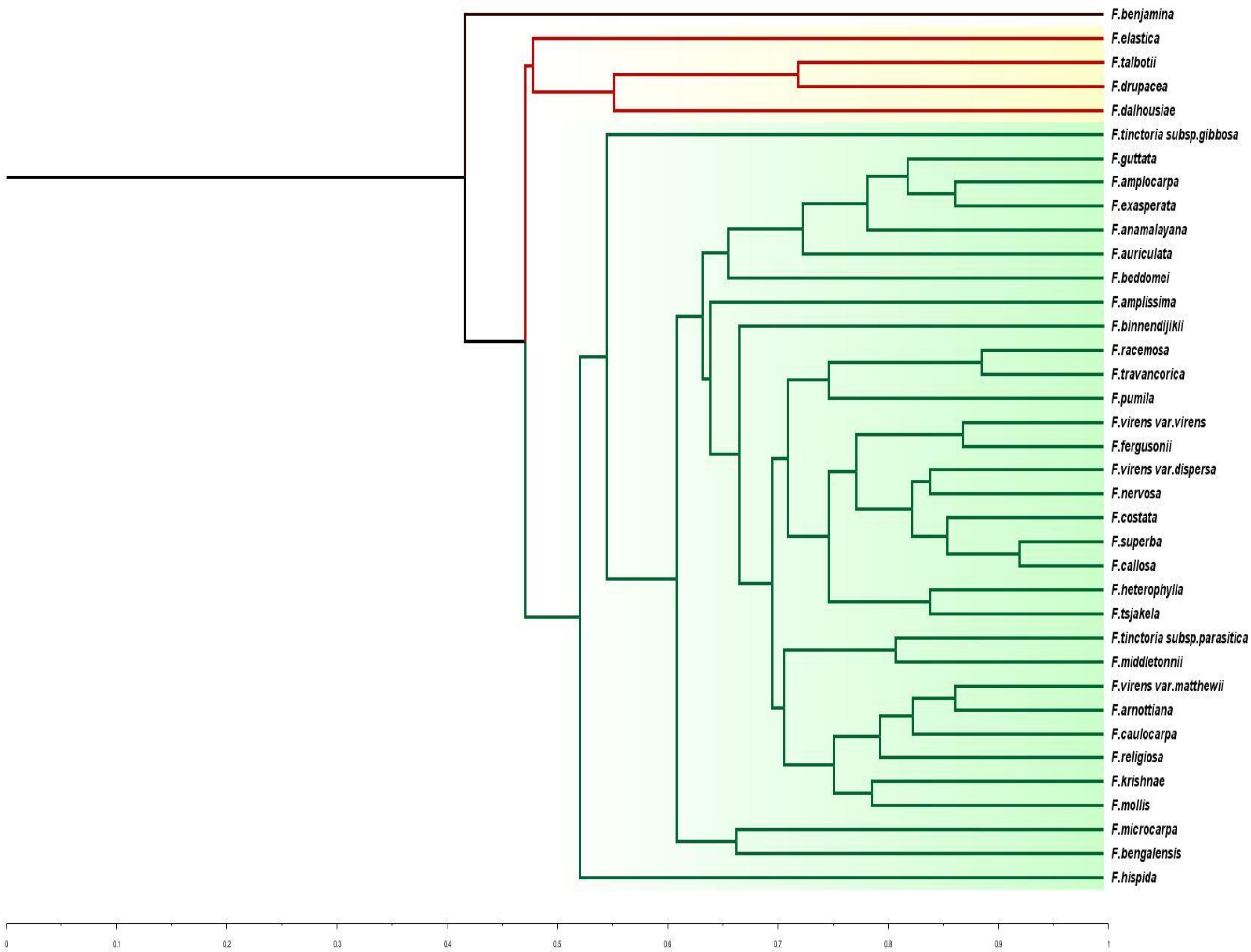

Fig.3. Phenogram based on leaf venation patterns

The key for the identification of all the taxa of *Ficus* in the Western Ghats region based on leaf venation pattern is provided below.

1a. Secondary venation brochidodromous …………………………………….………….. 2

1b. Secondary venation weak brochidodromous …………………………………...……. 23

2a. Leaf base angle acute …………………………………………………………...… 3

2b. Leaf base angle obtuse …………………………………………………….....…… 9

3a. Apex of leaf convex ………………………………………………………...……. 4

3b. Apex of leaf acuminate ……………………………………..………………………. 5

4a. Alternate percurrent type of 3^0 veins; regular polygonal reticulate type of 5^0 veins; rounded or truncate leaf base ……………………………………...……….…. ***F. virens*** **var.** ***virens***

4b. Random reticulate type of 3^0 veins; dichotomizing type of 5^0 veins; decurrent leaf base ……………………………………………………………………………….. ***F. microcarpa***

5a. 3^0 vein angles inconsistent ………………………………………………………….. 6

5b. 3^0 vein angles uniform ……………………………………………………..... ***F. drupacea***

6a. Inter-2^0 veins with strong inter secondaries; alternate percurrent 3^0 veins; admedially ramified 3^0 veins course; regular polygonal reticulate 4^0 and 5^0 veins ………………….……… 7

6b. Inter-2^0 veins without inter secondaries; mixed opposite or alternate 3^0 veins; exmedially ramified 3^0 veins course; dichotomizing 4^0 and 5^0 veins ………………...……. ***F. benjamina***

7a. Leaf base rounded; 2^0 veins spacing increasing towards base ……………………...….. 8

7b. Leaf base decurrent; 2^0 veins spacing decreasing towards base or irregular .. ***F. binnendijkii***

8a. Mesophyll size lamina; lamina ovate; 3^0 veins to 1^0 veins acute in angle ……………………………………………………………...… ***F. virens*** **var.** ***matthewii***

8b. Notophyll size lamina; lamina oblong; 3^0 veins to 1^0 veins obtuse in angle ……………………………………………………………… ***F. virens*** **var.** ***dispersa***

9a. Leaf apex angle acute 10

9b. Leaf apex angle obtuse ………………………………………………….. ***F. dalhousiae***

10a. 5^0 veins dichotomizing ……………………………………………………………………… 11

10b. 5^0 veins regular polygonal reticulate ………………………………………………………… 12

11a. Base of lamina convex; 2^0 veins spacing irregular; 2^0 vein angles smoothly decreasing towards base; inter-2^0 veins with weak inter secondaries; exmedially ramified 3^0 veins course; 3^0 vein angles inconsistent …………………………………………………………... ***F. talbotii***

11b. Base of lamina rounded or truncate; 2^0 veins spacing uniform; 2^0 vein angles with 2 pair acute basal secondaries; inter-2^0 veins with strong inter secondaries; admedially ramified 3^0 veins course; 3^0 vein angles uniform ……………………………………...…. ***F. amplissima***

12a. Alternate percurrent type of 4^0 veins ………………………...……………..……..… 13

12b. Regular polygonal reticulate of 4^0 veins ………………………………………………..… 14

13a. Lamia mesophyll, ovate, base cordate ………………………………………. ***F. arnottiana***

13b. Lamina notophyll, elliptic or oblong, base rounded .... ***F. costata***

14a. 3^0 veins to 1^0 veins acute in angle ………………………………………………………….. 15

14b. 3^0 veins to 1^0 veins obtuse in angle ……………………………………………..…….. 19

15a. Inter secondaries of inter 2^0 veins strong; 3^0 vein categories alternate percurrent ……. 16

15b. Inter secondaries of inter 2^0 veins absent; 3^0 vein categories not prominent …… ***F. elastica***

16a. Leaf base rounded; apex acuminate …………………………………………………… 17

16b. Leaf base cordate or truncate; apex straight or truncate ……………………..………… 18

17a. 2^0 veins spacing increasing towards base; 2^0 vein angles with 2 pair acute basal secondaries …………………………………………………………………………………...….. ***F. superba***

17b. 2^0 veins spacing irregular; 2^0 vein angles without 2 pair acute basal secondaries ………………………………………………………………….. ***F. tinctoria* subsp. *parasitica***

18a. Lamina cordate in shape, apex acuminate; 3^0 vein angle variability uniform…. ***F. religiosa***

18b. Lamina ovate in shape, apex truncate; 3^0 vein angle variability inconsistent .***F. caulocarpa***

19a. 3^0 veins alternate percurrent; 3^0 veins angle variability inconsistent ………………..… 20

19b. 3^0 veins mixed alternate and opposite; 3^0 veins angle variability increasing exmedially ………………………………………………………………………………… ***F. amplocarpa***

20a. Rounded or truncate leaf base; inter secondaries of inter 2^0 veins strong ……………..…. 21

20b. Cup shaped leaf base; inter secondaries of inter 2^0 veins weak ……………..... ***F. krishnae***

21a. 2^0 veins spacing increasing towards base; lamina mesophyll ………………………….. 22

21b. 2^0 veins spacing decreasing towards base; lamina notophyll ………………….. ***F. nervosa***

22a. Leaf base truncate or cordate, apex convex ……………………………………... ***F. mollis***

22b. Leaf base rounded or decurrent, apex acuminate …………………………….. ***F. callosa***

23a. 3^0 veins course exmedially ramified ………...…………………………………………. 24

23b. 3^0 veins course admedially ramified ………...…………………………………………. 25

24a. Lamina microphyll; angle of leaf base acute; decurrent base; inter secondaries of inter 2^0 veins weak; 3^0 veins to 1^0 veins acute in angle; 3^0 veins angle variability inconsistent ………………………………………………………………… ***F. tinctoria*** **subsp.** ***gibbosa***

24b. Lamina mesophyll; angle of leaf base obtuse; rounded base; inter secondaries of inter 2^0 veins absent; 3^0 veins to 1^0 veins obtuse in angle; 3^0 veins angle variability uniform ……………………………………………………………………………… ***F. beddomei***

25a. Angle of the leaf base acute ………………………………………………………. 26

25b. Angle of the leaf base obtuse ………………………………………………...… 31

26a. Leaf apex convex ……………………………………………………….………. 27

26b. Leaf apex acuminate …………………………………..………………………….. 28

27a. Ovate lamina, base truncate; 3^0 veins to 1^0 veins obtuse in angle; 5^0 veins dichotomizing ………………………………..……………………..…………………… ***F. benghalensis***

27b. Elliptic or oblong lamina, base rounded; 3^0 veins to 1^0 veins acute in angle; 5^0 veins regular polygonal reticulate ……………………………………………………….. ***F. fergusonii***

28a. Base convex or rounded; leaf margin entire; 3^0 veins to 1^0 veins acute or obtuse; 3^0 vein angles inconsistent; 4^0 vein categories regular polygonal reticulate ……………………….. 29

28b. Base truncate; leaf margin crenate; 3^0 veins to 1^0 veins perpendicular; 3^0 vein angles uniform; 4^0 vein categories alternate percurrent ……………………………….… ***F. hispida***

29a. 3^0 veins alternate percurrent; 3^0 veins to 1^0 veins acute in angle; base cuneate or convex …………………………………………………………………………….…………… 30

29b. 3^0 veins random reticulate; 3^0 veins to 1^0 veins obtuse in angle; base rounded …………………………………………………………………………..….. ***F. tsjakela***

30a. 2^0 vein angles with 2 pair acute basal secondaries; leaf base convex ………… ***F. racemosa***

30b. 2^0 vein angles without 2 pair acute basal secondaries; leaf base cuneate … ***F. travancorica***

31a. Leaf margin entire ……………………………………………………………………… 32

31b. Leaf margin serrate ………………………………………………….... ***F. heterophylla***

32a. Apex of the leaf convex ………………………………………………………..… 33

32b. Apex of the leaf acuminate ……………………………………………………………. 34

33a. Lamina microphyll; inter-2^0 veins with strong inter secondaries; 3^0 veins alternate percurrent; 3^0 veins to 1^0 veins acute in angle; 3^0 vein angles inconsistent …………. ***F. pumila***

33b. Lamina mesophyll; inter-2^0 veins without inter secondaries; 3^0 veins mixed opposite or alternate; 3^0 veins to 1^0 veins obtuse in angle; 3^0 vein angles increasing exmedially …………………………………………………………………………..... ***F. auriculata***

34a. Leaf base rounded; lamina mesophyll …………………………………………………. 35

34b. Leaf base cordate; lamina notophyll ………………………………………….. ***F. guttata***

35a. 3^0 vein angles inconsistent; 3^0 veins alternate percurrent or random reticulate ………... 36

35b. 3^0 vein angles increasing exmedially; 3^0 veins mixed opposite or alternate ……………………………………………………………………………….. ***F. exasperata***

36a. Lamina elliptic; 2^0 vein angles without 2 pair acute basal secondaries; 3^0 veins random reticulate, 3^0 veins to 1^0 veins acute in angle ………………..………………….. ***F. middletonii***

36b. Lamina ovate or oblong; 2^0 vein angles with 2 pair acute basal secondaries; 3^0 veins alternate percurrent, 3^0 veins to 1^0 veins obtuse in angle …………………….. ***F. anamalayana***

DISCUSSION

Numerous characteristics of leaves have the potential to be taxonomically significant, according to Carlquist (1961). The venation pattern is one among them (Foster & Arnot 1960). Leaf veins are a crucial component of leaf structure and are in charge of the long-distance movement of water, nutrients, and photo assimilates in addition to providing mechanical support for leaves (Onoda *et al*., 2011; Malinowski, 2013). Variations in leaf venation patterns can be utilized to distinguish between species within a genus in addition to distinguishing taxa. In order to identify and categorize species, leaf venation can be categorized into a number of features or patterns, such as veinlets and ultimate marginal venation (Hickey, 1973; Sehgal & Paliwal, 2008). According to Hickey (1973) and Inamdar *et al*., (1983), monocotyledons and dicotyledonous plants exhibit a rich range of venation patterns. The relevance of veinlet termination endings in the Bignoniaceae family was recognized by Ogundipe and Wujek (2004). The significance of main and minor vein patterns, as well as additional characteristics like shape, base, apex, texture, margin, etc., are listed in Hickey's (1973) taxonomy of vein architecture. According to Badron *et al*., (2014), leaf venation patterns, which differ among plants, can be categorized by size and provide valuable information for plant identification, particularly in groupings like Ficus species. The minor venation pattern is defined by Plymale & Wylie (1944) as the first three types of veins from the major vein, including the ultimate veinlets.

The current work attempts to resolve the taxonomic complexity for the identification of the genus *Ficus* L. According to the study, the majority of the 37 taxa of *Ficus* L. had simple leaves with a brochidodromous secondary venation. Others exhibited weak brochidodromous kind. All species had pinnate primary veins that were straight and unbranched. The evolutionary trend in the genus was analysed using phenetic analysis, and the evolutionary relatedness was analysed using a phenogram. Eleven sister lineages that have more similar traits and are closely linked were found based on the phenetic study. *F. drupacea* and *F. talbotii* have different quinary and secondary venation patterns. *F. drupacea* exhibits brochidodromous and regular polygonal reticulate, whereas *F. talbotii* exhibits weak brochidodromous and dichotomizing vein patterns. Only the secondary venation distinguishes *F. amplocarpa* from *F. exasperata*; the former has a weak brochidodromous type, while the latter has a brochidodromous type. Although the leaf base form and secondary vein angle of *F. racemosa* and *F. travancorica* differ, they both display similar venation patterns. One has a cunate base, while the other has a convex base with two pair acute basal secondaries. The size of the leaves and the secondary venation of *F. virens* var. *virens* and *F. fergusonii* are different. Notophyllous leaves with a brochidodromous type of secondary venation are found in virens, whereas mesophyll leaves with a weak brochidodromous venation form in other species. Different leaf shapes and secondary vein spacing are found in *F. nervosa* and *F. virens* var. *dispersa*. In *F. nervosa* leaves are elliptic to ovate in shape, with vein spacing growing toward the base, whereas *F. virens* var. *dispersa* leaves are oblong with vein spacing rising toward the base. The most similar species, *F. superba* and *F. callosa*, differ only in their tertiary vein angle to the primary. *F. callosa* have an oblique angle, whereas superba have an acute angle. The sole distinction between *F. heterophylla* and *F. tsjakela* is that the former had a serrate margin, whereas the latter have an entire margin. *F. middletonii* and *F. tinctoria* ssp. *parasitica* have different secondary and tertiary vein patterns.one exhibit brochidodromous secondary venation and a random reticulate tertiary vein pattern, while other possess alternate percurrent tertiary venation and brochidodromous secondary venation. *F. krishnae* and *F. mollis* have different intersecondary veins and bases. One has weak intersecondaries and a cup-shaped base, while the other has cordate intersecondaries and strong intersecondaries. Secondary and tertiary veins in *F. microcarpa* and *F. bengalensis* differ; one has weak brochidodromous and alternating percurrent venation, while the other has brochidodromous and random reticulate venation.

In this study, all 37 *Ficus* taxa are grouped into three clades. *F. benjamina* is the only species found in Clade 1. The Clade 2 is further separated into two subclades, one of which contains the single taxon F. elastica, and the other two of which include *F. talbotii, F. drupacea*, and *F. dalhousiae*. Clade 3 is subdivided into eight subclades, which include thirty-two *Ficus* L. species.

The results have been supported by previous investigations by Siti-khaulah & Noraini (2016) and Badron *et al.* (2014). They both studied the venation patterns on the leaves of *Ficus* species from the Peninsular region of Malaysia and emphasized how important these patterns are for taxonomic classification. In their study with 21 *Ficus* taxa, Badron *et al.* (2014) discovered eight distinct types of leaf veination, including simple veinlets, tri-, bi-, and uni-veinlets, as well as species without veinlets. Siti-Khaulah & Noraini (2016), on the other hand, studied eight species, focusing on characteristics such areolar venation (open or closed) and ultimate marginal venation (complete or incomplete), as well as differentiating between simple and complicated veinlets. Special anatomical features including trichomes and cystolith cells were seen in both investigations, confirming their significance in species identification. However, Siti-Khaulah and Noraini stressed the structural completeness and complexity of venation, whereas Ummu Hani Badron *et al*……………. classified venation primarily by the quantity and type of veinlets. Both investigations showed that differences in leaf venation patterns offer useful taxonomic features for identifying species within the genus *Ficus*, despite their differing scales and areas of focus.

Ficus comprises a wide variety of roadside and garden trees, including *Ficus religiosa*, *Ficus elastica*, and *Ficus microcarpa*, as well as indoor ornamental plants. The distinctive stipules that leave a scar after abscission, the milky juice, the tiny unisexual flowers that are frequently placed on a variety of shaped receptacles, and the highly distinctive fruits, or syconia, make it easy to identify the genus (Hutchinson & Dalziel 1958). It can be challenging to identify species, particularly in the field, because some species lack syconia and have similar morphological characteristics (Badron *et al.,* 2014). A taxonomic key for identifying each species based on leaf venation pattern is provided by the current study, which aids in solving this identification issue.

CONCLUSION

The leaf venation patterns of 37 *Ficus* L. taxa found in the western Ghats region were examined. For every *Ficus* taxonomic group, 66 states and 18 characteristics were examined. These observations were transformed into numerical data to create the phenogram. Based on phenetic analysis, 37 taxa have been divided into 3 clades. Clade 1 has only one species, *F. benjamina*. There are two subclades in Clade 2, and eight subclades in Clade 3. By creating a taxonomy key for *Ficus* L. based on phenetic analysis and visible traits, this aids in resolving the taxonomic challenge in genus identification. The most related clade, according to the analysis, was *F. superba* and *F. callosa*, with 92% similarity. Simple leaves with pinnate main venation are seen in all species. Twenty-five of the species exhibited the brochidodromous type of secondary venation, whilst the remaining species exhibited a lesser form. Most taxa have regular polygonal reticulate quaternary and quinary venation patterns.

Additional information on the venation pattern will be obtained by analysing the venation using fresh leaves and different vein cleaning methods. This vein cleaning technique can be used to solve vein identification problems in species such as *F. elastica* and *F. benjamina*.

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Appendix 1: Data sheet prepared for the leaf venation pattern study in the genus *Ficus*

Sl No	Character	Chacter state
1	MORPHOTYPE NAME	
2	MORPHOTYPE	
3	MAJOR PLANT GROUP	
4	ORGAN TYPE	
5	RECORD DATE	
7	DIAGANOSTIC FEATURES	
8	PLANT FAMILY	
9	LEAF ATTACHMENT	Alternate
		Opposite
10	LEAF ORGANISATION	Simple
10	PETIOLE FEATURES	simple petiole
		Base swollen
		short petiole
		Long petiole
11	LAMINAR SIZE	Mesophyll
		microphyll
		Notophyll
12	LAMINAR SHAPE	Elliptic
		Cordate
		Obovate
		Ovate
		Oblong
13	LAMINAR SYMMETRY	Symmetrical
		Asymmentrical
14	BASE ANGLE	Acute
		Obtuse
		Wide obtuse
15	APEX ANGLE	Acute
		Obtuse
		Wide obtuse
16	BASE SHAPE	Cuneate
		cup shaped
		Convex
		Rounded
		Truncate
		lobate
		cordate
		Decurrent
		Concave
17	POSITION OF PETIOLAR ATTACHMENT	Marginal

		peltate eccentric
18	APEX SHAPE	Straight
		Convex
		Rounded
		Truncate
		Acuminate
		Complex
19	MARGINE TYPE	Entire
		serrate
		crenate
20	LOBATION	Unlobed
		lobed
21	1^0 VEIN CATEGORY	Pinnate
22	2^0 VEIN CATEGORY	Brochidodromous
		weak brochidodromous
23	AGROPHIC VEIN	Simple
		Compund
24	2^0 VEIN SPACING	Increasing towards base
		uniform
		decreasing towards base
		Irregular
25	2^0 VEIN ANGLE	2pair acute basal secondaries
		uniform
		one pair acute basal secondaries
26	INTER-2^0 VEINS	Strong intersecondaries
27	3^0 VEIN CATEGORY	Alternate percurrent
		mixed opp/alt
		Alternate reticulate
28	3^0 VEIN COURSE	Admedially ramified
		exmedially ramified
29	3^0 VEIN ANGLE TO 1^0	Acute
		Perpendicular
30	3^0 VEIN ANGLE VARIABILITY	inconsistent
		increasing exmedially
		uniform
32	5^O VEIN CATEGORY	Regular polygonal reticulate
		dichotomizing
33	AREOLATION	alternate percurrent
		Regular Polygonal Reticulate
		Dichotomizing
		Moderately developed

		Well developed

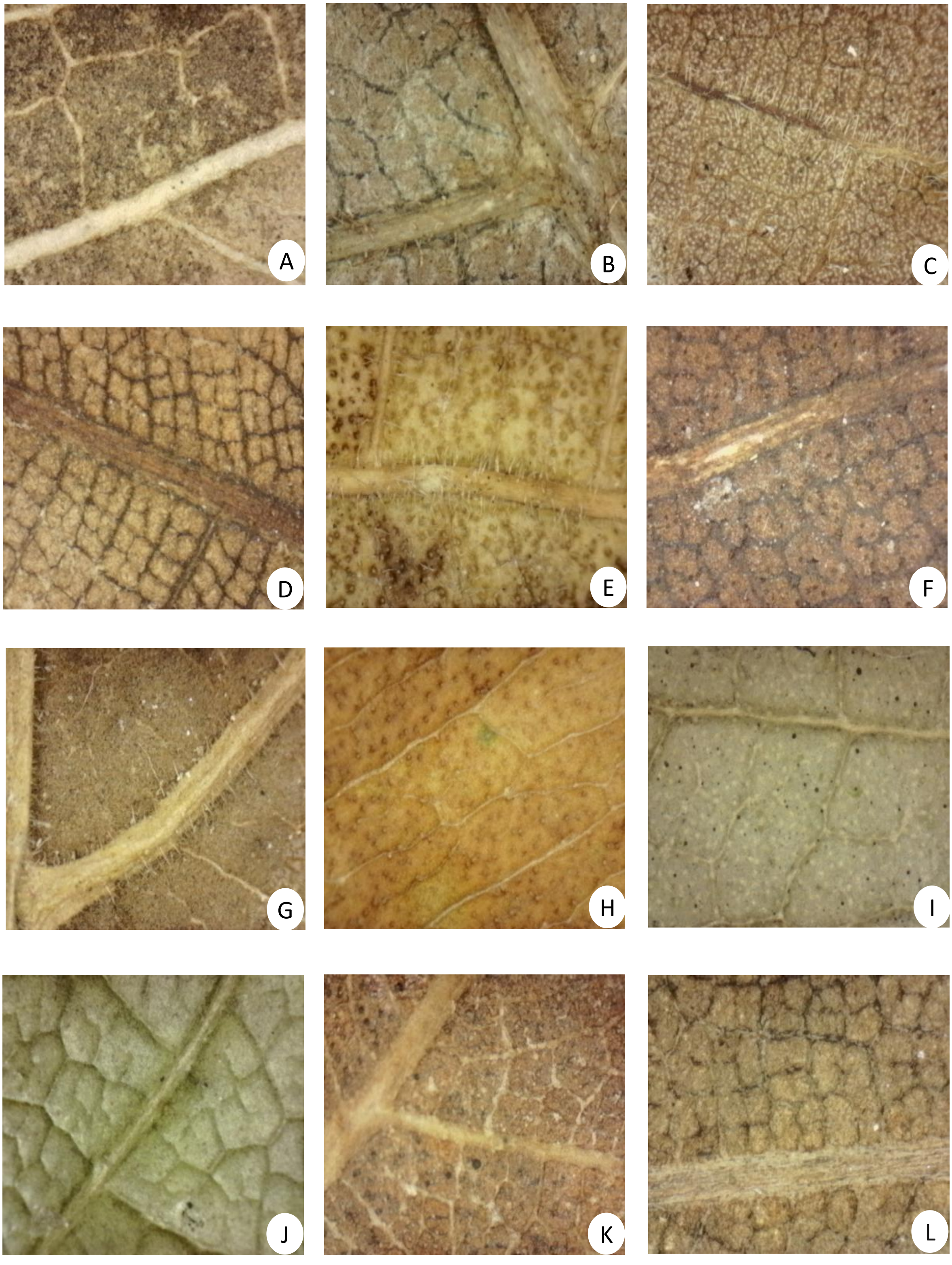

Fig. 1. 2^0 Vein Category: A. *F. amplissima* **B.** *F. amplocarpa* **C.** *F. anamalayana* **D.** *F. arnottiana* **E.** *F. auriculata* **F.** *F. beddomei* **G.** *F. benghalensis* **H.** *F. benjamina* **I.** *F. binnendykii* **J.** *F. callosa* **K.** *F. caulocarpa* **L.** *F. costata*

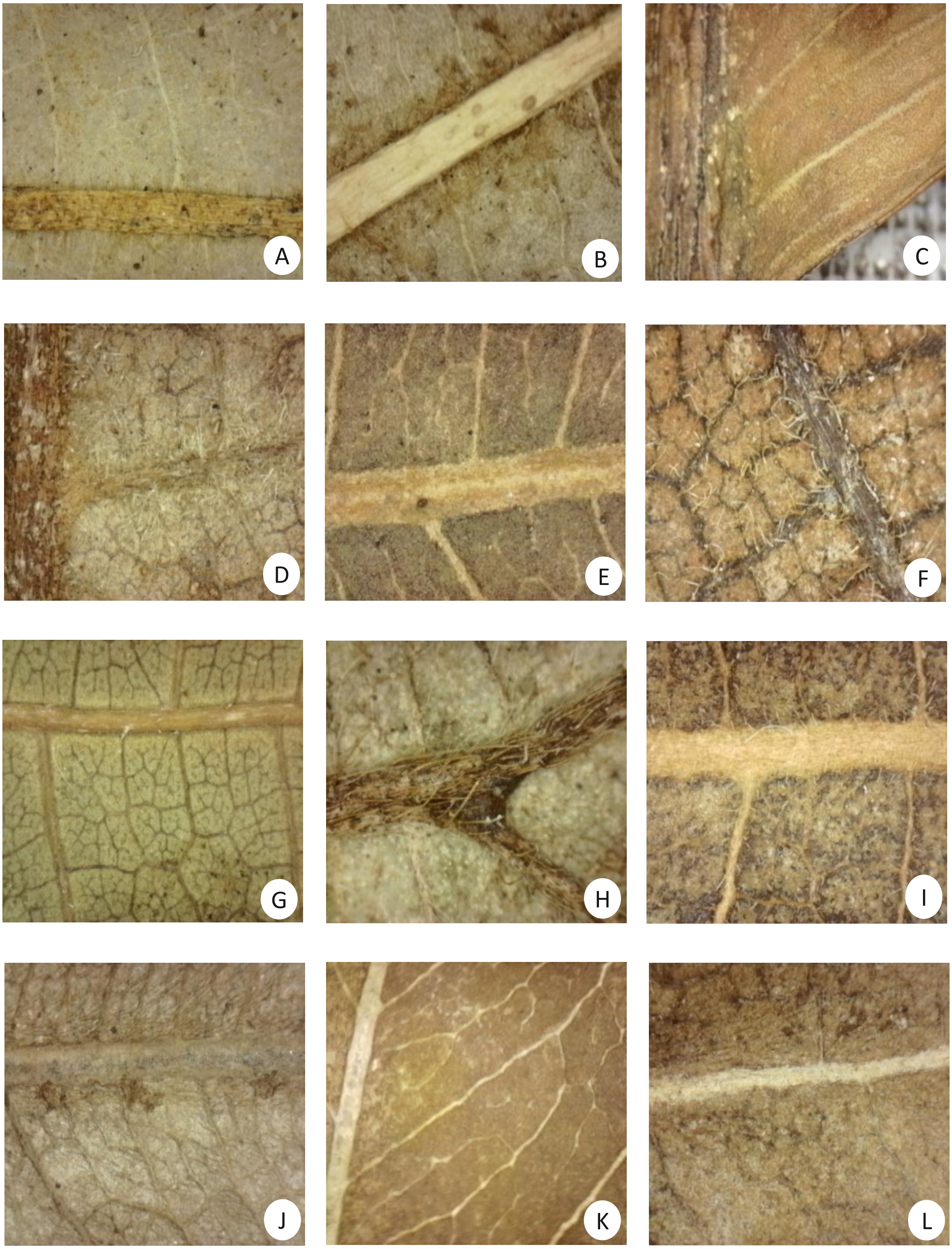

Fig. 2. 2^0 Vein Category: A. *F. dalhousieae* **B.** *F. drupacea* **C.** *F. elastica* **D.** *F. exasperata* **E.** *F. fergusonii* **F.** *F. guttata* **G.** *F. heterophylla* **H.** *F. hispida* **I.** *F. krishnae* **J.** *F. middletonnii* **K.** *F. microcarpa* **L.** *F. mollis.*

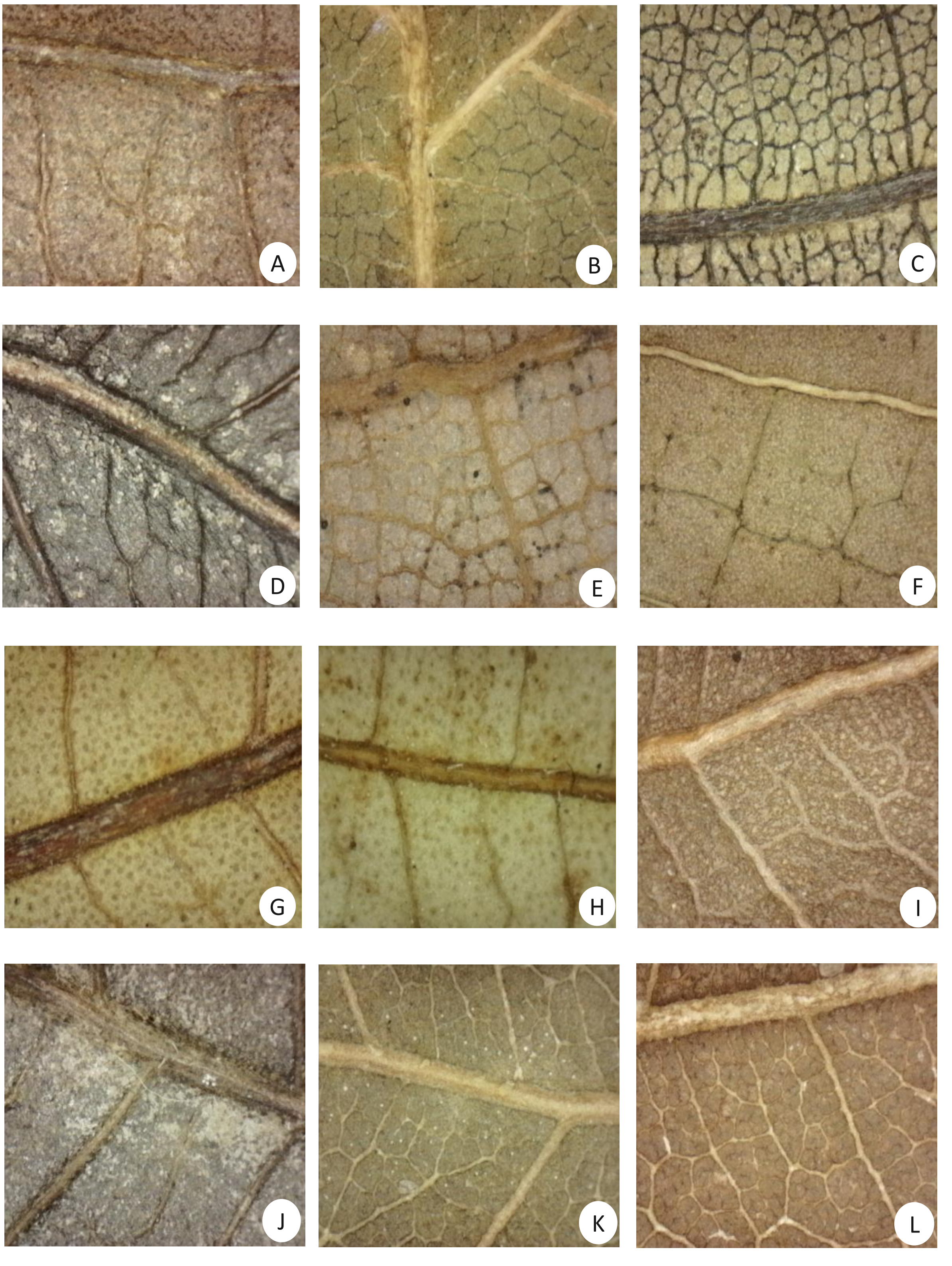

Fig. 3. 2^0 Vein Category; A. *F. nervosa* **B.** *F. pumila* **C.** *F. racemosa* **D.** *F. religiosa* **E.** *F. superba* **F.** *F. talbotii* **G.** *F. tinctoria ssp. Parasitica* **H.** *F. tinctoria ssp. gibbosa* **I.** *F. travancorica* **J.** *F. tsjakela* **K.** *F. virens var. dispersa* **L.** *F. virens var. matthewii*

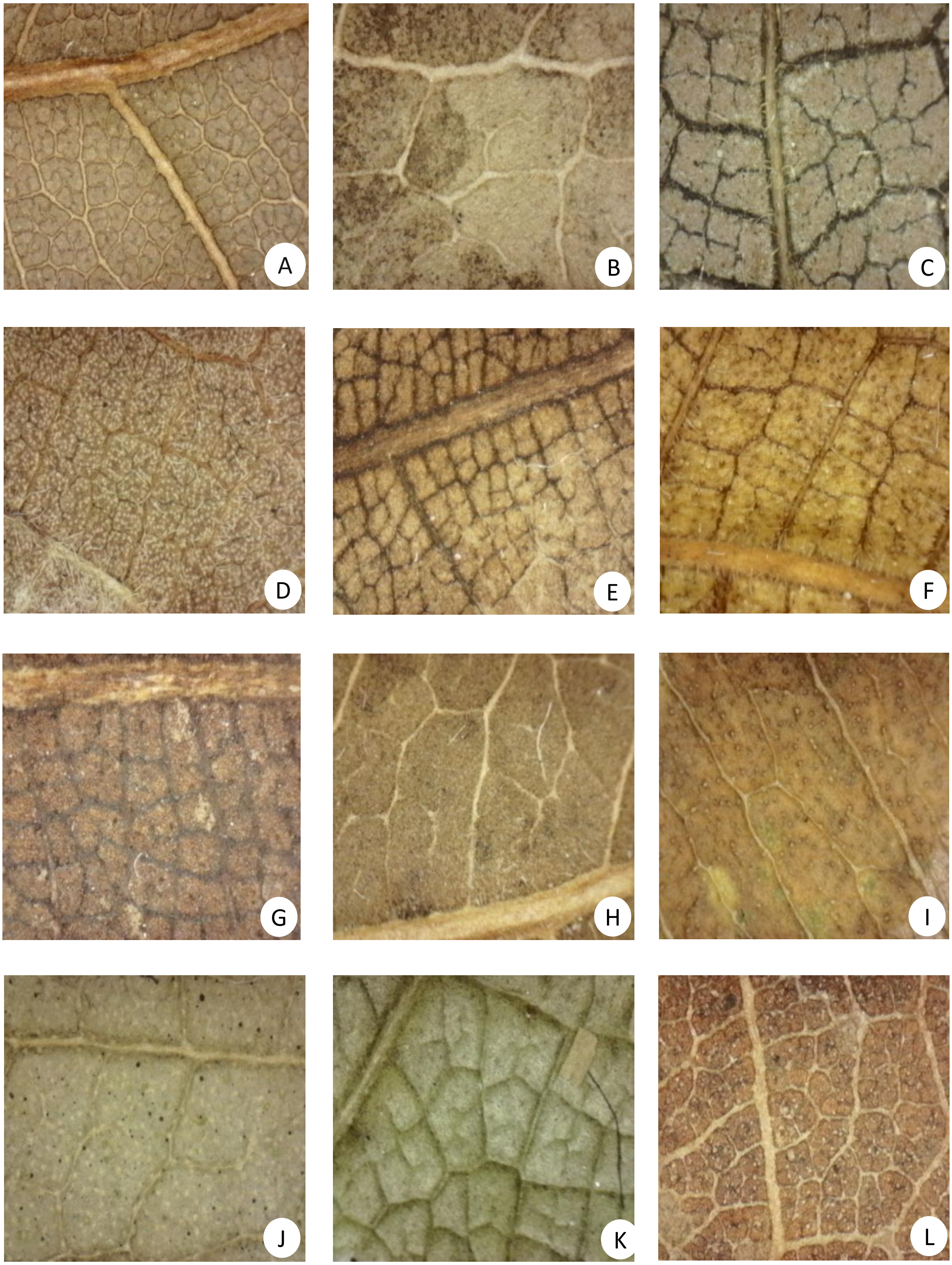

Fig. 4. 2^0 Vein Category: A. *F. virens* var. *virens*. **3^0 Vein Category: B.** *F. amplissima* **C.** *F. amplocarpa* **D.** *F. anamalayana* **E.** *F. arnottiana* **F.** *F. auriculata* **G.** *F. beddomei* **H.** *F. bengalensis* **I.** *F. benjamina* **J.** *F. binnendykii* **K.** *F. callosa* **L.** *F. caulocarpa* .

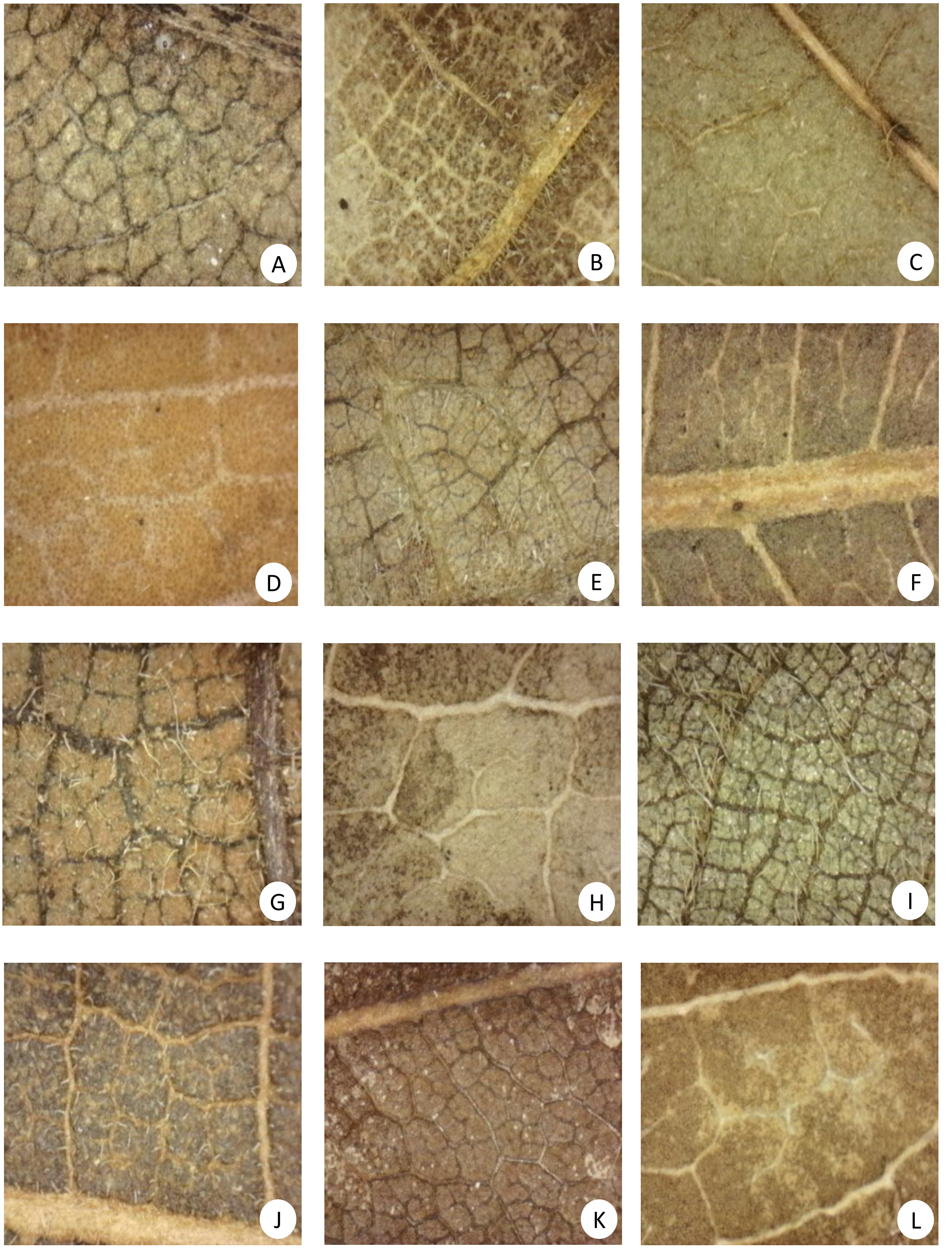

Fig. 5. 3^0 Vein Category: A. *F. costata* **B**. *F. dalhousieae* **C.** *F. drupacea* **D.** *F. elastica* **E.** *F. exasperata* **F.** *F. fergusonii* **G.** *F. guttata* **H.** *F. heterophylla* **I.** *F. hispida* **J.** *F. krishnae* **K.** *F. middletonii* **L.** *F. microcarpa.*

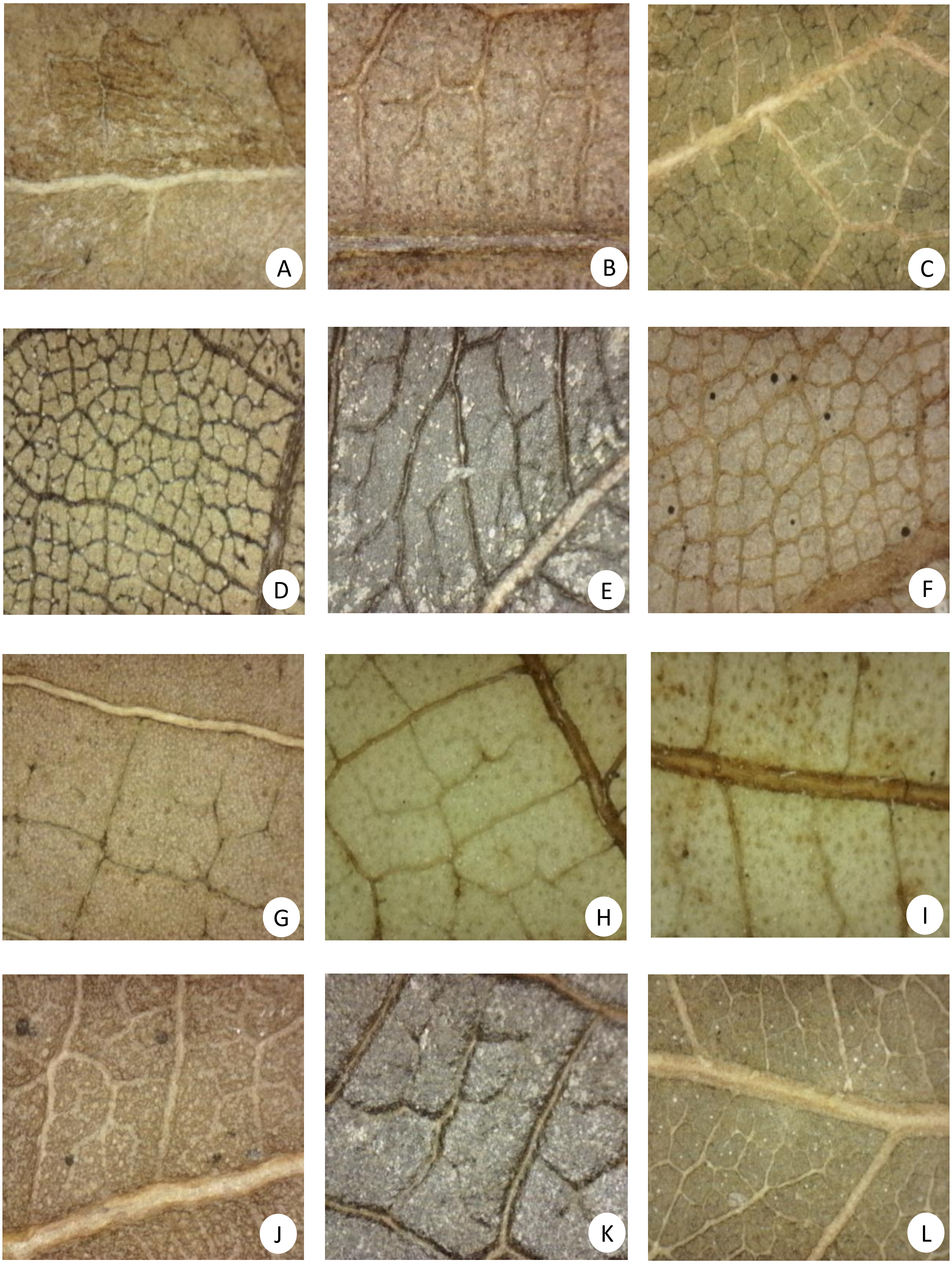

Fig. 6. 3^0 Vein Category; A. *F. mollis* **B**. *F. nervosa* **C.** *F. pumila* **D.** *F. racemosa* **E.** *F. religiosa* **F.** *F. superba* **G.** *F. talbotii* **H.** *F. tinctoria ssp. Parasitica* **I.** *F. tinctoria ssp. gibbosa* **J.** *F. travancorica* **K.** *F. tsjakela* **I.** *F. virens var. dispersa.*

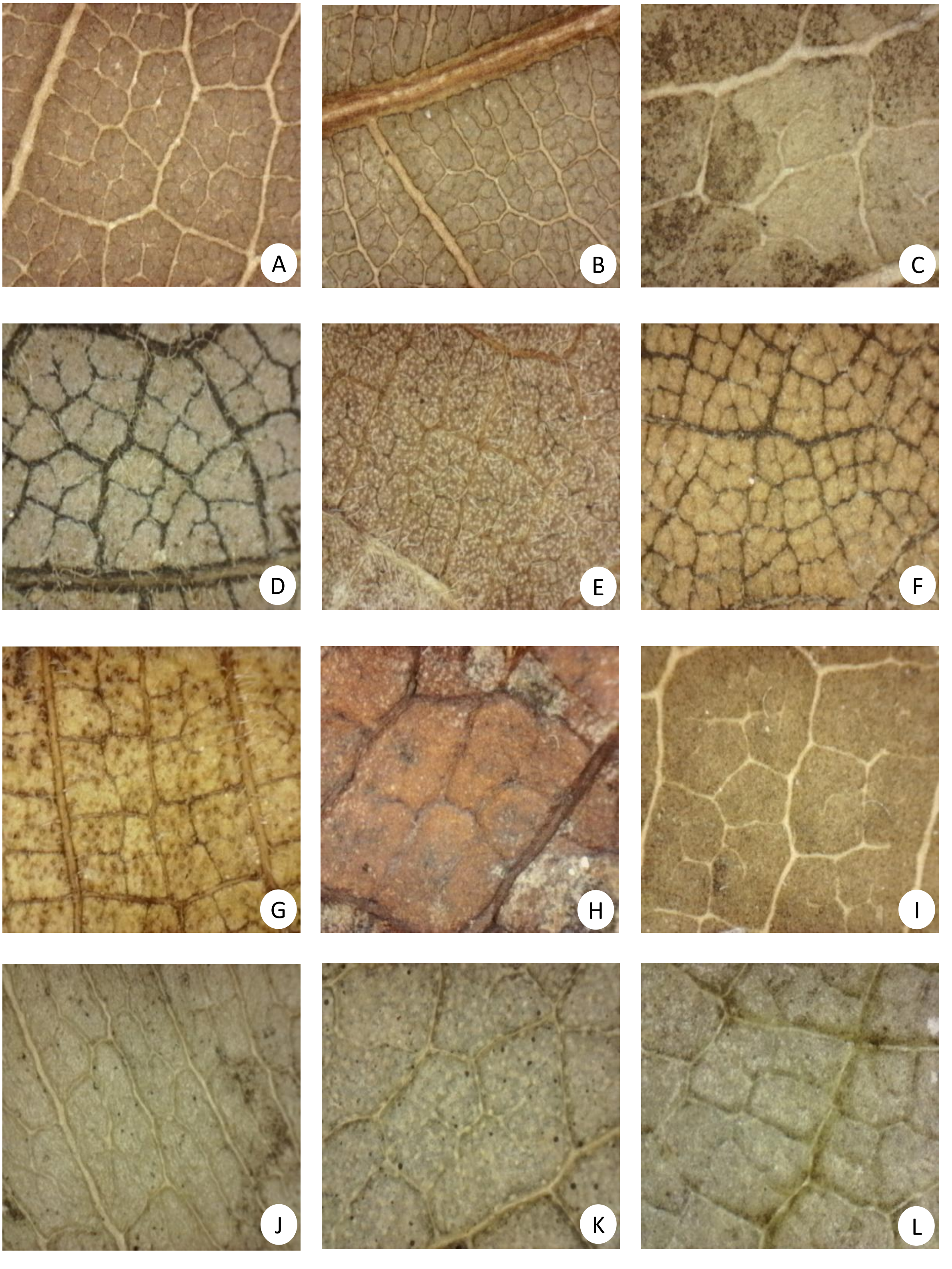

Fig. 7. 3^0 Vein Category: A. *F. virens var. matthewii* **B.** *F. virens* var. *virens*. **4^0 Vein Category: C.** *F. amplissima* **D.** *F. amplocarpa* **E.** *F. anamalayana* **F.** *F. arnottiana* **G.** *F. auriculata* **H.** *F. beddomei* **I.** *F. bengalensis* **J.** *F. benjamina* **K.** *F. binnendykii* **L.** *F. callosa*

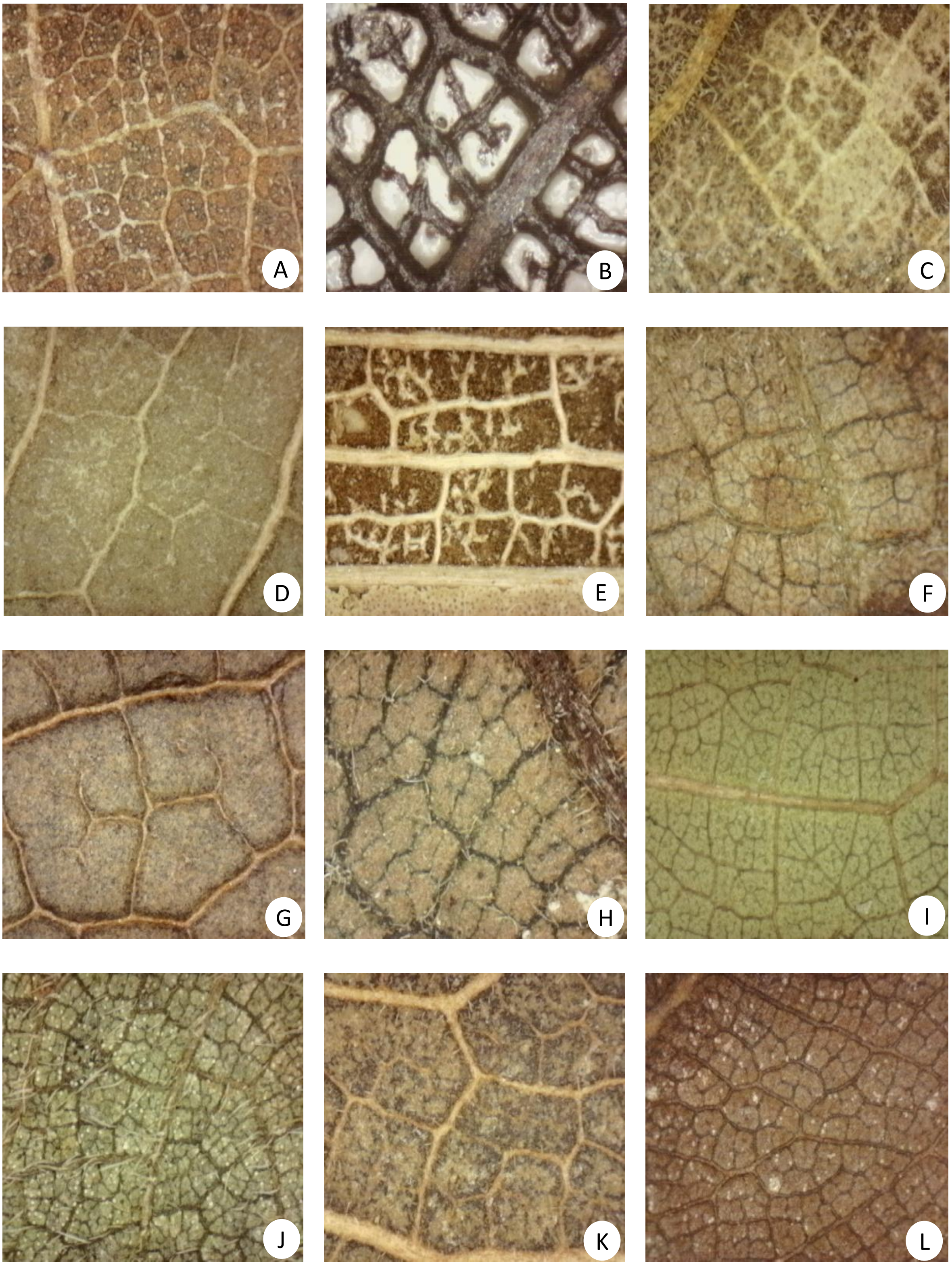

Fig. 8. 4^0 Vein Category: A. *F. caulocarpa* **B.** *F. costata* **C**. *F. dalhousieae* **D.** *F. drupacea* **E.** *F. elastica* **F.** *F. exasperata* **G.** *F. fergusonii* **H.** *F. guttata* **I.** *F. heterophylla* **J.** *F. hispida* **K.** *F. krishnae* **L.** *F. middletonnii*

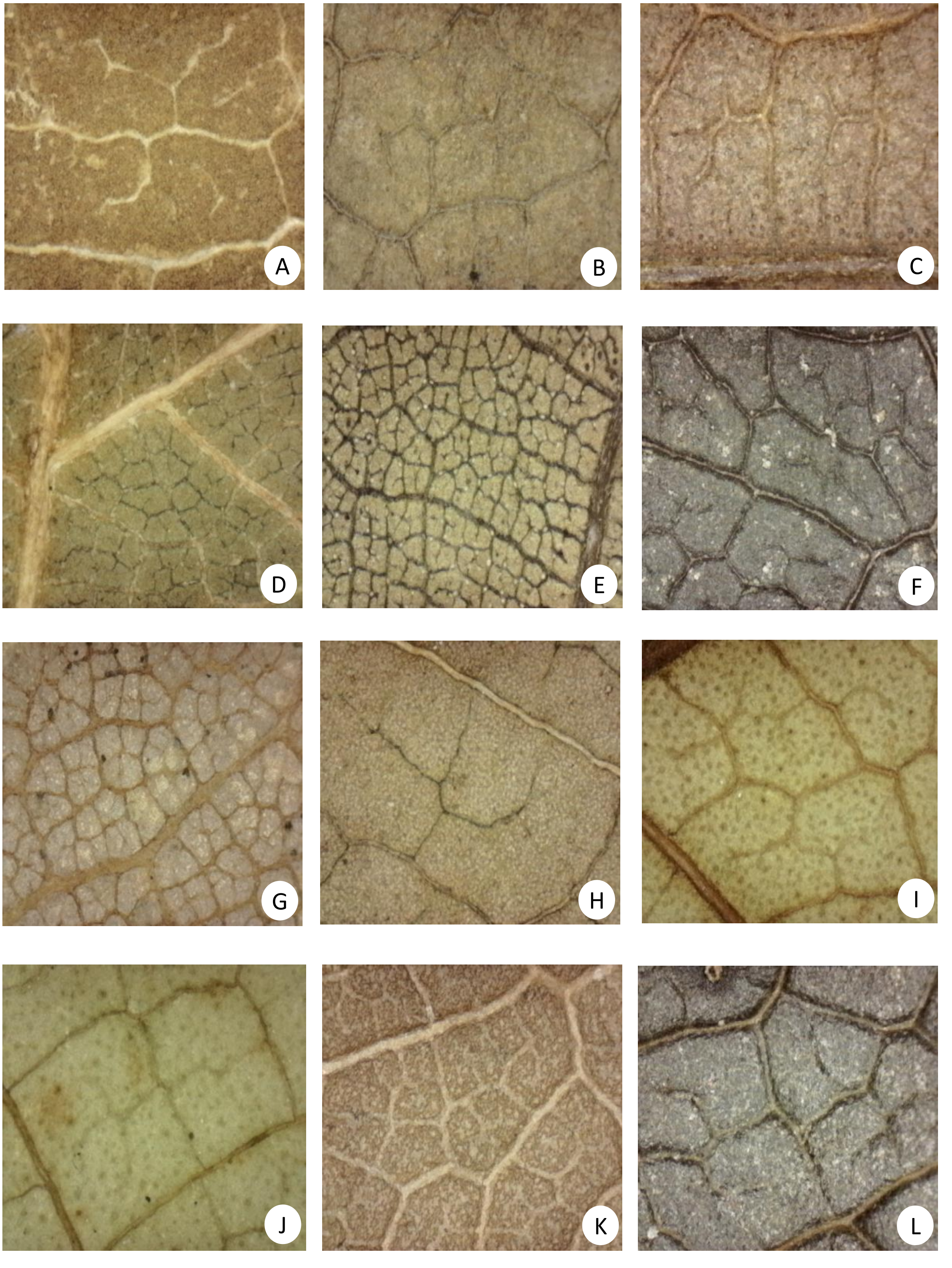

Fig. 9. 4^0 Vein Category A. *F. microcarpa* **B.** *F. mollis* **C**. *F. nervosa* **D.** *F. pumila* **E.** *F. racemosa* **F.** *F. religiosa* **G.** *F. superba* **H.** *F. talbotii* **I.** *F. tinctoria ssp. Parasitica* **J.** *F. tinctoria ssp. gibbosa* **K.** *F. travancorica* **L.** *F. tsjakela*

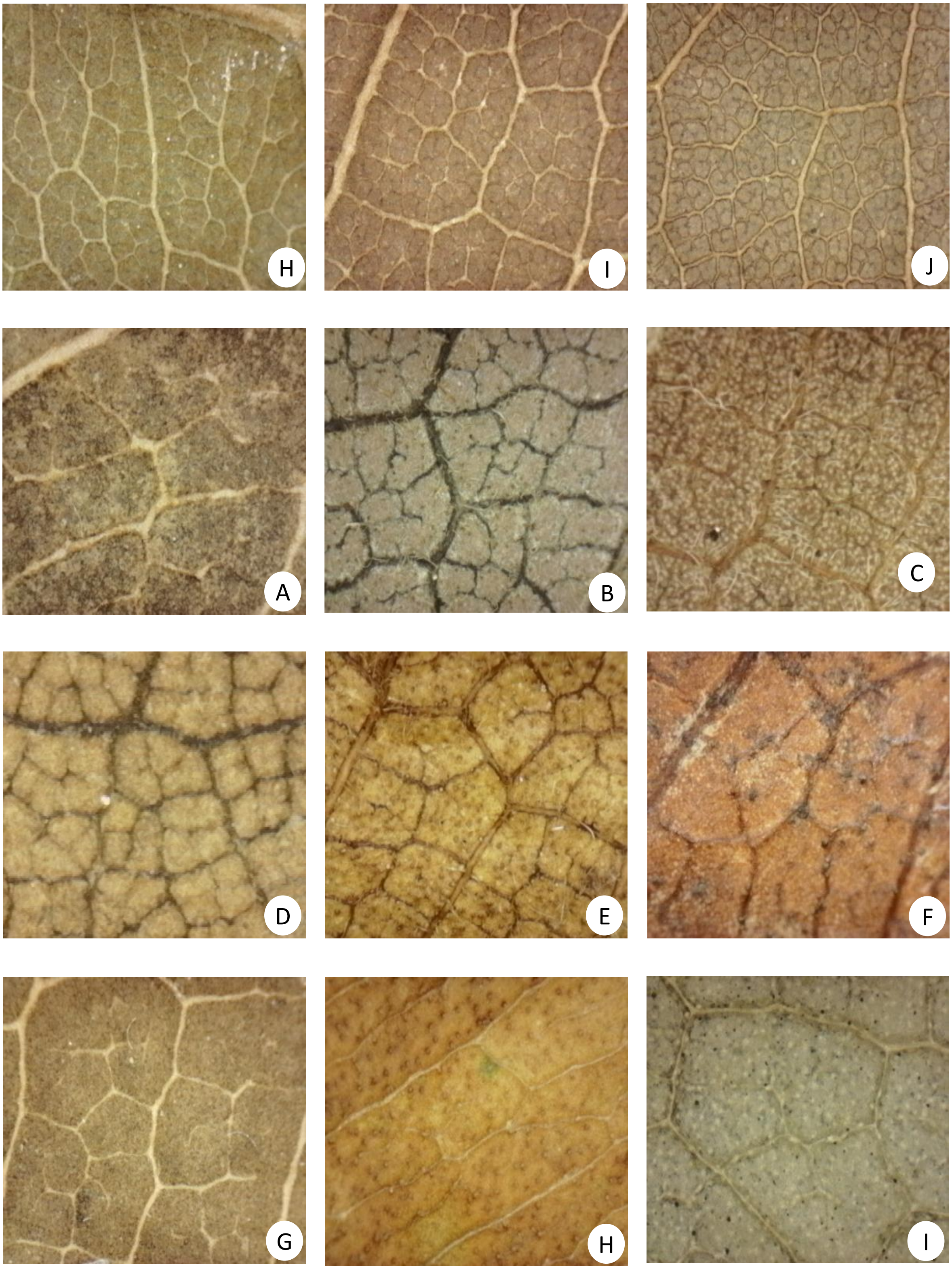

Fig. 10. 4^0 Vein Category: A. *F. virens var. dispersa* **B.** *F. virens var. matthewii* **C.** *F. virens* var. *virens.* **5^0 Vein Category; D.** *F. amplissima* **E.** *F. amplocarpa* **F.** *F. anamalayana* **G.** *F. arnottiana* **H.** *F. auriculata* **I.** *F. beddomei* **J.** *F. bengalensis* **K.** *F. benjamina* **L.** *F. binnendykii.*

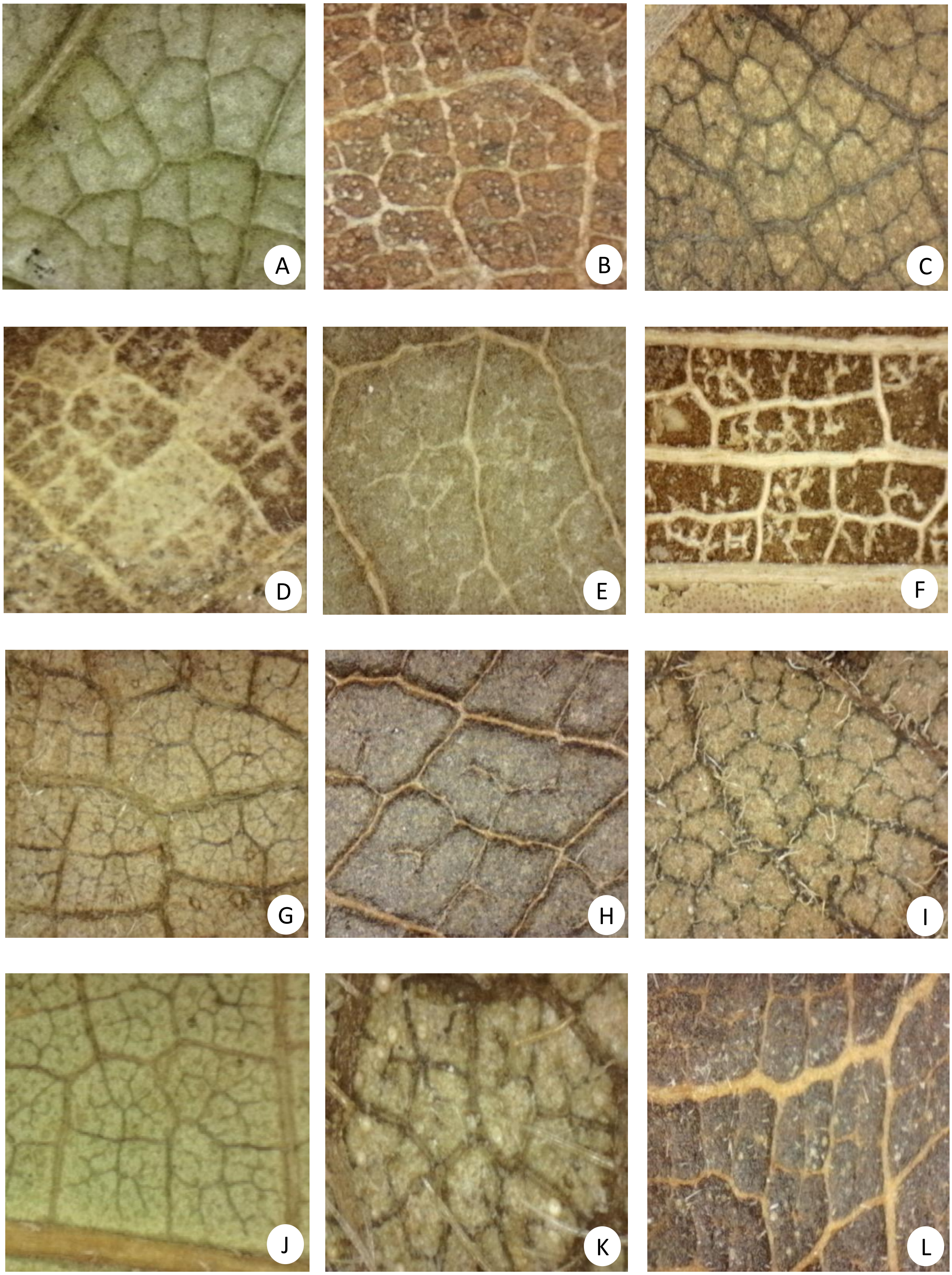

Fig. 11. 5^0 Vein Category: A. *F. callosa* **B.** *F. caulocarpa* **C.** *F. costata* **D.** *F. dalhousieae* **E.** *F. drupacea* **F.** *F. elastica* **G.** *F. exasperata* **H.** *F. fergusonii* **I.** *F. guttata* **J.** *F. heterophylla* **K.** *F. hispida* **L.** *F. krishnae*

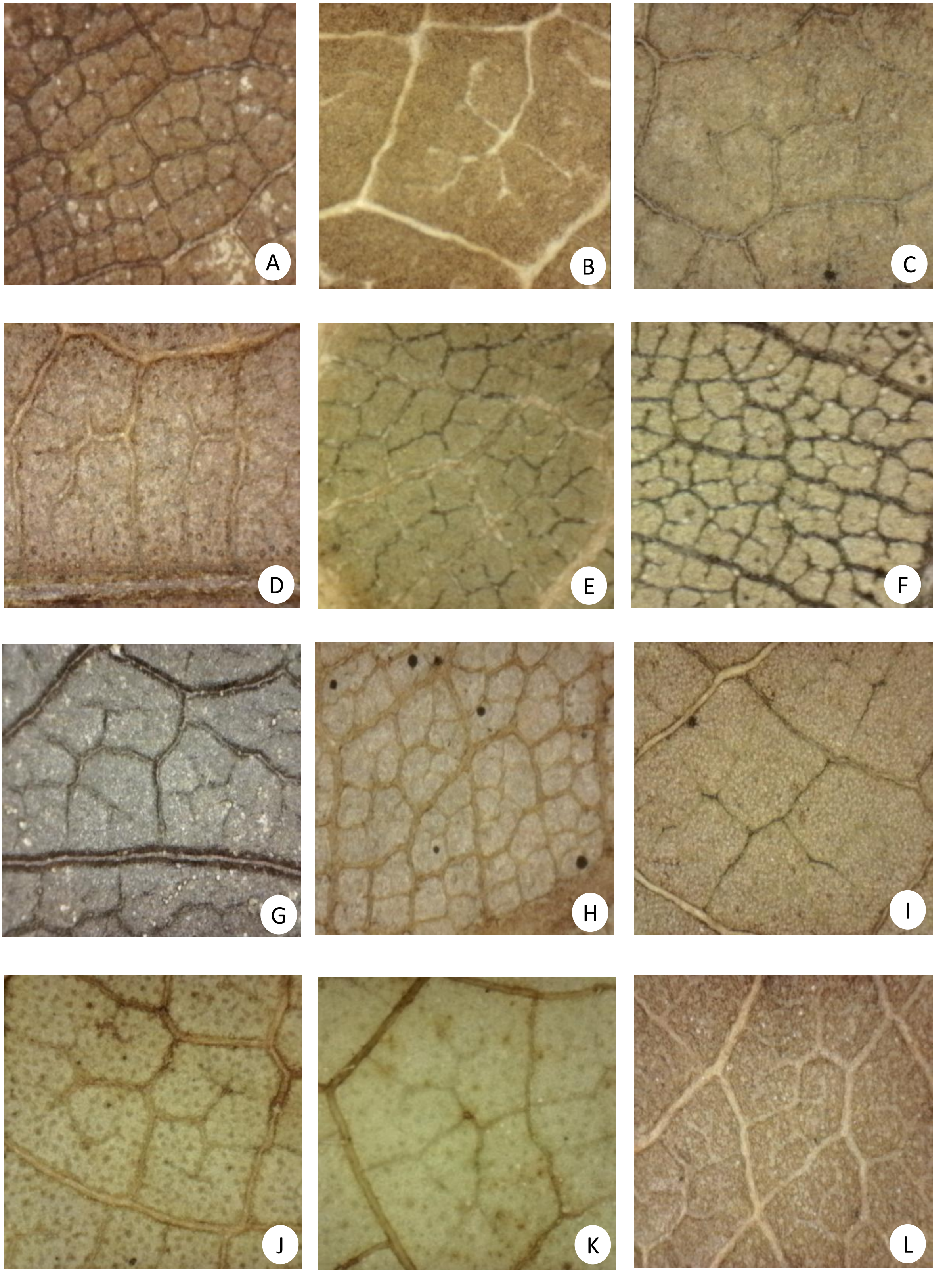

Fig. 12. 5^0 Vein Category: A. *F. middletonnii* **B.** *F. microcarpa* **C.** *F. mollis* **D**. *F. nervosa* **E.** *F. pumila* **F.** *F. racemosa* **G.** *F. religiosa* **H.** *F. superba* **I.** *F. talbotii* **J.** *F. tinctoria ssp. Parasitica* **K.** *F. tinctoria ssp. gibbosa* **L.** *F. travancorica*

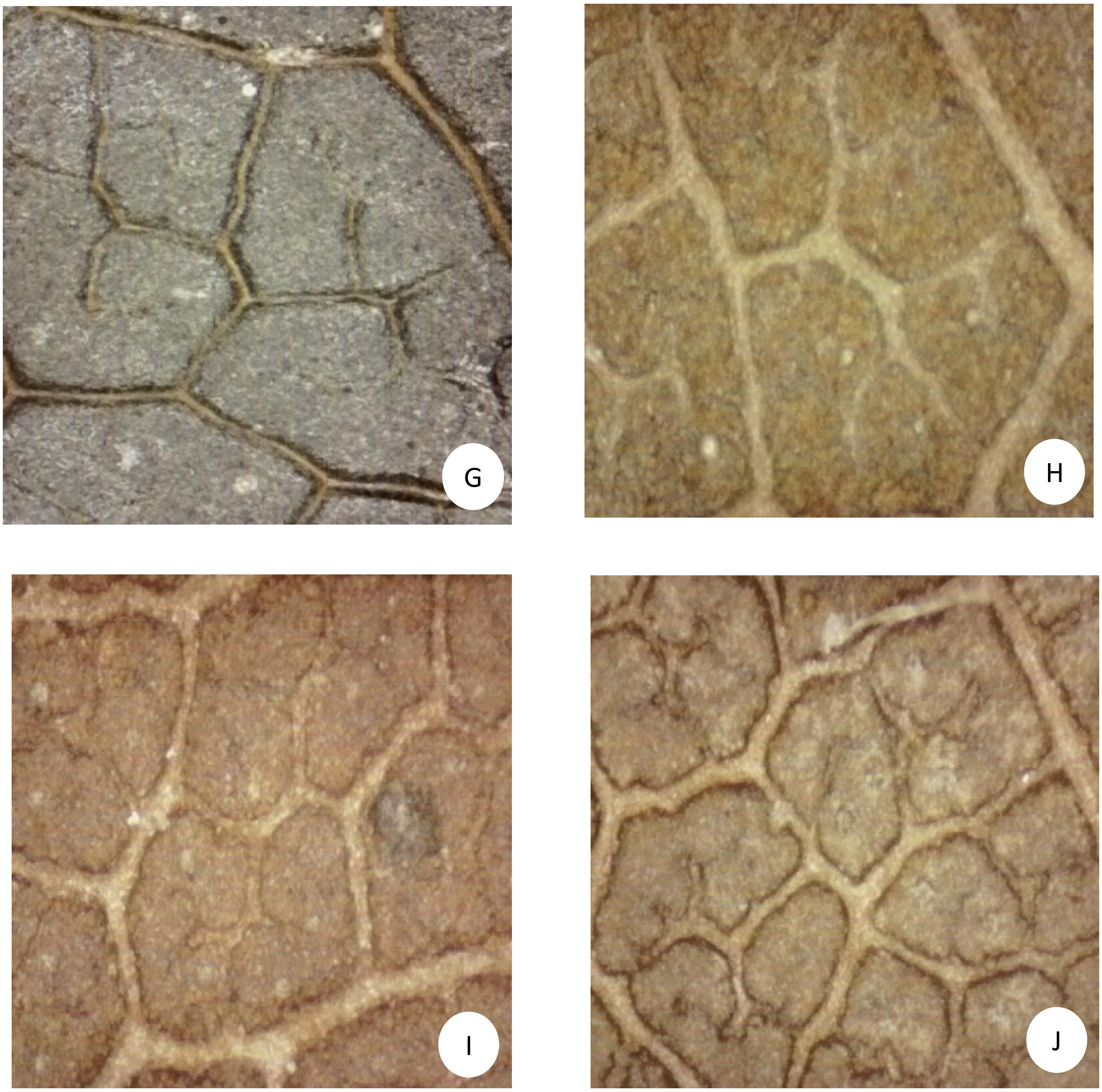

Fig. 13. 5^0 Vein Category: A. *F. tsjakela* **B.** *F. virens var. dispersa.* **C.** *F. virens var. matthewii* **D.** *F. virens* var. *virens.*

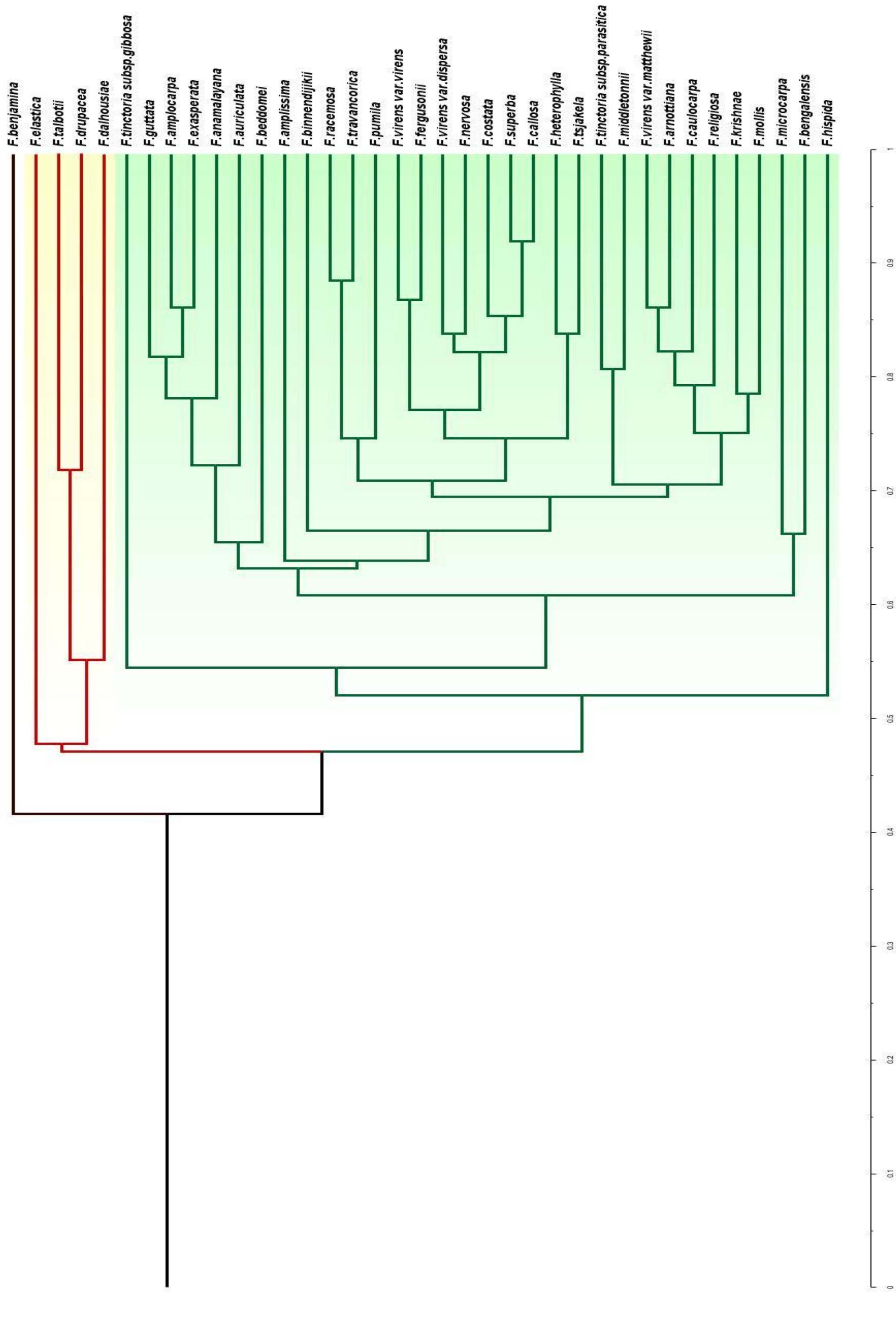

Fig. 14. Phenogram based on leaf venation patterns

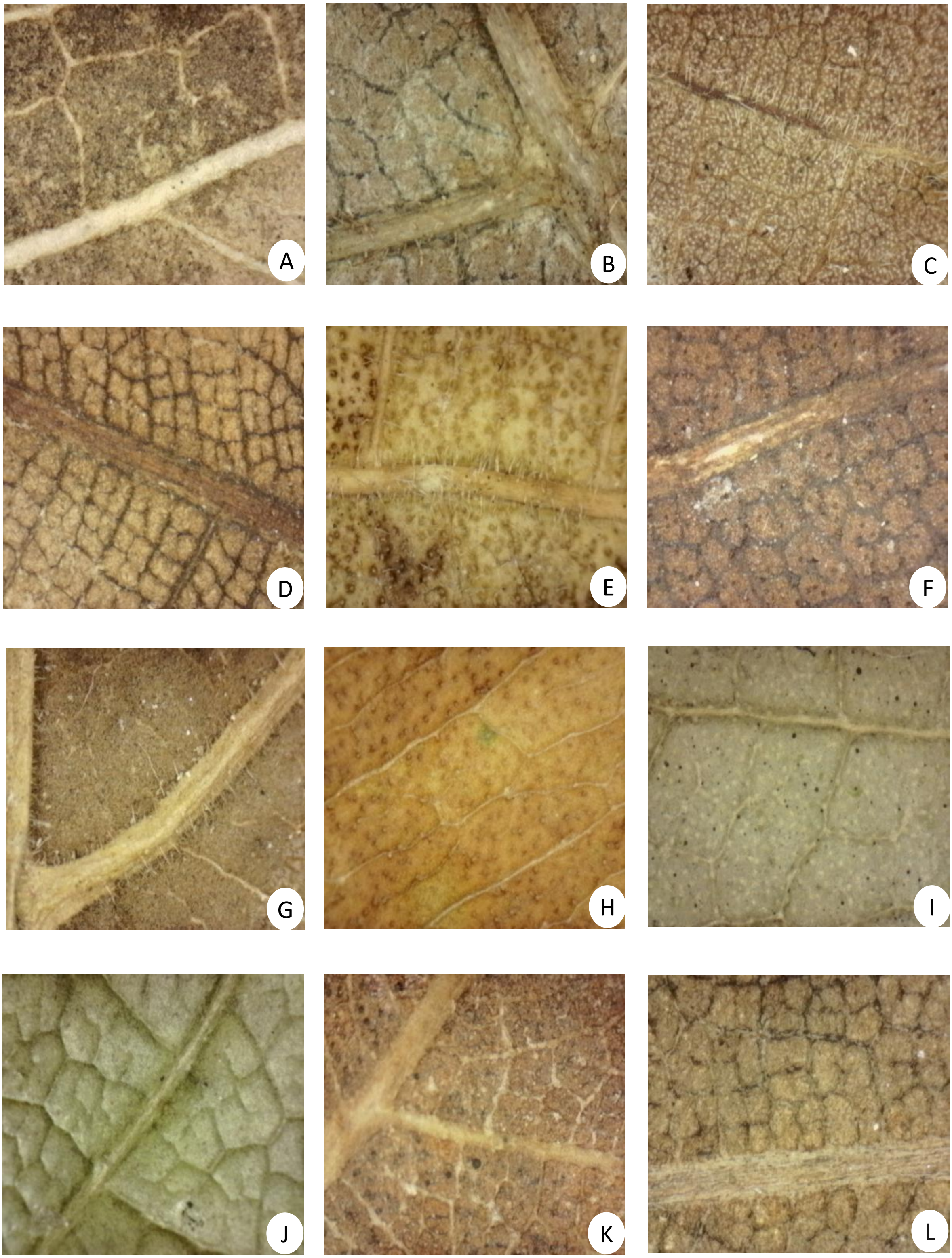

Fig. 1. 2^0 Vein Category: A. *F. amplissima* **B.** *F. amplocarpa* **C.** *F. anamalayana* **D.** *F. arnottiana* **E.** *F. auriculata* **F.** *F. beddomei* **G.** *F. benghalensis* **H.** *F. benjamina* **I.** *F. binnendykii* **J.** *F. callosa* **K.** *F. caulocarpa* **L.** *F. costata*

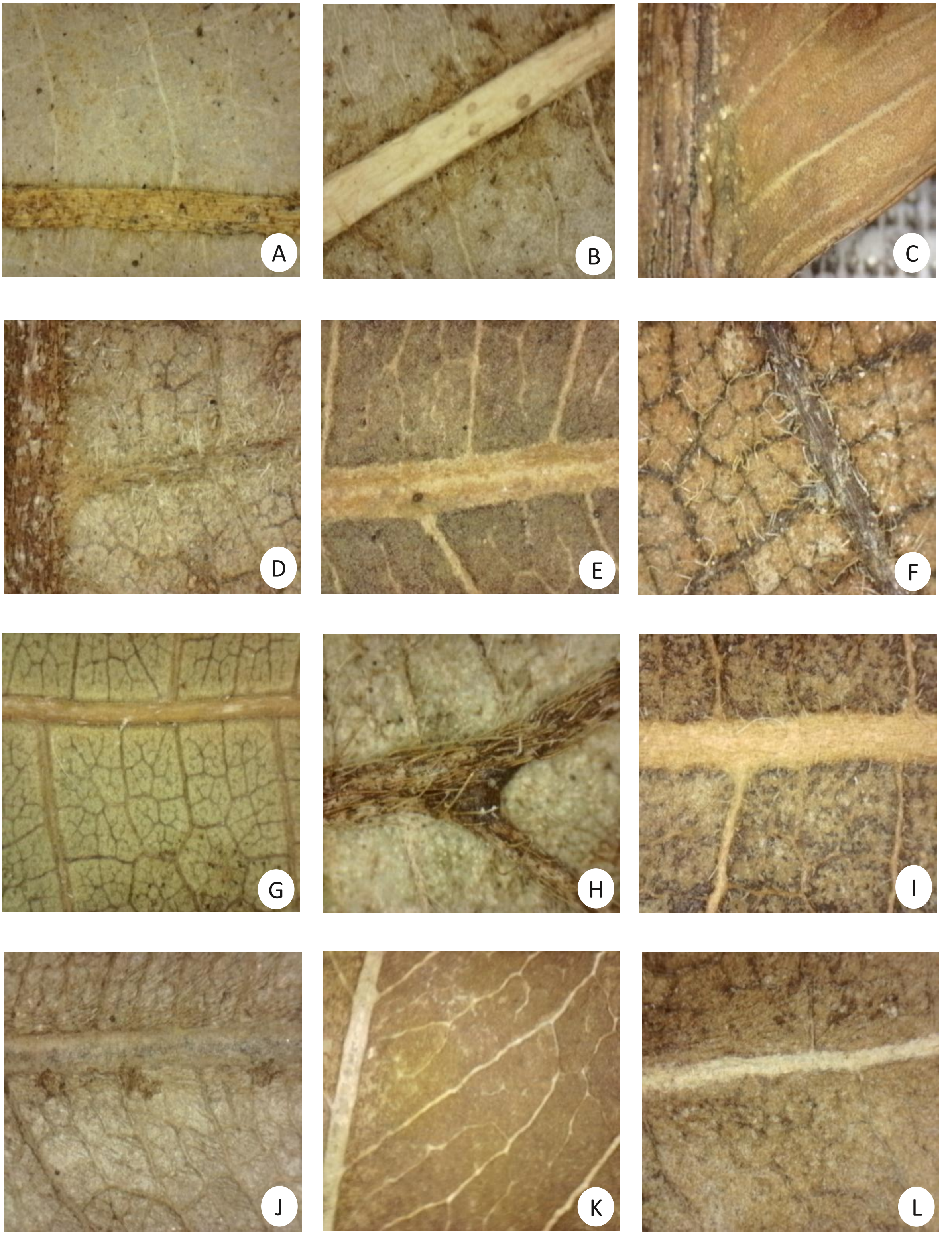

Fig. 2. 2^0 Vein Category: A. *F. dalhousieae* **B.** *F. drupacea* **C.** *F. elastica* **D.** *F. exasperata* **E.** *F. fergusonii* **F.** *F. guttata* **G.** *F. heterophylla* **H.** *F. hispida* **I.** *F. krishnae* **J.** *F. middletonnii* **K.** *F. microcarpa* **L.** *F. mollis.*

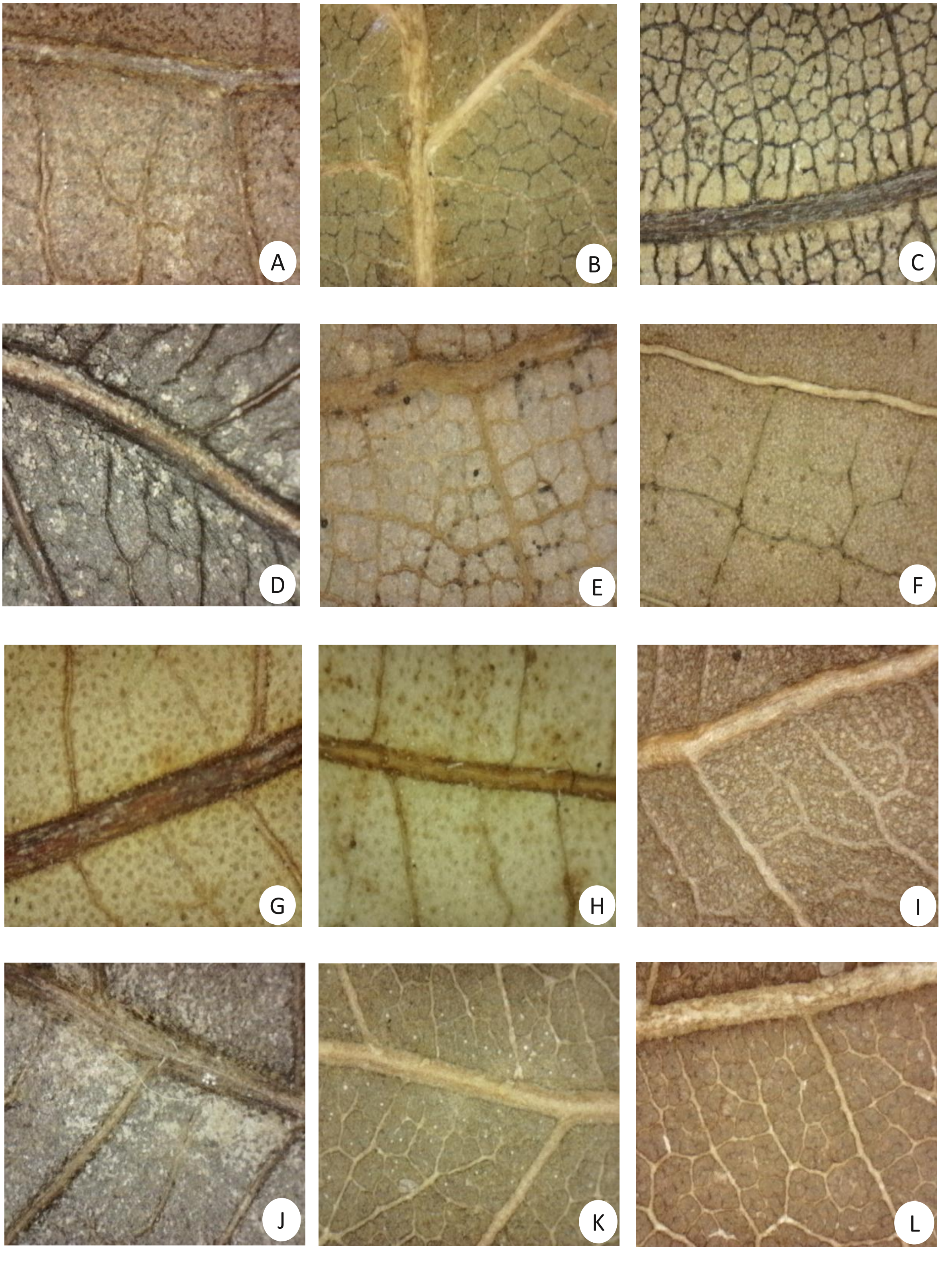

Fig. 3. 2^0 Vein Category; A. *F. nervosa* **B.** *F. pumila* **C.** *F. racemosa* **D.** *F. religiosa* **E.** *F. superba* **F.** *F. talbotii* **G.** *F. tinctoria ssp. Parasitica* **H.** *F. tinctoria ssp. gibbosa* **I.** *F. travancorica* **J.** *F. tsjakela* **K.** *F. virens var. dispersa* **L.** *F. virens var. matthewii*

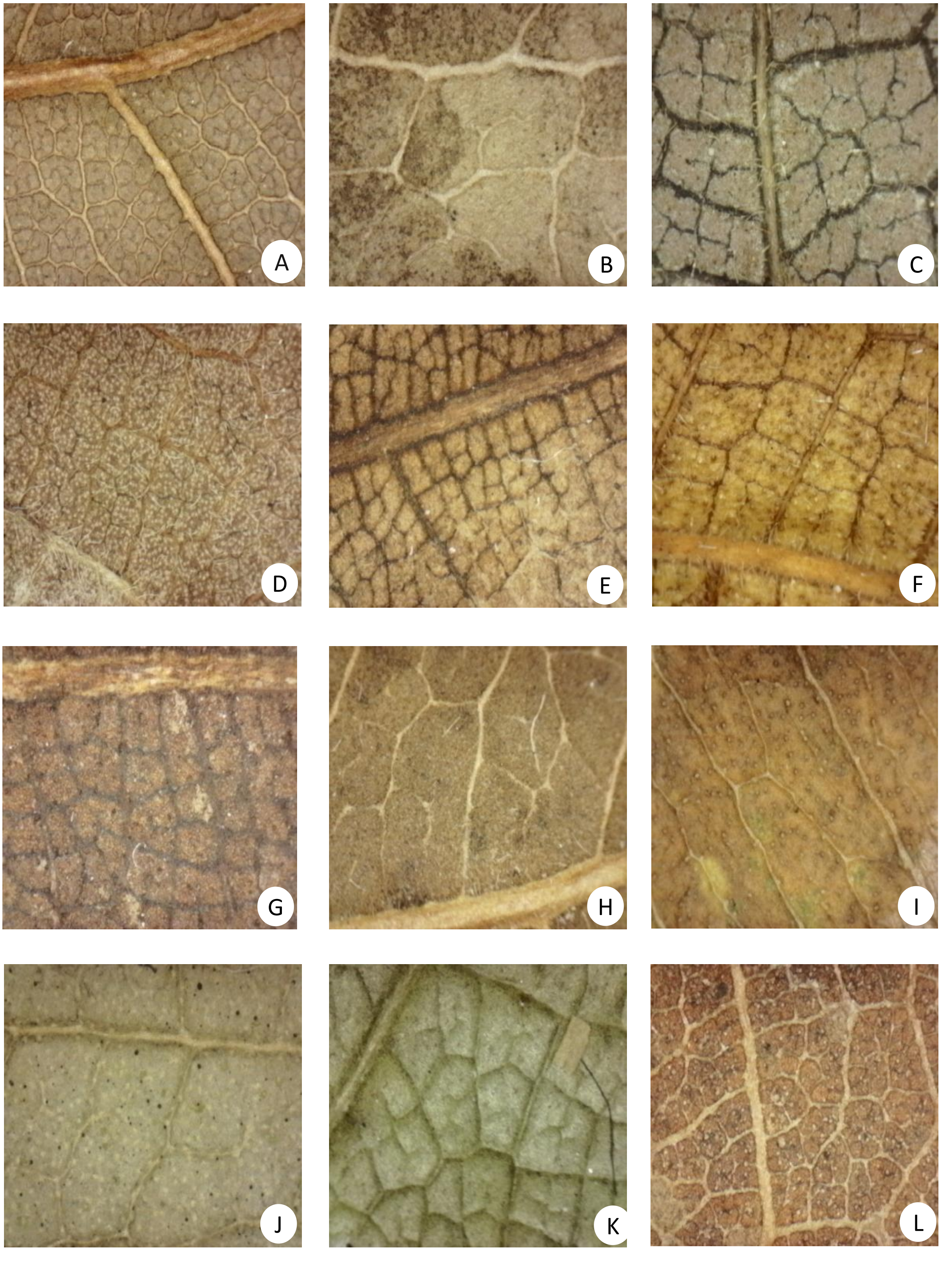

Fig. 4. 2^0 **Vein Category: A.** *F. virens* var. *virens*. 3^0 **Vein Category: B.** *F. amplissima* **C.** *F. amplocarpa* **D.** *F. anamalayana* **E.** *F. arnottiana* **F.** *F. auriculata* **G.** *F. beddomei* **H.** *F. bengalensis* **I.** *F. benjamina* **J.** *F. binnendykii* **K.** *F. callosa* **L.** *F. caulocarpa* .

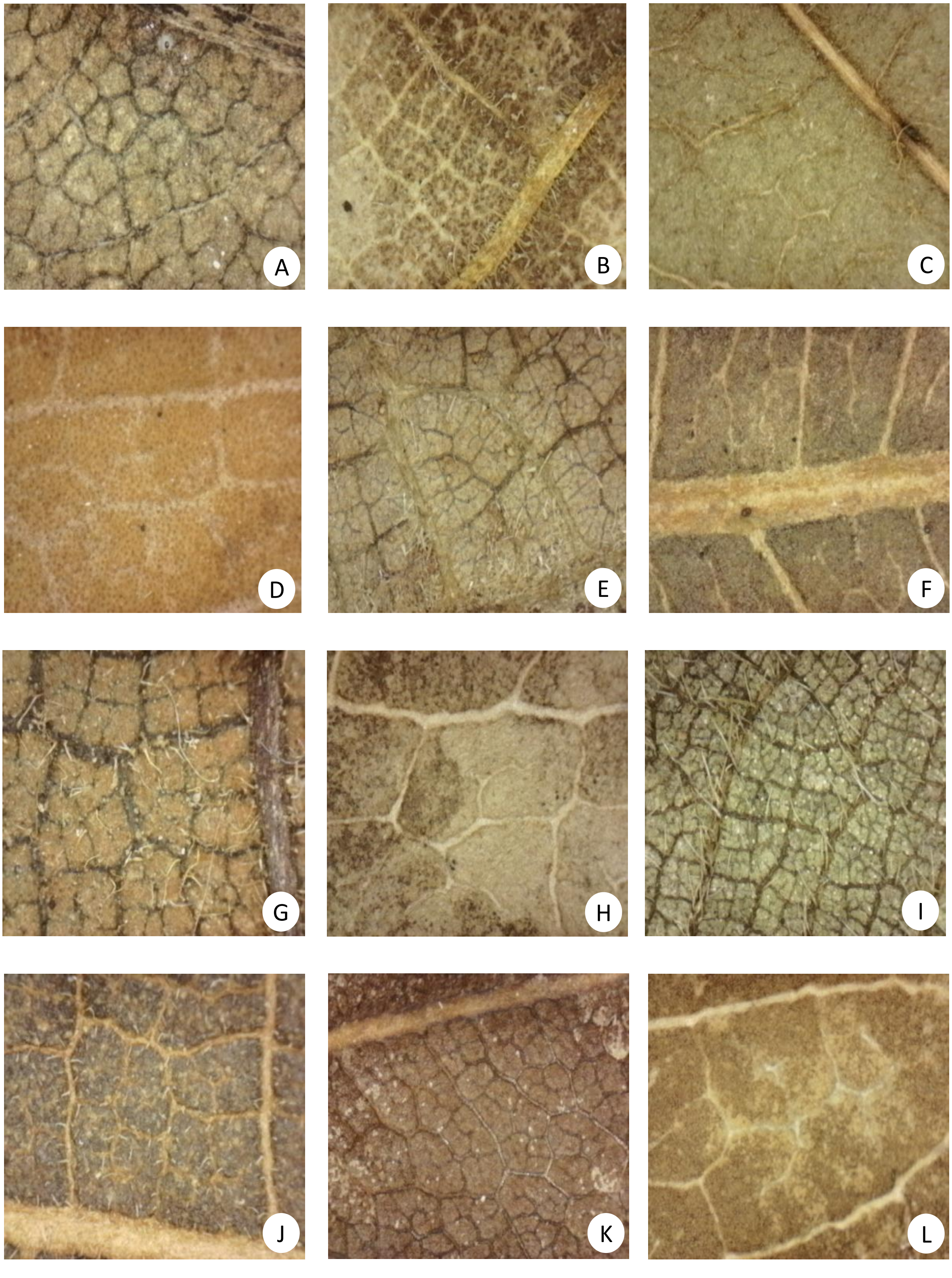

Fig. 5. 3^0 **Vein Category: A.** *F. costata* **B**. *F. dalhousieae* **C.** *F. drupacea* **D.** *F. elastica* **E.** *F. exasperata* **F.** *F. fergusonii* **G.** *F. guttata* **H.** *F. heterophylla* **I.** *F. hispida* **J.** *F. krishnae* **K.** *F. middletonnii* **L.** *F. microcarpa.*

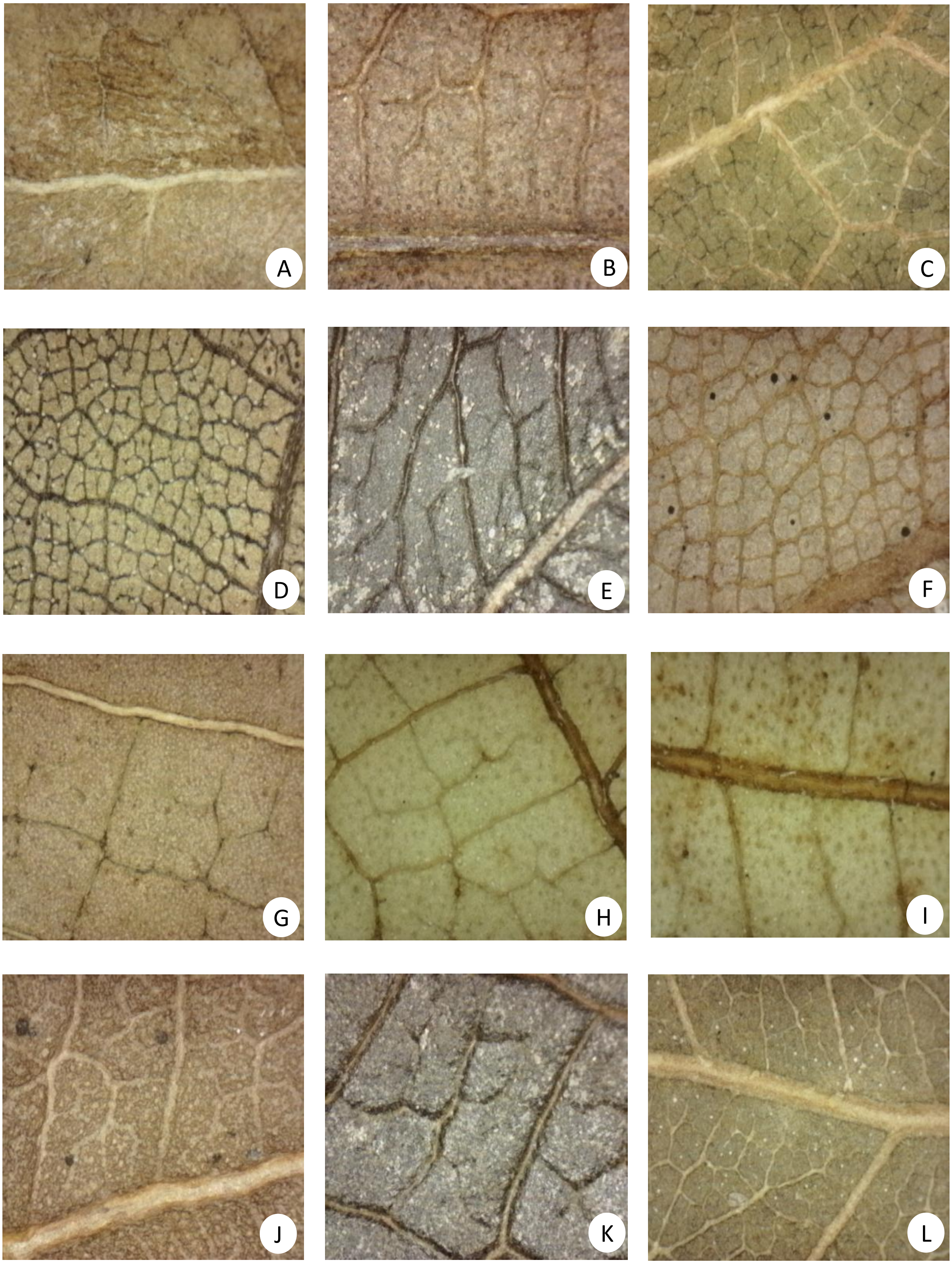

Fig. 6. 3^0 Vein Category; A. *F. mollis* **B**. *F. nervosa* **C.** *F. pumila* **D.** *F. racemosa* **E.** *F. religiosa* **F.** *F. superba* **G.** *F. talbotii* **H.** *F. tinctoria ssp. Parasitica* **I.** *F. tinctoria ssp. gibbosa* **J.** *F. travancorica* **K.** *F. tsjakela* **I.** *F. virens var. dispersa.*

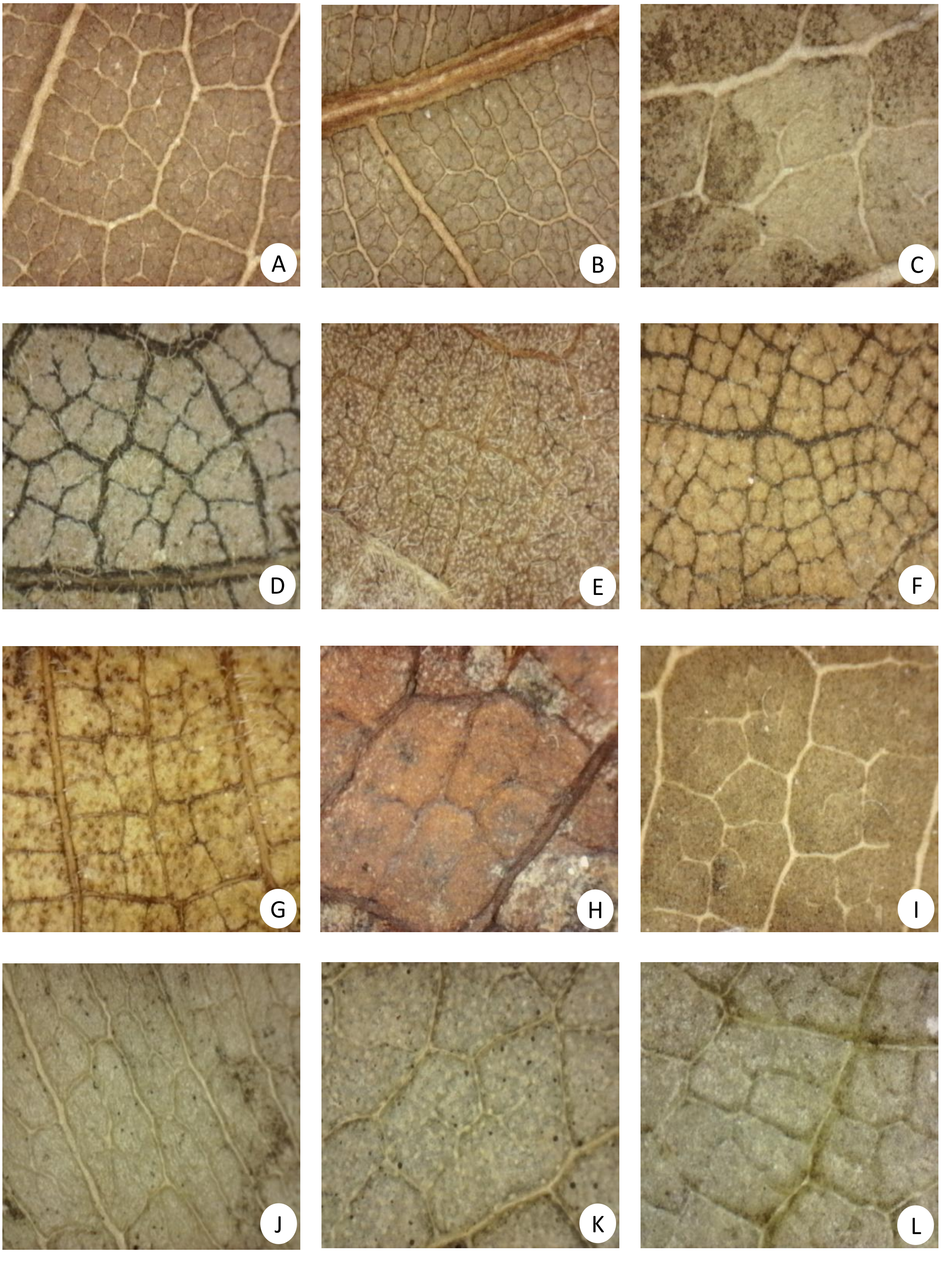

Fig. 7. 3^0 Vein Category: A. *F. virens var. matthewii* **B.** *F. virens* var. *virens.* **4^0 Vein Category: C.** *F. amplissima* **D.** *F. amplocarpa* **E.** *F. anamalayana* **F.** *F. arnottiana* **G.** *F. auriculata* **H.** *F. beddomei* **I.** *F. bengalensis* **J.** *F. benjamina* **K.** *F. binnendykii* **L.** *F. callosa*

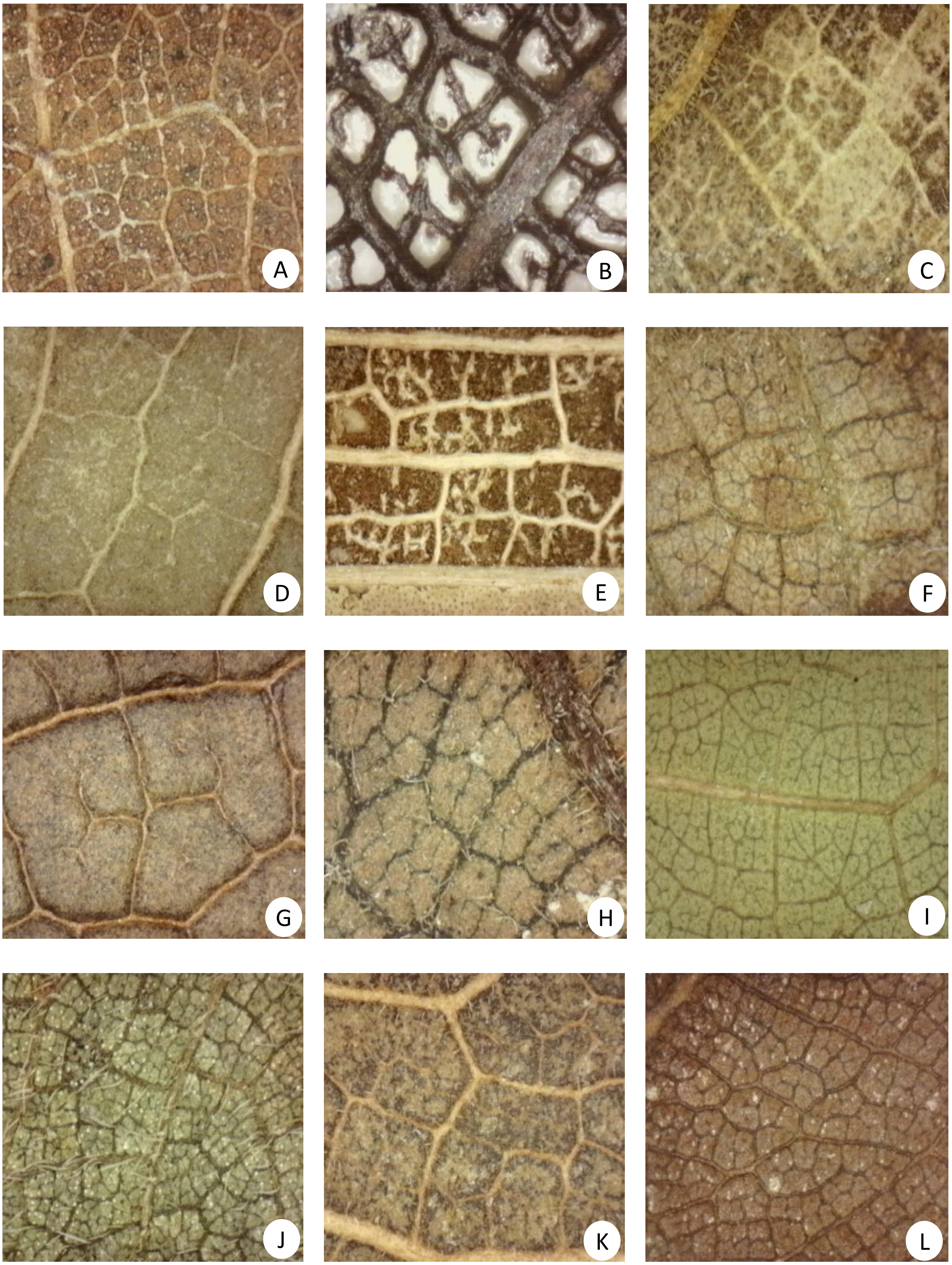

Fig. 8. 4^0 Vein Category: **A.** *F. caulocarpa* **B.** *F. costata* **C**. *F. dalhousieae* **D.** *F. drupacea* **E.** *F. elastica* **F.** *F. exasperata* **G.** *F. fergusonii* **H.** *F. guttata* **I.** *F. heterophylla* **J.** *F. hispida* **K.** *F. krishnae* **L.** *F. middletonnii*

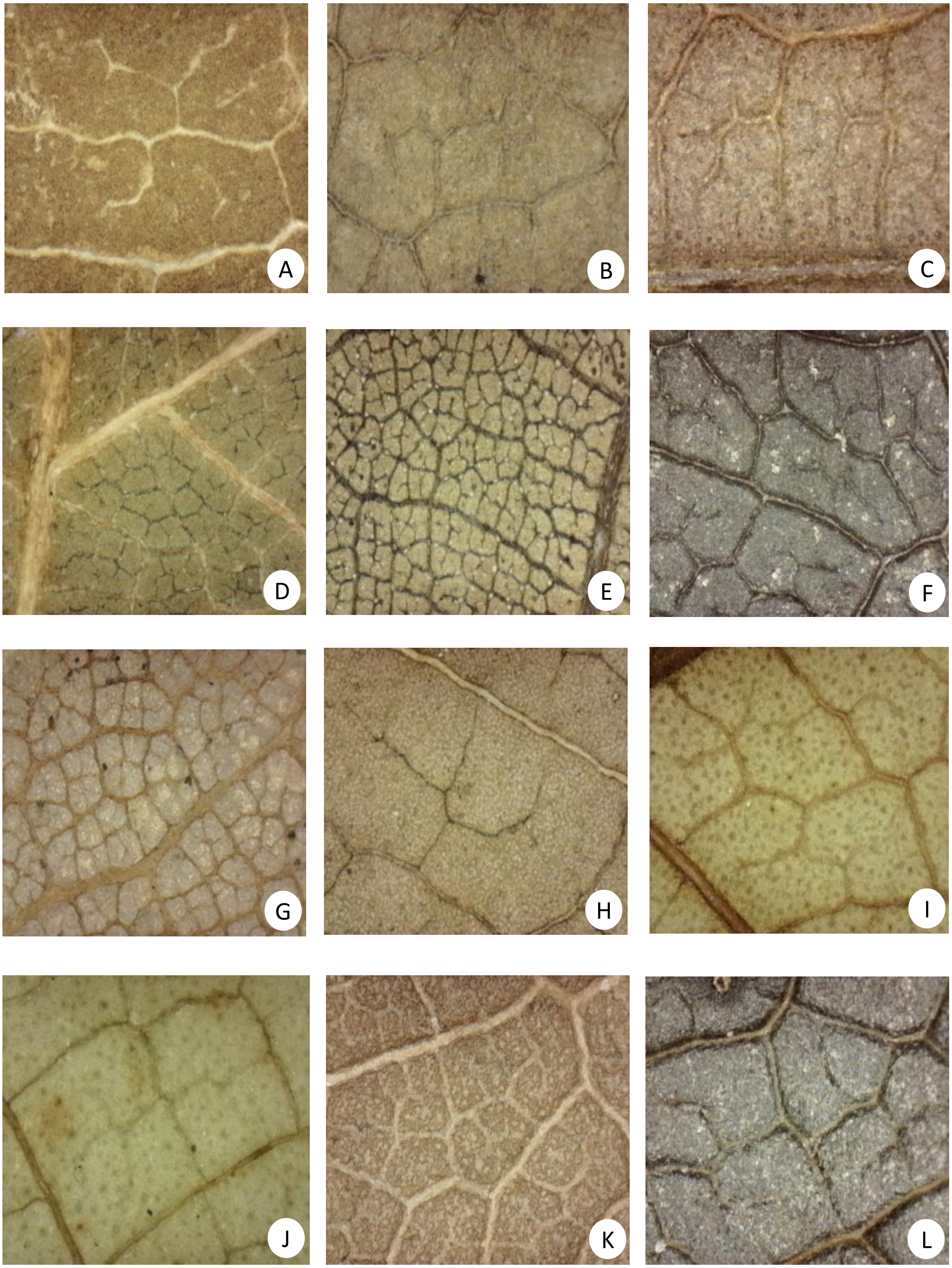

Fig. 9. 4^0 Vein Category A. *F. microcarpa* **B.** *F. mollis* **C.** *F. nervosa* **D.** *F. pumila* **E.** *F. racemosa* **F.** *F. religiosa* **G.** *F. superba* **H.** *F. talbotii* **I.** *F. tinctoria ssp. Parasitica* **J.** *F. tinctoria ssp. gibbosa* **K.** *F. travancorica* **L.** *F. tsjakela*

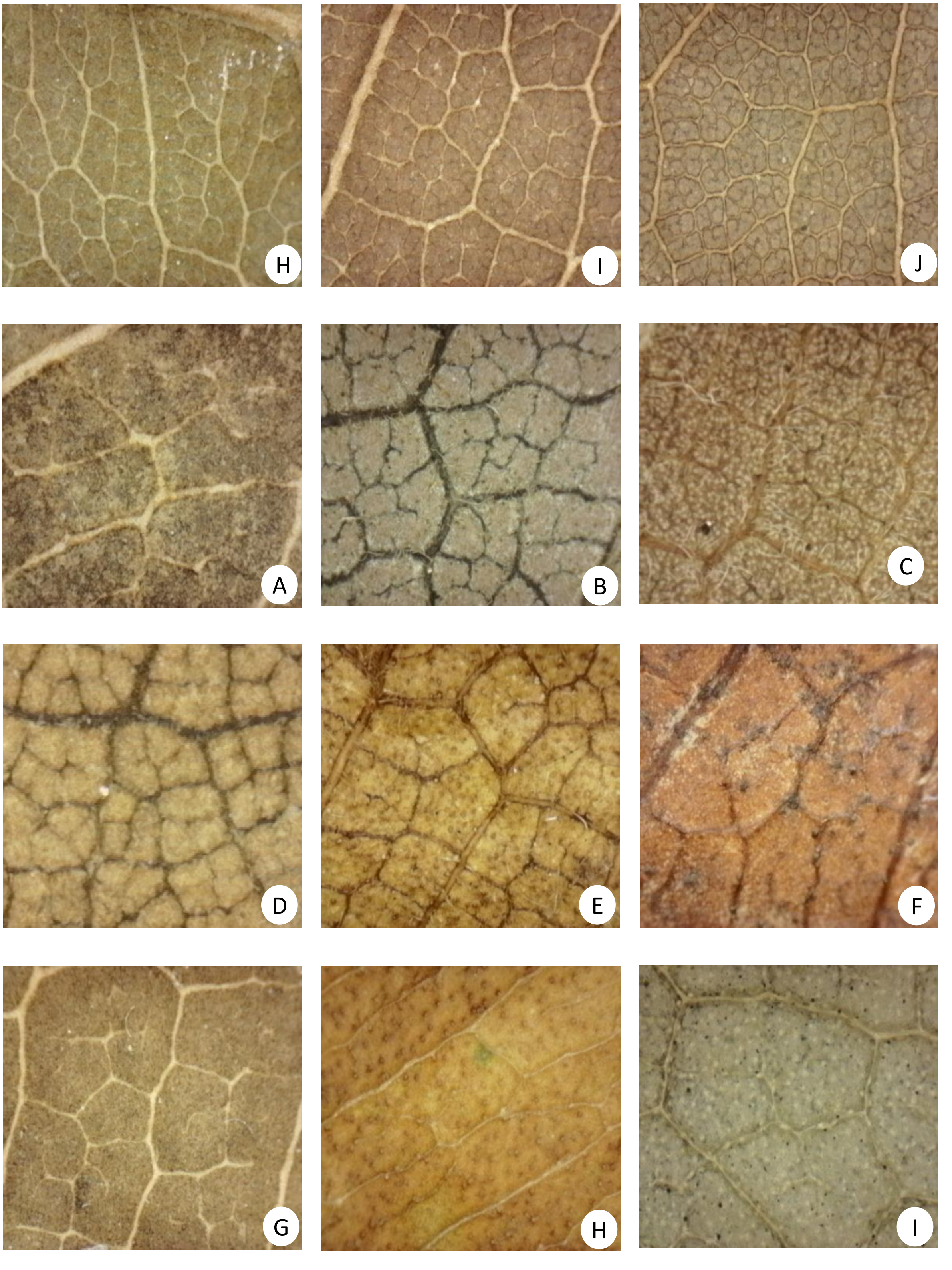

Fig. 10. 4^0 Vein Category: A. *F. virens var. dispersa* **B.** *F. virens var. matthewii* **C.** *F. virens* var. *virens*. **5^0 Vein Category; D.** *F. amplissima* **E.** *F. amplocarpa* **F.** *F. anamalayana* **G.** *F. arnottiana* **H.** *F. auriculata* **I.** *F. beddomei* **J.** *F. bengalensis* **K.** *F. benjamina* **L.** *F. binnendykii***.**

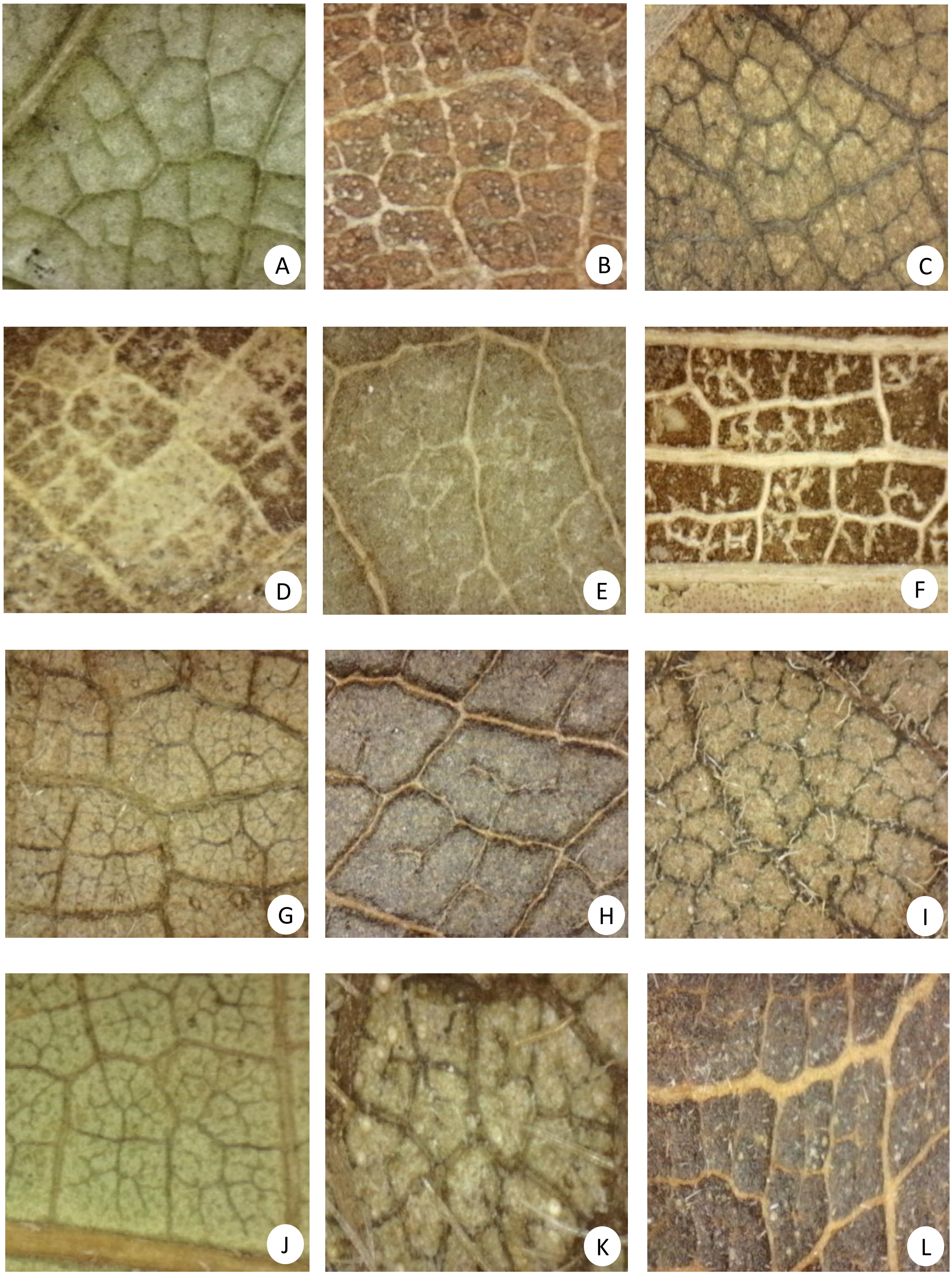

Fig. 11. 5^0 Vein Category: A. *F. callosa* **B.** *F. caulocarpa* **C.** *F. costata* **D**. *F. dalhousieae* **E.** *F. drupacea* **F.** *F. elastica* **G.** *F. exasperata* **H.** *F. fergusonii* **I.** *F. guttata* **J.** *F. heterophylla* **K.** *F. hispida* **L.** *F. krishnae*

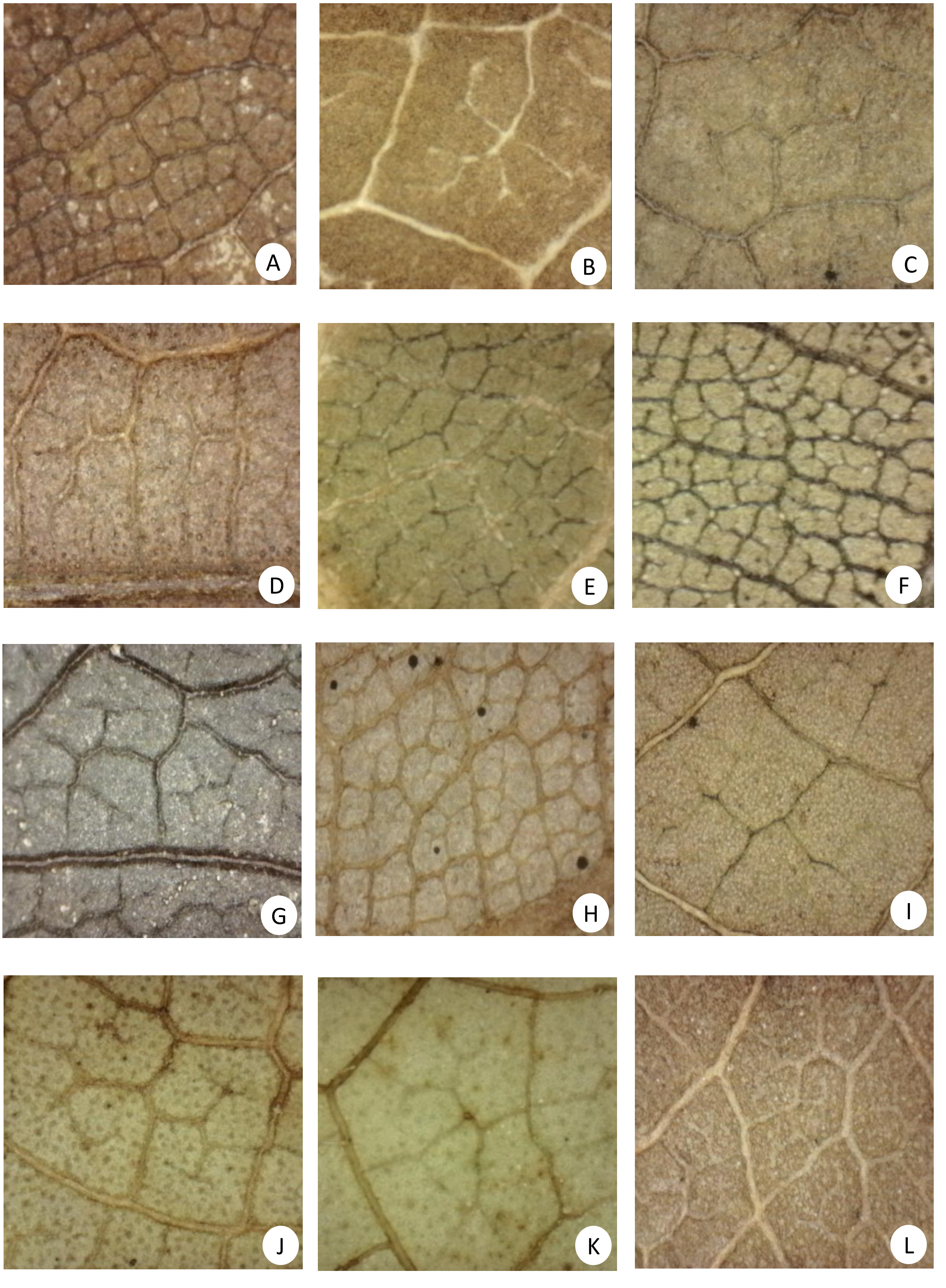

Fig. 12. 5^0 Vein Category: A. *F. middletonnii* **B.** *F. microcarpa* **C.** *F. mollis* **D**. *F. nervosa* **E.** *F. pumila* **F.** *F. racemosa* **G.** *F. religiosa* **H.** *F. superba* **I.** *F. talbotii* **J.** *F. tinctoria ssp. Parasitica* **K.** *F. tinctoria ssp. gibbosa* **L.** *F. travancorica*

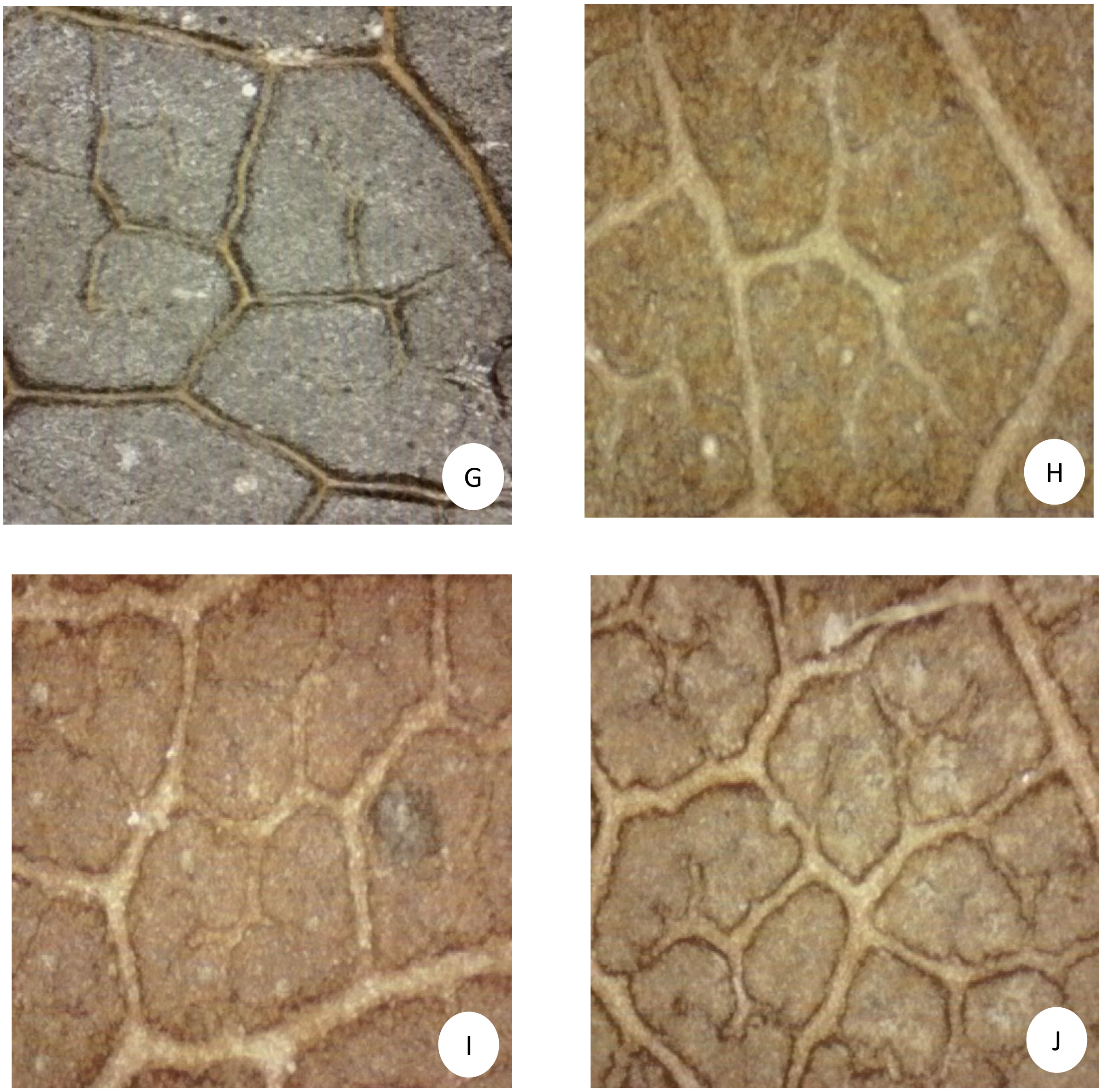

Fig. 13. 5^0 Vein Category: A. *F. tsjakela* **B.** *F. virens var. dispersa.* **C.** *F. virens var. matthewii* **D.** *F. virens* var. *virens.*

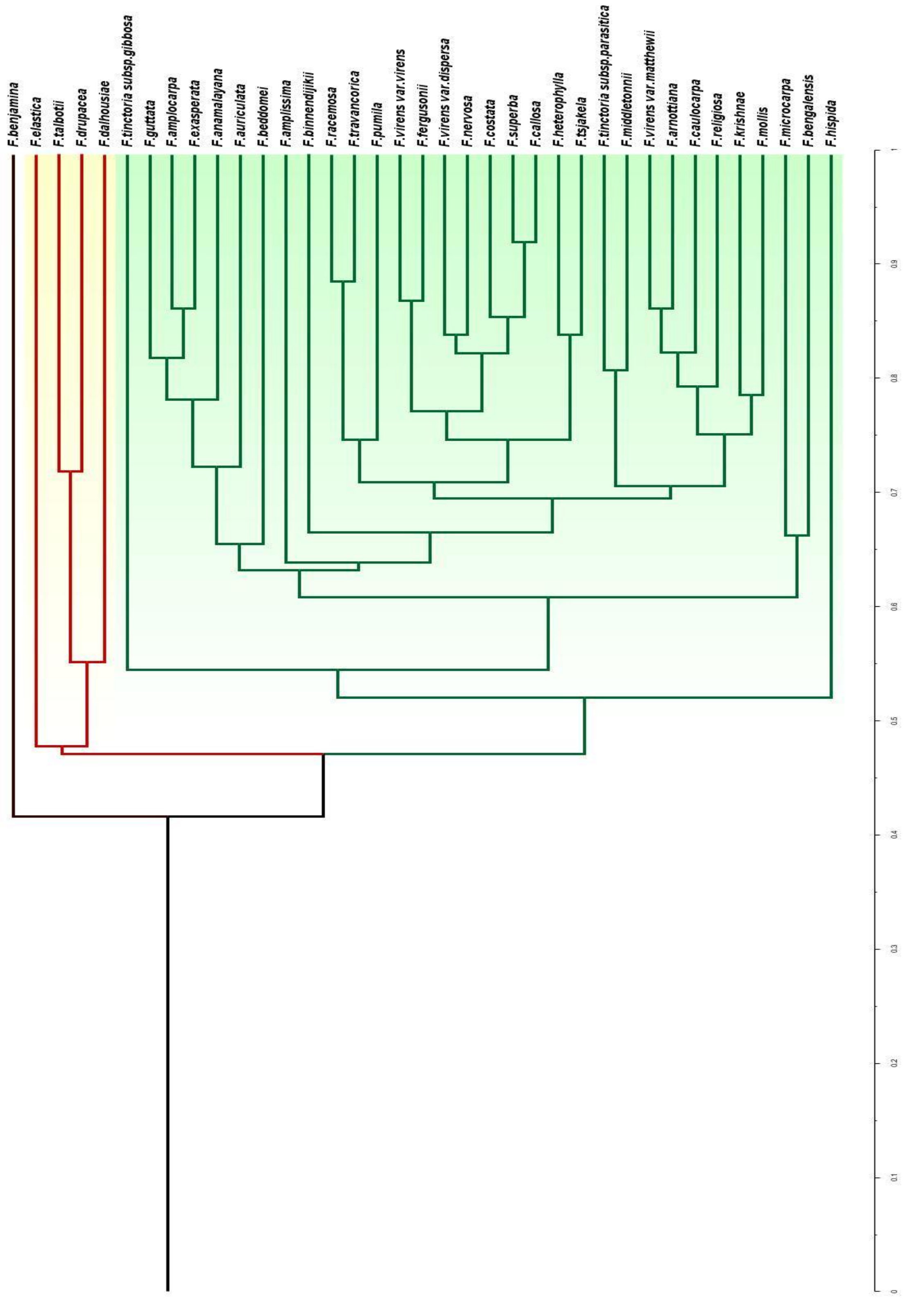

Fig. 14. Phenogram based on leaf venation patterns

Appendix

Appendix 1: Data sheet prepared for the leaf venation pattern study in the genus *Ficus*

Sl No	Character	Chacter state
1	MORPHOTYPE NAME	
2	MORPHOTYPE	
3	MAJOR PLANT GROUP	
4	ORGAN TYPE	
5	RECORD DATE	
7	DIAGANOSTIC FEATURES	
8	PLANT FAMILY	
9	LEAF ATTACHMENT	Alternate
		Opposite
10	LEAF ORGANISATION	Simple
10	PETIOLE FEATURES	simple petiole
		Base swollen
		short petiole
		Long petiole
11	LAMINAR SIZE	Mesophyll
		microphyll
		Notophyll
12	LAMINAR SHAPE	Elliptic
		Cordate
		Obovate
		Ovate
		Oblong
13	LAMINAR SYMMETRY	Symmetrical
		Asymmentrical
14	BASE ANGLE	Acute
		Obtuse
		Wide obtuse
15	APEX ANGLE	Acute
		Obtuse
		Wide obtuse
16	BASE SHAPE	Cuneate
		cup shaped
		Convex
		Rounded
		Truncate
		lobate
		cordate
		Decurrent
		Concave
17	POSITION OF PETIOLAR ATTACHMENT	Marginal

		peltate eccentric
18	APEX SHAPE	Straight
		Convex
		Rounded
		Truncate
		Acuminate
		Complex
19	MARGINE TYPE	Entire
		serrate
		crenate
20	LOBATION	Unlobed
		lobed
21	1^0 VEIN CATEGORY	Pinnate
22	2^0 VEIN CATEGORY	Brochidodromous
		weak brochidodromous
23	AGROPHIC VEIN	Simple
		Compund
24	2^0 VEIN SPACING	Increasing towards base
		uniform
		decreasing towards base
		Irregular
25	2^0 VEIN ANGLE	2pair acute basal secondaries
		Uniform
		one pair acute basal secondaries
26	INTER-2^0 VEINS	Strong intersecondaries
27	3^0 VEIN CATEGORY	Alternate percurrent
		mixed opp/alt
		Alternate reticulate
28	3^0 VEIN COURSE	Admedially ramified
		exmedially ramified
29	3^0 VEIN ANGLE TO 1^0	Acute
		Perpendicular
30	3^0 VEIN ANGLE VARIABILITY	Inconsistent
		increasing exmedially
		Uniform
32	5^0 VEIN CATEGORY	Regular polygonal reticulate
		Dichotomizing
33	AREOLATION	alternate percurrent
		Regular Polygonal Reticulate
		Dichotomizing
		Moderately developed
		Well developed

Appendix 2 - Morphological chatacter states of the taxa of *Ficus* studied

Character				
MORPHOTYPE NAME	*F. amplissima*	*F. amplocarpa*	*F. anamalayana*	*F. arnottiana*
LEAF ATTACHMENT	Alternate	Alternate	Alternate	Alternate
LEAF ORGANISATION	simple	simple	simple	simple
PETIOLE FEATURES	Simple petiole	Long petiole	Simple petiole	Long petiole
LAMINAR SIZE	mesophyll	mesophyll	mesophyll	mesophyll
LAMINAR SHAPE	elliptic/oblong	ovate	ovate/oblong	ovate
LAMINAR SYMMETRY	symmetrical	symmetrical	symmetrical	symmetrical
BASE ANGLE	obtuse	obtuse	obtuse	obtuse
APEX ANGLE	acute	acute	acute	acute
BASE SHAPE	rounded/Truncate	cordate	lobate	cordate
POSITION OF PETIOLAR ATTACHMENT	Marginal	Marginal	Marginal	Marginal
APEX SHAPE	acuminate	acuminate	acuminate	acuminate
LOBATION	unlobed	unlobed	unlobed	unlobed
Leaf margin	Entire	Entire	Entire	Entire
1^0 VEIN CATEGORY	pinnate	pinnate	pinnate	pinnate
2^0 VEIN CATEGORY	brochidodromous	brochidodromous	weak brochidodromous	brochidodromous
AGROPHIC VEIN	simple	simple	simple	simple
2^0 VEIN SPACING	uniform	increasing towards base	increasing towards base	increasing towards base
2^0 VEIN ANGLE	two pair acute basal secondaries	two pair acute basal secondaries	two pair acute basal secondaries	two pair acute basal secondaries
INTER-2^0 VEINS	strong intersecondaries	strong intersecondaries	strong intersecondaries	strong intersecondaries
3^0 VEIN CATEGORY	random reticulate	mixed alt/opp	alternate percurrent	alternate percurrent
3^0 VEIN COURSE	Admedially ramified	Admedially ramified	Admedially ramified	Admedially ramified
3^0 VEIN ANGLE TO 1^0	Perpendicular	Obtuse	Obtuse	Acute
3^0 VEIN ANGLE VARIABILITY	inconsistent	Increasing examedially	inconsistent	inconsistent
4^0 VEIN CATEGORY	regular polygonal reticulate	regular polygonal reticulate	regular polygonal reticulate	regular polygonal reticulate
5^0 VEIN CATEGORY	Dichotomizing	regular polygonal reticulate	regular polygonal reticulate	regular polygonal reticulate

Appendix 2 - Morphological chatacter states of the taxa of *Ficus* studied

Character				
MORPHOTYPE NAME	*F. auriculata*	*F.beddomei*	*Ficus benghalensis*	*F.benjamina*
LEAF ATTACHMENT	Alternate	Alternate	Alternate	Alternate
LEAF ORGANISATION	simple	simple	Simple	simple
PETIOLE FEATURES	long petiole	Simple petiole	Base swollen	short petiole
LAMINAR SIZE	Mesophyll	mesophyll	Mesophyll	Microphyll
LAMINAR SHAPE	cordate	ovate	Ovate	elliptic
LAMINAR SYMMETRY	symmetrical	symmetrical	Symmentrical	symmetrical
BASE ANGLE	obtuse	obtuse	Acute	acute
APEX ANGLE	acute	acute	Acute	acute
BASE SHAPE	cordate	rounded	Trunicate	cuneate
POSITION OF PETIOLAR ATTACHMENT	marginal	Marginal	Marginal	Marginal
APEX SHAPE	convex	straight	Convex	acuminate
LOBATION	unlobed	unlobed	Unlobed	unlobed
Leaf margin	Entire	Entire	entire	Entire
1^0 VEIN CATEGORY	pinnate	pinnate	pinnate	pinnate
2^0 VEIN CATEGORY	weak brochidodromous	weak brochidodromous	weak brochidodromous	brochidodromous
AGROPHIC VEIN	simple	simple	Simple	simple
2^0 VEIN SPACING	increasing towards base	increasing towards base	Increasing towards base	uniform
2^0 VEIN ANGLE	two pair acute basal secondaries	two pair acute basal secondaries	2 pair acute basal secondaries	two pair acute basal secondaries
INTER-2^0 VEINS	absent intersecondaries	intersecondaries absent	Strong intersecondaries	intersecondaries absent
3^0 VEIN CATEGORY	mixed opp/alt	alternate percurrent	Alternate percurrent	Mixed opp/alt
3^0 VEIN COURSE	admedially ramified	exmedially reticulate	Admedially ramified	exmedially ramified
3^0 VEIN ANGLE TO 1^0	obtuse	obtuse	obtuse	obtuse
3^0 VEIN ANGLE VARIABILITY	increasing exmedially	uniform	inconsistent	inconsistent
4^0 VEIN CATEGORY	regular polygonal reticulate	regular polygonal reticulate	Regular polygonal reticulate	dicotomizing
5^O VEIN CATEGORY	regular polygonal reticulate	regular polygonal reticulate	Dichotomizing	dicotomizing

Appendix 2 - Morphological chatacter states of the taxa of *Ficus* studied

Character				
MORPHOTYPE NAME	*F. binnendykii*	*F. callosa*	*F. caulocarpa*	*F. costata*
LEAF ATTACHMENT	Alternate	Alternate	Alternate	Alternate
LEAF ORGANISATION	simple	simple	simple	simple
PETIOLE FEATURES	short petiole	Simple petiole	Long petiole	Simple petiole
LAMINAR SIZE	Mesophyll	mesophyll	mesophyll	notophyll
LAMINAR SHAPE	oblong	elliptic/oblong	ovate	elliptic/oblong
LAMINAR SYMMETRY	symmetrical	symmetrical	symmetrical	symmetrical
BASE ANGLE	acute	obtuse	obtuse	obtuse
APEX ANGLE	acute	acute	acute	acute
BASE SHAPE	decurrent	rounded/Decurrent	truncate	rounded
POSITION OF PETIOLAR ATTACHMENT	marginal	marginal	marginal	marginal
APEX SHAPE	acuminate	acuminate	truncate	acuminate
LOBATION	unlobed	unlobed	unlobed	unlobed
Leaf margin	Entire	Entire	Entire	Entire
1^0 VEIN CATEGORY	pinnate	pinnate	pinnate	pinnate
2^0 VEIN CATEGORY	brochidodromous	brochidodromous	brochidodromous	brochidodromous
AGROPHIC VEIN	simple	simple	simple	simple
2^0 VEIN SPACING	Decreasing towards base	increasing towards base	increasing towards base	increasing towards base
2^0 VEIN ANGLE	Two pair acute basal secondaries	two pair acute basal secondaries	Two pair acute basal secondaries	two pair acute basal secondaries
INTER-2^0 VEINS	strong intersecondaries	strong intersecondaries	strong intersecondaries	strong intersecondaries
3^0 VEIN CATEGORY	alternate percurrent	alternate percurrent	alternate percurrent	alternate percurrent
3^0 VEIN COURSE	Admedially ramified	Admedially ramified	Admedially ramified	Admedially ramified
3^0 VEIN ANGLE TO 1^0	Acute	obtuse	acute	Acute
3^0 VEIN ANGLE VARIABILITY	inconsistent	inconsistent	inconsistent	inconsistent
4^0 VEIN CATEGORY	regular polygonal reticulate	regular polygonal reticulate	regular polygonal reticulate	regular polygonal reticulate
5^O VEIN CATEGORY	regular polygonal reticulate	regular polygonal reticulate	regular polygonal reticulate	regular polygonal reticulate

Appendix 2 - Morphological chatacter states of the taxa of *Ficus* studied

Character				
MORPHOTYPE NAME	*F. dalhousieae*	*F. drupacea*	*F. elastica*	*F. exasperata*
LEAF ATTACHMENT	Alternate	Alternate	Alternate	Alternate
LEAF ORGANISATION	simple	simple	simple	simple
PETIOLE FEATURES	Long petiole	Simple petiole	Swollen petiole	Simple petiole
LAMINAR SIZE	mesophyll	Mesophyll	Mesophyll	Mesophyll
LAMINAR SHAPE	ovate	elliptic	oblong	Elliptic/Ovate
LAMINAR SYMMETRY	symmetrical	symmetrical	symmetrical	Symmeterical
BASE ANGLE	obtuse	acute	obtuse	Obtuse
APEX ANGLE	obtuse	acute	acute	Acute
BASE SHAPE	cordate	rounded	rounded	Rounded
POSITION OF PETIOLAR ATTACHMENT	marginal	marginal	Marginal	Marginal
APEX SHAPE	acuminate	acuminate	convex	Acuminate
LOBATION	unlobed	unlobed	unlobed	Unlobed
Leaf margin	Entire	Entire	Entire	Entire
1^0 VEIN CATEGORY	pinnate	pinnate	pinnate	Pinnate
2^0 VEIN CATEGORY	brochidodromous	brochidodromous	brochidodromous	Weak brochidodromous
AGROPHIC VEIN	simple	simple	Simple	sSimple
2^0 VEIN SPACING	irregular	increasing towards base	uniform	Increasing towards base
2^0 VEIN ANGLE	two pair acute basal secondaries	two pair acute basal secondaries	uniform	Two pair acute basal secondaries
INTER-2^0 VEINS	weak intersecondaries	weak intersecondaries	intersecondaries absent	Strong intersecondaries
3^0 VEIN CATEGORY	Mixed opp/alt	random reticulate	random reticulate	Mixed opp/alt
3^0 VEIN COURSE	sinuous	exmedially ramified	Not prominet	Admedially ramified
3^0 VEIN ANGLE TO 1^0	obtuse	obtuse	acute	Obtuse
3^0 VEIN ANGLE VARIABILITY	uniform	uniform	uniform	Increasing exmedially
4^0 VEIN CATEGORY	regular polygonal reticulate	regular polygonal reticulate	regular ploygonal reticulate	Regular polygonal reticulate
5^O VEIN CATEGORY	regular polygonal reticulate	dichotomizing	regular ploygonal reticulate	Regular polygonal reticulate

Appendix 2 - Morphological chatacter states of the taxa of *Ficus* studied

Character			
MORPHOTYPE NAME	*F. fergusonii*	*F. guttata*	*F. heterophylla*
LEAF ATTACHMENT	Alternate	Alternate	Alternate
LEAF ORGANISATION	simple	simple	simple
PETIOLE FEATURES	Long petiole	Simple petiole	short petiole
LAMINAR SIZE	Mesophyll	Notophyll	Notophyll
LAMINAR SHAPE	Elliptic/oblong	Ovate	Elliptic/oblong
LAMINAR SYMMETRY	symmetrical	symmetrical	symmetrical
BASE ANGLE	acute	obtuse	obtuse
APEX ANGLE	acute	acute	acute
BASE SHAPE	rounded	cordate	rounded
POSITION OF PETIOLAR ATTACHMENT	Marginal	Marginal	Marginal
APEX SHAPE	convex	Acuminate	acuminate
LOBATION	unlobed	unlobed	unlobed
Leaf margin	Entire	Entire	Entire
1^0 VEIN CATEGORY	pinnate	pinnate	pinnate
2^0 VEIN CATEGORY	weak brochidodromous	weak brochidodromous	weak brochidodromous
AGROPHIC VEIN	Simple	Simple	simple
2^0 VEIN SPACING	increasing towards base	increasing towards base	increasing towards base
2^0 VEIN ANGLE	two pair acute basal secondaries	two pair acute basal secondaries	two pair acute basal secondaries
INTER-2^0 VEINS	strong intersecondaries	strong intersecondaries	strong intersecondaries
3^0 VEIN CATEGORY	Alternate percurrent	mixed alt/opp	random reticulate
3^0 VEIN COURSE	Admedially ramified	Admedially ramified	Admedially ramified
3^0 VEIN ANGLE TO 1^0	Acute	Obtuse	obtuse
3^0 VEIN ANGLE VARIABILITY	Inconsistent	Inconsistent	inconsistent
4^0 VEIN CATEGORY	Regular polygonal reticulate	Regular polygonal reticulate	regular polygonal reticulate
5^O VEIN CATEGORY	Regular polygonal reticulate	Regular polygonal reticulate	Regular polygonal reticulate

Appendix 2 - Morphological chatacter states of the taxa of *Ficus* studied

Character				
MORPHOTYPE NAME	*F. hispida*	*F. krishnae*	*F. middletonii*	*F . microcarpa*
LEAF ATTACHMENT	opposite	Alternate	Alternate	Alternate
LEAF ORGANISATION	simple	simple	simple	Simple
PETIOLE FEATURES	Simple petiole	Long petiole	Long petiole	simple petiole
LAMINAR SIZE	Mesophyll	mesophyll	Mesophyll	Mesophyll
LAMINAR SHAPE	oblong	elliptic/ovate	elliptic	Elliptic
LAMINAR SYMMETRY	symmetrical	symmetrical	symmetrical	Symmetrical
BASE ANGLE	acute	obtuse	obtuse	Acute
APEX ANGLE	acute	acute	acute	Acute
BASE SHAPE	Truncate	cup shaped	rounded	Decurrent
POSITION OF PETIOLAR ATTACHMENT	Marginal	peltate eccentric	Marginal	Marginal
APEX SHAPE	acuminate	acuminate	acuminate	Convex
LOBATION	unlobed	unlobed	unlobed	Unlobed
Leaf margin	Entire	Entire	Entire	Entire
1^0 VEIN CATEGORY	pinnate	pinnate	pinnate	Pinnate
2^0 VEIN CATEGORY	weak brochidodromous	brochidodromous	weak brochidodromous	Brochidodromous
AGROPHIC VEIN	simple	simple	Simple	Simple
2^0 VEIN SPACING	increasing towards base	increasing towards base	increasing towards base	Increasing towards base
2^0 VEIN ANGLE	two pair acute basal secondaries	2 pair acute basal secondaries	Present	2pair acute basal secondaries
INTER-2^0 VEINS	strong intersecondaries	weak intersecondaries	strong intersecondaries	Strong intersecondaries
3^0 VEIN CATEGORY	mixed alt/opp	Alternate percurrent	random reticulate	random reticulate
3^0 VEIN COURSE	Admedially ramified	Admedially ramified	Admedially ramified	admedially ramified
3^0 VEIN ANGLE TO 1^0	perpendicular	Obtuse	Acute	Acute
3^0 VEIN ANGLE VARIABILITY	uniform	inconsistent	Inconsistent	inconsistent
4^0 VEIN CATEGORY	Alternate percurrent	regular polygonal reticulate	Regular polygonal reticulate	Regular polygonal reticulate
5^O VEIN CATEGORY	Regular polygonal reticulate	regular polygonal reticulate	Regular polygonal reticulate	dichotomizing

Appendix 2 - Morphological chatacter states of the taxa of *Ficus* studied

Character				
MORPHOTYPE NAME	*F. mollis*	*F. nervosa*	*F. pumila*	*F. racemosa*
LEAF ATTACHMENT	Alternate	Alternate	Alternate	Alternate
LEAF ORGANISATION	simple	Simple	simple	Simple
PETIOLE FEATURES	Long petiole	Short	short petiole	simple petiole
LAMINAR SIZE	mesophyll	Notophyll	microphyll	Mesophyll
LAMINAR SHAPE	elliptic	elliptic/ovate	oblong	Oblong
LAMINAR SYMMETRY	symmetrical	symmetrical	symmetrical	Symmetrical
BASE ANGLE	obtuse	Obtuse	obtuse	Acute
APEX ANGLE	acute	acute	acute	Acute
BASE SHAPE	Truncate	rounded	cordate	convex
POSITION OF PETIOLAR ATTACHMENT	Marginal	Marginal	Marginal	Marginal
APEX SHAPE	convex/cordate	acuminate	convex	Acuminate
LOBATION	unlobed	unlobed	unlobed	Unlobed
Leaf margin	Entire	Entire	Entire	entire
1^0 VEIN CATEGORY	pinnate	pinnate	pinnate	Pinnate
2^0 VEIN CATEGORY	brochidodromous	Brochidodromous	weak brochidodromous	Weak Brochidodromous
AGROPHIC VEIN	simple	Simple	Simple	Simple
2^0 VEIN SPACING	increasing towards base	decreasing towards base	increasing towards base	Increasing Towards Base
2^0 VEIN ANGLE	two pair acute basal secondaries	two pair acute basal secondaries	two pair acute basal secondaries	2 Pair Acute Basal Secondaries
INTER-2^0 VEINS	strong intersecondaries	strong intersecondaries	strong intersecondaries	Strong Intersecondaries
3^0 VEIN CATEGORY	Alternate percurrent	Alternate percurrent	Alternate percurrent	alternate percurrent
3^0 VEIN COURSE	Admedially ramified	Admedially ramified	Admedially ramified	admedially ramified
3^0 VEIN ANGLE TO 1^0	Obtuse	Obtuse	Acute	acute
3^0 VEIN ANGLE VARIABILITY	inconsistent	Inconsistent	Inconsistent	inconsistent
4^0 VEIN CATEGORY	regular polygonal reticulate	Regular polygonal reticulate	Regular polygonal reticulate	regular polygonal reticulate
5^0 VEIN CATEGORY	regular polygonal reticulate	Regular polygonal reticulate	regular polygonal reticulate	regular polygonal reticulate

Appendix 2 - Morphological chatacter states of the taxa of *Ficus* studied

Character				
MORPHOTYPE NAME	*F. religiosa*	*F. superba*	*F. talbotii*	*F. tintctoria* ssp. *Parasitica*
LEAF ATTACHMENT	Alternate	Alternate	Alternate	Alternate
LEAF ORGANISATION	Simple	simple	simple	Simple
PETIOLE FEATURES	Long petiole	Long petiole	Long petiole	Swollen petiole
LAMINAR SIZE	Mesophyll	Mesophyll	Mesophyll	Mesophyll
LAMINAR SHAPE	Cordate	elliptic/oblong	elliptic/ovate	Elliptic,ovate
LAMINAR SYMMETRY	Symmetrical	symmetrical	symmetrical	Asymmetrical
BASE ANGLE	Obtuse	obtuse	Acute	Obtuse
APEX ANGLE	Acute	acute	acute	Acute
BASE SHAPE	Truncate/ cordate	rounded	convex	Rounded
POSITION OF PETIOLAR ATTACHMENT	Marginal	Marginal	Marginal	Marginal
APEX SHAPE	Straight	acuminate	acuminate	Acuminate
LOBATION	Unlobed	unlobed	unlobed	Unlobed
Leaf margin	entire	Entire	Entire	Entire
1^0 VEIN CATEGORY	Pinnate	pinnate	pinnate	Pinnate
2^0 VEIN CATEGORY	Brochidodromous	Brochidodromous	Weak brochidodromous	Brochidodromous
AGROPHIC VEIN	Simple	Simple	Simple	Simple
2^0 VEIN SPACING	Increasing Towards base	increasing towards base	Increasing towards base	irregular
2^0 VEIN ANGLE	2 pair acute basal secondaries	two pair acute basal secondaries	Present	Present
INTER-2^0 VEINS	Strong intersecondaries	strong intersecondaries	weak intersecondaries	Strong intersecondaries
3^0 VEIN CATEGORY	Alternate percurrent	Alternate percurrent	Random reticulate	Alternate percurrent
3^0 VEIN COURSE	Admedially ramified	Admedially ramified	exmedially ramified	Admedially ramified
3^0 VEIN ANGLE TO 1^0	Acute	Acute	acute	Acute
3^0 VEIN ANGLE VARIABILITY	uniform	Inconsistent	Uniform	inconsistent
4^0 VEIN CATEGORY	Regular polygonal reticulate	Regular polygonal reticulate	regular polygonal reticulate	Regular Polygonal Reticulate
5^O VEIN CATEGORY	Regular Polygonal Reticulate	Regular polygonal reticulate	regular polygonal reticulate	Regular Polygonal Reticulate

Appendix 2 - Morphological chatacter states of the taxa of *Ficus* studied

Character			
MORPHOTYPE NAME	*F.tinctoria ssp. gibbosa*	*F. travancorica*	*F. tsjakela*
LEAF ATTACHMENT	Alternate	Alternate	Alternate
LEAF ORGANISATION	simple	Simple	Simple
PETIOLE FEATURES	short petiole	simple petiole	Long petiole
LAMINAR SIZE	microphyll	Mesophyll	Mesophyll
LAMINAR SHAPE	elliptic/ovate	oblong	Elliptic/oblong
LAMINAR SYMMETRY	asymmetrical	Symmetrical	symmetrical
BASE ANGLE	acute	Acute	Acute
APEX ANGLE	acute	Acute	Acute
BASE SHAPE	decurrent	Cunate	rounded
POSITION OF PETIOLAR ATTACHMENT	Marginal	Marginal	marginal
APEX SHAPE	Acuminate	Acuminate	acuminate
LOBATION	unlobed	Unlobed	unlobed
Leaf margin	Entire	Entire	Entire
1^0 VEIN CATEGORY	pinnate	Pinnate	Pinnate
2^0 VEIN CATEGORY	weak brochidodromous	weak brochidodromous	weak bronchidodromous
AGROPHIC VEIN	Simple	Simple	Simple
2^0 VEIN SPACING	increasing towards base	Increasing towards base	increasing towards base
2^0 VEIN ANGLE	Prsent	Present	two pair acute basal secondaries
INTER-2^0 VEINS	weak intersecondaries	Strong intersecondaries	strong intersecondaries
3^0 VEIN CATEGORY	alternate percurrent	Alternate percurrent	Alternate reticulate
3^0 VEIN COURSE	exmedially ramified	Admedially ramified	Admedially ramified
3^0 VEIN ANGLE TO 1^0	acute	Acute	Obtuse
3^0 VEIN ANGLE VARIABILITY	inconsistent	inconsistent	inconsistent
4^0 VEIN CATEGORY	regular polygonal reticulate	Regular polygonal reticulate	regular polygonal reticulate
5^O VEIN CATEGORY	regular polygonal reticulate	Regular polygonal reticulate	reticular polygonal reticulate

Appendix 2 - Morphological chatacter states of the taxa of *Ficus* studied

Character			
MORPHOTYPE NAME	*F. virens var. dispersa*	*F.virens* var.*Matthewii*	*F.virens* var. *virens*
LEAF ATTACHMENT	Alternate	Alternate	Alternate
LEAF ORGANISATION	simple	Simple	Simple
PETIOLE FEATURES	Long petiole	Simple petiole	Long petiole
LAMINAR SIZE	Notophyll	Mesophyll	Notophyll
LAMINAR SHAPE	oblong	ovate	Elliptic/ oblong
LAMINAR SYMMETRY	symmetrical	Symmetrical	Symmetrical
BASE ANGLE	acute	Obtuse	Acute
APEX ANGLE	acute	Acute	Acute
BASE SHAPE	rounded	Rounded	Rounded/Truncate
POSITION OF PETIOLAR ATTACHMENT	Marginal	Marginal	Marginal
APEX SHAPE	acuminate	Acuminate	Convex
LOBATION	unlobed	Unlobed	unlobed
Leaf margin	Entire	Entire	Entire
1^0 VEIN CATEGORY	pinnate	Pinnate	Pinnate
2^0 VEIN CATEGORY	Brochidodromous	Brochidodromous	Brochidodromous
AGROPHIC VEIN	Simple	Simple	Simple
2^0 VEIN SPACING	increasing towards base	Increasing towards base	increasing towards base
2^0 VEIN ANGLE	two pair acute basal secondaries	2.pair acute basal secondaries	two pair acute basal secondaries
INTER-2^0 VEINS	strong intersecondaries	Strong intersecondaries	strong intersecondaries
3^0 VEIN CATEGORY	Alternate percurrent	Alternate percurrent	Alternate percurrent
3^0 VEIN COURSE	Admedially ramified	Admedially ramified	Admedially ramified
3^0 VEIN ANGLE TO 1^0	Obtuse	Acute	Acute
3^0 VEIN ANGLE VARIABILITY	Inconsistent	Inconsistent	Inconsistent
4^0 VEIN CATEGORY	Regular polygonal reticulate	Regular polygonal reticulate	Regular polygonal reticulate
5^O VEIN CATEGORY	Regular polygonal reticulate	Regular polygonal reticulate	Regular polygonal reticulate

Appendix 3 - Numerical data matrix of taxa of *Ficus* studied

F. amplissima	1 0 0 1 0 0 0 1 0 1 0 1 0 0 0 0 0 1 1 0 0 0 0 0 0 0 1 0 1 0 0 1 1 0 0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0 1 1 0 0 1 0 0 0 1
F. amplocarpa	1 0 0 0 0 0 1 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 1 1 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 1 0 0 1 0
F. anamalayana	1 0 0 0 0 0 1 1 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 1 0 1 0 0 1 0 1 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 1 0 1 0 0 1 0 0 1 0
F. arnottiana	1 0 0 0 0 0 1 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 1 1 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 1 1 0
F. auriculata	1 0 0 0 1 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 0 1 0 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0 1 0 0 1 0 1 0 0 1 0
F. beddomei	1 0 0 0 0 0 1 0 0 1 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 1 1 0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0 0 1 0 0 1 0 0 0 1 1 0 0 1 0
F. benghalensis	1 0 0 0 0 0 1 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 1 0 1 0 0 1 0 0 0 1
F. benjamina	0 1 0 1 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 1 1 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 1 0 0 0 1 0 0 1
F. binnendykii	0 0 0 0 0 0 0 1 1 0 0 1 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 1 0 0 1 1 0 0 0 1 1 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 1 0
F. callosa	1 0 0 1 0 0 0 1 0 1 0 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0 0 1 1 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 0 1 0 1 0 0 1 0 0 1 0
F. caulocarpa	1 0 0 0 0 0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 1 0 0 1 0 0 1 1 0 1 0 0 1 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0
F. costata	0 0 1 1 0 0 0 1 0 1 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 1 1 0 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 1 1 0
F. dalhousieae	1 0 0 0 0 0 1 0 0 1 0 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 1 1 0 0 0 0 1 1 0 0 0 0 0 1 0 0 0 1 0 0 0 0 1 0 1 0 0 0 1 1 0 0 1 0
F. drupacea	1 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 1 1 0 1 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 1 0 0 0 1 1 0 0 0 1
F. elastica	1 0 0 0 0 0 0 1 0 1 0 1 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 1 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 1 1 0 0 0 0 1 1 0 0 1 0
F. exasperata	1 0 0 1 0 0 1 0 0 1 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 0 1 0 0 1 0 1 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 1 0 1 0 0 1 0
F. fergusonii	1 0 0 1 0 0 0 1 1 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0
F. guttata	0 0 1 0 0 0 1 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 1 0 1 1 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 0 1 0 0 0 1 0 1 0 0 1 0 0 1 0
F. heterophylla	0 0 1 1 0 0 0 1 0 1 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 0 0 1 0 1 0 1 1 0 0 0 1 0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 1 0 1 0 0 1 0 0 1 0

Appendix 3 - Numerical data matrix of taxa of *Ficus* studied

F. hispida	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	1	1	0
F. krishnae	1	0	0	1	0	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	1	0	0	1	0
F. microcarpa	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	1
F. middletonii	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
F. mollis	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	1	0	0	1	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	1	0	0	1	0
F. nervosa	0	0	1	1	0	0	1	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	1	0	0	1	0
F. pumila	0	1	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
F. racemosa	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
F. religiosa	1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	1	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	1	0	0	1	0
F. superba	1	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
F. talbotii	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	1
F. tinctoria ssp. gibbosa	0	1	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	1	0	0	1	0	0	1	0
F. tinctoria ssp. Parasitica	1	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
F. travancorica	1	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
F. tsjakela	1	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	1	0	0	1	0
F. virens var. dispersa	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	1	0	0	1	0
F. virens var. Matthewii	1	0	0	0	0	0	1	0	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
F. virens var. virens	0	0	1	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1	1	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0

Appendix 4: Corelation value between the taxa of *Ficus* studied

	F. religiosa	*F. benghalensis*	*F. racemosa*	*F. microcarpa*	*F. tinctoria ssp. Parasitica*	*F. virens var.Matthewii*	*F. travancorica*	*F. tsjakela*	*F. virens var.virens*	*F. virens var.dispersa*	*F. nervosa*	*F. superba*	*F. middletonii*	*F. talbotii*	*F. tinctoria ssp.gibbosa*	*F. pumila*	*F. elastica*	*F. fergusonii*	*F. guttata*
F. religiosa	1	0.59	0.7	0.54	0.7	0.8	0.65	0.58	0.67	0.6	0.6	0.79	0.65	0.54	0.47	0.7	0.54	0.63	0.65
F. benghalensis	0.59	1	0.72	0.67	0.5	0.7	0.67	0.7	0.68	0.7	0.6	0.59	0.56	0.33	0.54	0.67	0.33	0.76	0.67
F. racemosa	0.7	0.72	1	0.61	0.6	0.8	0.89	0.81	0.74	0.8	0.6	0.81	0.72	0.44	0.65	0.78	0.44	0.86	0.67
F. microcarpa	0.54	0.67	0.61	1	0.5	0.6	0.56	0.65	0.79	0.7	0.6	0.65	0.61	0.5	0.54	0.61	0.39	0.7	0.56
F. tinctoria ssp. Parasitica	0.68	0.54	0.65	0.54	1	0.8	0.7	0.63	0.67	0.6	0.8	0.84	0.81	0.59	0.63	0.59	0.54	0.68	0.59
F. virens var. *Matthewii*	0.79	0.7	0.81	0.65	0.8	1	0.76	0.74	0.77	0.8	0.8	0.89	0.76	0.49	0.63	0.7	0.54	0.79	0.7
F. travancorica	0.65	0.67	0.89	0.56	0.7	0.8	1	0.76	0.68	0.7	0.6	0.76	0.78	0.39	0.7	0.72	0.44	0.81	0.61
F. tsjakela	0.58	0.7	0.81	0.65	0.6	0.7	0.76	1	0.72	0.8	0.7	0.79	0.81	0.43	0.58	0.65	0.43	0.84	0.7
F. virens var. *virens*	0.67	0.68	0.74	0.79	0.7	0.8	0.68	0.72	1	0.8	0.8	0.82	0.63	0.37	0.56	0.74	0.53	0.87	0.58
F. virens var. *dispersa*	0.65	0.67	0.78	0.67	0.6	0.8	0.72	0.81	0.84	1	0.8	0.81	0.61	0.33	0.54	0.67	0.44	0.76	0.72
F. nervosa	0.62	0.58	0.63	0.58	0.8	0.8	0.58	0.72	0.75	0.8	1	0.82	0.63	0.42	0.51	0.63	0.47	0.67	0.74
F. superba	0.79	0.59	0.81	0.65	0.8	0.9	0.76	0.79	0.82	0.8	0.8	1	0.81	0.54	0.58	0.76	0.59	0.84	0.65
F. middletonii	0.65	0.56	0.72	0.61	0.8	0.8	0.78	0.81	0.63	0.6	0.6	0.81	1	0.56	0.65	0.67	0.5	0.76	0.67
F. talbotii	0.54	0.33	0.44	0.5	0.6	0.5	0.39	0.43	0.37	0.3	0.4	0.54	0.56	1	0.49	0.33	0.5	0.38	0.33
F. tinctoria ssp. gibbosa	0.47	0.54	0.65	0.54	0.6	0.6	0.7	0.58	0.56	0.5	0.5	0.58	0.65	0.49	1	0.59	0.32	0.63	0.54
F. pumila	0.7	0.67	0.78	0.61	0.6	0.7	0.72	0.65	0.74	0.7	0.6	0.76	0.67	0.33	0.59	1	0.5	0.81	0.72
F. elastica	0.54	0.33	0.44	0.39	0.5	0.5	0.44	0.43	0.53	0.4	0.5	0.59	0.5	0.5	0.32	0.5	1	0.54	0.33
F. fergusonii	0.63	0.76	0.86	0.7	0.7	0.8	0.81	0.84	0.87	0.8	0.7	0.84	0.76	0.38	0.63	0.81	0.54	1	0.59
F. guttata	0.65	0.67	0.67	0.56	0.6	0.7	0.61	0.7	0.58	0.7	0.7	0.65	0.67	0.33	0.54	0.72	0.33	0.59	1

Appendix 4: Corelation value between the taxa of *Ficus* studied

	F. religiosa	*F. benghalensis*	*F. racemosa*	*F. microcarpa*	*F. tinctoria ssp. Parasitica*	*F. virens var. Matthewii*	*F. travancorica*	*F. tsjakela*	*F. virens var.virens*	*F. virens var.dispersa*	*F. nervosa*	*F. superba*	*F. middletonii*	*F. talbotii*	*F. tinctoria ssp.gibbosa*	*F. pumila*	*F. elastica*	*F. fergusonii*	*F. guttata*
F. hispida	0.59	0.56	0.67	0.39	0.4	0.5	0.61	0.65	0.53	0.6	0.4	0.54	0.5	0.28	0.38	0.5	0.33	0.59	0.56
F. heterophylla	0.53	0.54	0.65	0.59	0.6	0.6	0.59	0.84	0.67	0.8	0.8	0.74	0.76	0.38	0.47	0.65	0.38	0.68	0.76
F. krishnae	0.68	0.65	0.65	0.54	0.7	0.8	0.59	0.68	0.62	0.7	0.8	0.79	0.65	0.54	0.63	0.59	0.43	0.63	0.7
F. mollis	0.79	0.76	0.65	0.65	0.7	0.7	0.59	0.68	0.77	0.7	0.7	0.79	0.65	0.43	0.47	0.76	0.49	0.74	0.7
F. amplissima	0.62	0.58	0.58	0.63	0.7	0.7	0.53	0.72	0.65	0.6	0.7	0.77	0.68	0.58	0.36	0.53	0.53	0.62	0.53
F. amplocarpa	0.76	0.61	0.61	0.5	0.6	0.8	0.56	0.65	0.53	0.7	0.7	0.7	0.61	0.44	0.43	0.61	0.44	0.54	0.83
F. anamalayana	0.68	0.76	0.81	0.49	0.7	0.8	0.76	0.79	0.62	0.8	0.8	0.79	0.7	0.38	0.58	0.76	0.43	0.74	0.81
F. arnottiana	0.81	0.61	0.72	0.56	0.8	0.9	0.67	0.59	0.63	0.7	0.7	0.81	0.67	0.44	0.54	0.72	0.44	0.65	0.72
F. beddomei	0.59	0.61	0.56	0.33	0.5	0.6	0.5	0.59	0.47	0.6	0.6	0.59	0.56	0.44	0.54	0.56	0.5	0.59	0.61
F. benjamina	0.32	0.44	0.39	0.5	0.4	0.4	0.39	0.49	0.42	0.5	0.5	0.43	0.33	0.44	0.49	0.33	0.28	0.38	0.44
F. binnendykii	0.61	0.57	0.74	0.63	0.7	0.7	0.69	0.67	0.7	0.8	0.8	0.72	0.51	0.4	0.56	0.63	0.4	0.67	0.57
F. callosa	0.72	0.63	0.74	0.63	0.8	0.8	0.68	0.82	0.75	0.8	0.9	0.92	0.74	0.47	0.56	0.68	0.53	0.77	0.68
F. caulocarpa	0.79	0.7	0.7	0.59	0.8	0.8	0.65	0.58	0.72	0.6	0.7	0.79	0.65	0.49	0.53	0.7	0.49	0.68	0.65
F. costata	0.68	0.49	0.7	0.65	0.7	0.8	0.65	0.68	0.82	0.8	0.8	0.89	0.7	0.43	0.53	0.7	0.49	0.74	0.65
F. dalhousieae	0.59	0.39	0.39	0.28	0.5	0.5	0.33	0.43	0.32	0.4	0.5	0.49	0.39	0.56	0.38	0.39	0.5	0.32	0.51
F. drupacea	0.54	0.56	0.5	0.61	0.5	0.6	0.44	0.7	0.53	0.6	0.5	0.59	0.56	0.72	0.54	0.33	0.44	0.54	0.44
F. auriculata	0.65	0.61	0.56	0.44	0.4	0.5	0.5	0.59	0.47	0.5	0.5	0.54	0.56	0.33	0.38	0.67	0.44	0.59	0.72
F.exasperata	0.63	0.65	0.65	0.49	0.7	0.7	0.59	0.79	0.56	0.6	0.7	0.74	0.76	0.43	0.53	0.59	0.43	0.68	0.81

Appendix 4: Corelation value between the taxa of *Ficus* studied

	F. hispida	*F. heterophylla*	*F. krishnae*	*F. mollis*	*F. amplissima*	*F. amplocarpa*	*F. anamalayana*	*F. arnottiana*	*F. beddomei*	*F. benjamina*	*F. binnendykii*	*F. callosa*	*F. caulocarpa*	*F.costata*	*F. dalhousieae*	*F. drupacea*	*F. auriculata*	*F. exasperata*
F. religiosa	0.59	0.53	0.68	0.79	0.62	0.757	0.684	0.811	0.59	0.32	0.61	0.718	0.789	0.68	0.59	0.54	0.65	0.63
F. benghalensis	0.56	0.54	0.65	0.76	0.58	0.611	0.757	0.611	0.61	0.44	0.57	0.632	0.703	0.49	0.39	0.56	0.61	0.65
F. racemosa	0.67	0.65	0.65	0.65	0.58	0.611	0.811	0.722	0.56	0.39	0.74	0.737	0.703	0.7	0.39	0.5	0.56	0.65
F. microcarpa	0.39	0.59	0.54	0.65	0.63	0.5	0.486	0.556	0.33	0.5	0.63	0.632	0.595	0.65	0.28	0.61	0.44	0.49
F. tinctoria ssp. Parasitica	0.38	0.58	0.74	0.68	0.67	0.649	0.684	0.757	0.54	0.38	0.67	0.769	0.789	0.74	0.54	0.49	0.43	0.68
F. virens var. *Matthewii*	0.54	0.63	0.79	0.74	0.67	0.757	0.789	0.865	0.65	0.43	0.72	0.821	0.842	0.79	0.54	0.59	0.54	0.74
F. travancorica	0.61	0.59	0.59	0.59	0.53	0.556	0.757	0.667	0.5	0.39	0.69	0.684	0.649	0.65	0.33	0.44	0.5	0.59
F. tsjakela	0.65	0.84	0.68	0.68	0.72	0.649	0.789	0.595	0.59	0.49	0.67	0.821	0.579	0.68	0.43	0.7	0.59	0.79
F. virens var. *virens*	0.53	0.67	0.62	0.77	0.65	0.526	0.615	0.632	0.47	0.42	0.7	0.75	0.718	0.82	0.32	0.53	0.47	0.56
F. virens var.*dispersa*	0.56	0.76	0.7	0.7	0.63	0.667	0.757	0.667	0.56	0.5	0.8	0.842	0.649	0.81	0.44	0.61	0.5	0.65
F. nervosa	0.42	0.77	0.77	0.72	0.7	0.684	0.769	0.684	0.58	0.47	0.76	0.85	0.667	0.82	0.53	0.53	0.47	0.72
F. superba	0.54	0.74	0.79	0.79	0.77	0.703	0.789	0.811	0.59	0.43	0.72	0.923	0.789	0.89	0.49	0.59	0.54	0.74
F. middletonii	0.5	0.76	0.65	0.65	0.68	0.611	0.703	0.667	0.56	0.33	0.51	0.737	0.649	0.7	0.39	0.56	0.56	0.76
F. talbotii	0.28	0.38	0.54	0.43	0.58	0.444	0.378	0.444	0.44	0.44	0.4	0.474	0.486	0.43	0.56	0.72	0.33	0.43
F. tinctoria ssp. gibbosa	0.38	0.47	0.63	0.47	0.36	0.432	0.579	0.541	0.54	0.49	0.56	0.564	0.526	0.53	0.38	0.54	0.38	0.53
F. pumila	0.5	0.65	0.59	0.76	0.53	0.611	0.757	0.722	0.56	0.33	0.63	0.684	0.703	0.7	0.39	0.33	0.67	0.59
F. elastica	0.33	0.38	0.43	0.49	0.53	0.444	0.432	0.444	0.5	0.28	0.4	0.526	0.486	0.49	0.5	0.44	0.44	0.43
F. fergusonii	0.59	0.68	0.63	0.74	0.62	0.541	0.737	0.649	0.59	0.38	0.67	0.769	0.684	0.74	0.32	0.54	0.59	0.68
F. guttata	0.56	0.76	0.7	0.7	0.53	0.833	0.811	0.722	0.61	0.44	0.57	0.684	0.649	0.65	0.61	0.44	0.72	0.81

Appendix 4: Corelation value between the taxa of *Ficus* studied

	F. hispida	*F. heterophylla*	*F. krishnae*	*F. mollis*	*F. amplissima*	*F. amplocarpa*	*F. anamalayana*	*F. arnottiana*	*F. beddomei*	*F. benjamina*	*F. binnendykii*	*F. callosa*	*F. caulocarpa*	*F.costata*	*F. dalhousieae*	*F. drupacea*	*F. auriculata*	*F. exasperata*
F. hispida	1	0.54	0.43	0.49	0.53	0.556	0.595	0.556	0.44	0.33	0.51	0.526	0.486	0.54	0.39	0.44	0.5	0.59
F. heterophylla	0.54	1	0.63	0.63	0.67	0.595	0.737	0.541	0.54	0.38	0.56	0.769	0.526	0.74	0.38	0.54	0.54	0.74
F. krishnae	0.43	0.63	1	0.79	0.62	0.757	0.789	0.757	0.65	0.49	0.61	0.821	0.737	0.68	0.65	0.65	0.59	0.74
F. mollis	0.49	0.63	0.79	1	0.67	0.757	0.737	0.757	0.59	0.43	0.61	0.821	0.789	0.68	0.54	0.54	0.7	0.68
F. amplissima	0.53	0.67	0.62	0.67	1	0.579	0.615	0.579	0.42	0.53	0.59	0.75	0.615	0.67	0.42	0.63	0.42	0.62
F. amplocarpa	0.56	0.59	0.76	0.76	0.58	1	0.757	0.778	0.61	0.44	0.57	0.737	0.703	0.59	0.72	0.56	0.78	0.86
F. anamalayana	0.59	0.74	0.79	0.74	0.62	0.757	1	0.757	0.7	0.38	0.67	0.821	0.737	0.68	0.54	0.49	0.65	0.79
F. arnottiana	0.56	0.54	0.76	0.76	0.58	0.778	0.757	1	0.56	0.39	0.63	0.737	0.811	0.81	0.56	0.44	0.56	0.65
F. beddomei	0.44	0.54	0.65	0.59	0.42	0.611	0.703	0.556	1	0.39	0.4	0.632	0.595	0.49	0.56	0.61	0.67	0.7
F. benjamina	0.33	0.38	0.49	0.43	0.53	0.444	0.378	0.389	0.39	1	0.46	0.474	0.324	0.43	0.39	0.61	0.39	0.43
F. binnendykii	0.51	0.56	0.61	0.61	0.59	0.571	0.667	0.629	0.4	0.46	1	0.757	0.667	0.67	0.46	0.46	0.4	0.5
F. callosa	0.53	0.77	0.82	0.82	0.75	0.737	0.821	0.737	0.63	0.47	0.76	1	0.718	0.82	0.53	0.63	0.58	0.77
F. caulocarpa	0.49	0.53	0.74	0.79	0.62	0.703	0.737	0.811	0.59	0.32	0.67	0.718	1	0.68	0.54	0.43	0.54	0.63
F. costata	0.54	0.74	0.68	0.68	0.67	0.595	0.684	0.811	0.49	0.43	0.67	0.821	0.684	1	0.38	0.49	0.43	0.63
F. dalhousieae	0.39	0.38	0.65	0.54	0.42	0.722	0.541	0.556	0.56	0.39	0.46	0.526	0.541	0.38	1	0.56	0.56	0.59
F. drupacea	0.44	0.54	0.65	0.54	0.63	0.556	0.486	0.444	0.61	0.61	0.46	0.632	0.432	0.49	0.56	1	0.44	0.59
F. auriculata	0.5	0.54	0.59	0.7	0.42	0.778	0.649	0.556	0.67	0.39	0.4	0.579	0.541	0.43	0.56	0.44	1	0.76
F.exasperata	0.59	0.74	0.74	0.68	0.62	0.865	0.789	0.649	0.7	0.43	0.5	0.769	0.632	0.63	0.59	0.59	0.76	1