# STUDIES ON LEAF ARCHITECTURAL PATTERN AND CULTICULAR FEATURES OF SOME MEMBERS OF PAPILIONACEAE

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**Abstract**

Leaf morphology, venation pattern and cuticular features of 21 genera and 29 species of Indian Papilionaceae have been studied. It has been observed that different parameters of leaf morphology and anatomy help in the identification of taxa up to genera and species. Further, leaf architectural pattern specially in regard to their secondary vein can be correlated with their basic chromosome numbers.

## Introduction

The family Papilionaceae consists of 482 genera and 12000 species and is world wide in distribution. In India the family is represented by 70 genera and 750 species, which show great variation in habit and anatomical features. While scanning the published literature on foliar anatomy of Papilionaceae, it was observed that except for the reports of Leelavathi *et al.* (1980) on "Foliar stomatal distribution patterns in Leguminosae and their taxonomic significance"; and that of Shah *et al.* (1975, p 67); Kannabiran and Krishnamurthy ( 974) and Gupta (1979) practically no information is available on leaf architectural patterns of this family although Metcalfe and Chalk (1979) have given a generalized account of cuticular features. Therefore, the present authors took up this project to evaluate the utility of leaf architecture and other morphological features in differentiating the taxa of the family.

## Material and methods

The material comprising leaves/leaflets was collected from Burdwan District. Various parameters were used for external morphology. For studying leaf architectural pattern fresh or dried leaves were treated with 5% NaOH solution for 24 to 36 hours depending on the texture of the leaf, and transferred to chloral hydrate solution following the method of Foster (1952) and Hickey (1973). Finally, the material was stained in 1% aquous safranine followed by gradual dehydration, and permanent slides were prepared in Canada balsam.

Similarly cuticular preparations were made for studying epidermal features of leaves/leaflets by treating them with 10% $HNO_3$ for 24-43 hours followed by 5% KOH solution treatment for 2-5 minutes and then washed in water. Then the cuticles of both the surfaces were separated and mounted in glycerine-jelly.

The taxa have been arranged according to the classification of Bentham and Hooker (1862-1883). The salient morphological features of the leaves of each taxon are given in the Table 1 to 4 and the venation patterns of 16 species are illustrated (Pl.1,2).

## Discussion

The family Papilionaceae is divided into 11 tribes on the basis of stamen characters, namely : Cenisteae, Trifolieae, Loteae, Galegeae, Hedysareae, Podalyriease, Vicieae, Phaseoleae, Abreae, Dalbergieae, Sophoreae. It has been observed that the leaves of this family show great variations in regard to external morphology, their architectural patterns such as (brochidodromous,

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**Table 1—(Contd.)**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| 11. | *S. aegyptica* | Compound | Stalked | Simple, even-pinnate | Symmetrical, oblong | Smooth | Acute | Entire | Mucronate |
| Tribe : Hedysareae | | | | | | | | | |
| 12. | *Aeschynomene indica* | Compound | Stalked | Simple, odd-pinnate | Asymmetrical (base only), Oblong-linear or lorate | Hairy | Obtuse or rounded | Entire | Mucronate |
| 13. | *A. aspera* | Compound | Stalked | Simple, odd-pinnate | Asymmetrical, oblong, narrow | Smooth | Obtuse or rounded | Entire | Mucronate |
| 14. | *Alysicarpus vaginalis* | Simple | Petiolate | — | Symmetrical, ovate, lanceolate | Hairy | Cordate | Entire | Acuminate |
| 15. | *Desmodium gangeticum* | Simple | Petiolate | — | Asymmetrical or symmetrical, ovate | Hairy | Rounded | Entire | Acute |
| 16. | *D. triflorum* | Compound | Stalked | Pinnate, 3-foliolate | Symmetrical, obovate cuneate | Hairy | Acute | Entire | Emarginate or truncate |
| Tribe : Viciaeae | | | | | | | | | |
| 17. | *Arbus precatorius* | Compound | Stalked | Bi-pinnate | Symmetrical. | Smooth | Obtuse | Entire | Mucronat |
| Tribe : Phaseoleae | | | | | | | | | |
| 18. | *Teramnus labialis* | Compound | Stalked | Pinnate, 3-foliolate | Central symmetrical lateral-asymmetrical, ovate | Hairy | Cordate | Entire | Obtuse |
| 19. | *Erythrina indica* | Compound | Stalked | Pinnate, 3-foliolate | Central symmetrical, lateral-asymmetrical, ovate | Smooth | Obtuse | Entire | Acute |
| 20. | *Mucuna pruriens* | Compound | Stalked | Pinnate, 3-foliclate | Central symmetrical, lateral-asymmetrical, ovate | Hairy | Cordate or rounded | Entire or crenate smoothly rounded | Mucronate |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21. *Butea superba* | Compound | Stalked | Pinnate, 3-foliolate | Central symmetrical, lateral-asymmetrical, ovate to obovate | Hairy | Acute | Entire | Obtuse |
| 22. *B. monosperma* | Compound | Stalked | Pinnate, 3-foliolate | Central symmetrical, lateral-asymmetrical, ovate-obovate | Hairy | Acute | Entire | Obtuse |
| 23. *Phaseolus trilobus* | Compound | Stalked | Pinnate, 3-foliolate | Central symmetrical lateral-asymmetrical, leaflets shortly 3-lobed | Hairy | Obtuse | Lobed | Obtuse, rarely acute |
| 24. *Vigna luteola* | Compound | Stalked | Pinnate, 3-foliolate | Central symmetrical, lateral-asymmetrical, lanceolate | Hairy | Obtuse | Entire | Attenuate |
| 25. *Clitoria ternatea* | Compound | Stalked | Pinnate, 3-foliolate | Central symmetrical, lateral-asymmetrical, lanceolate | Hairy | Obtuse or normal | Entire | Acuminate |
| 26. *Psophocarpus tetragonolobus* | Compound | Stalked | Pinnate, 3-foliolate | Middle-symmetrical, other two leaflets-asymmetrical, ovate (base only) | Hairy | Obtuse or normal | Entire | Acuminate |
| Tribe : Dalbergieae | | | | | | | | |
| 27. *Dalbergia sissoo* | Compound | Stalked | Simple, imperi-pinnate | Symmetrical, rarely asymmetrical, obovate | Smooth | Acute | Wavy | Acuminate |
| 28. *D. lanceolaria* | Compound | Stalked | Simple, imperi pinnate | Symmetrical, lanceolate | Hairy | Acute | Entire | Emarginate |
| 29. *Pongamia pinnate* | Compound | Stalked | Simple, imperi pinnate | Symmetrical, ovate | Hairy | Acute | Wavy | Acute |

**Table 2. Leaf architectural pattern of Papilionaceae**

| S. No. | Name of plant | Unicostate or multicostate | No. of secondaries & their nature | Reticulation upto | Areole formation by | Shape of areole | Areole mostly with (no. of vein endings) | Free vein ending consisting of tracheids in rows | Tips of vein endings | Marginal ultimate venation |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | *Crotalaria prostrata* | Unicostate | 6-10 pairs, brochidodromous | 6th | 4th & 5th | Polygonal | 1 | 2 | Curved, not swollen, branched or unbranched | Nearly complete, looped |
| 2. | *C. retusa* | Unicostate | 8-14 pairs, brochidodromous | 5th | 4th category | Quadrangular to polygonal | 1 | 2-3 | Curved, swollen, branched or unbranched | Complete, thin fimbrial vein formed |
| 3. | *Melilotus indica* | Unicostate | 8-10 pairs, craspidodromous | 6th | 4th & 5th or 4th category | Quadrangular to irregular | 1 | 1-2 | Straight or curved, swollen, very rarely branched | Incomplete |
| 4. | *M. alba* | Unicostate | 8-12 pairs, craspidodromous | 6th | 4th category or 4th 5th category | Irregular | 1 | 1-2 | Straight or curved, not swollen, very rarely branched | Nearly complete, looped |
| 5. | *Medicago lupulina* | Unicostate | 6-8 pairs, mixed craspidodromous | 6th | 3rd & 4th or 4th & 5th | Irregular | 0-1 | 2 | Swollen, curved, branched or unbranched | Complete, looped |
| 6. | *M. denticulata* | Unicostate | 6-12 pairs, secondaries parallelly arranged, mixed-craspidodromous | 6th | 4th category or 4th & 5th | Irregular | 0-1 | 1-2 | Swollen, curved, very rarely branched | Nearly complete, looped |
| 7. | *Indigofera trita* L. f. var. *trita* | Unicostate | 4-6 pairs, brochidodromous | 6th | 3rd & 4th or 4th & 5th | Irregular | 1 | 1-2 | Straight or curved, not swollen | Complete, looped |

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|---|---|---|---|---|---|---|---|---|---|---|
| 8. | *Millettia ovalifolia* | Unicostate | 7-9 pairs, Eucamptodromous | 6th | 4th & 5th | Quadrangular to polygonal | 1 | 2 | Mostly straight, rarely curved, rarely branched | Complete fimbrial vein formed |
| 9. | *Tephrosia purpurea* | Unicostate | Many & parallelly oriented but arranged in brochidodromous fashion | 6th | 5th & 4th | Quadrangular to various types | 1 | 1-2 | Swollen, rounded or blunt, rarely branched | Complete, looped |
| 10. | *Sesbania aegyptica* | Unicostate | 9-12 pairs, brochidodromous | 6th | 4th category or 3rd & 4th | Pentagonal | 1-2 | 2-3 | Swollen, sometimes tracheids fused to form a ball-like structure | Nearly complete, looped |
| 11. | *S. grandiflora* | Unicostate | 7-10 pairs, brochidodromous | 6th | 5th category or 4th & 5th | Quadrangular to irregular | 1 rarely 2 | 1-2 | Swollen, curved, sometimes tracheids fused to form a ball-like structure | Nearly complete, looped |
| 12. | *Aeschynomene indica* | Unicostate | 6-8 pairs, brochidodromous | 5th | 3rd & 4th or 4th category | Quadrangular to irregular | 0-1 | 1-2 | Swollen, rarely branched or unbranched, straight or curved | Complete, looped |
| 13. | *A. aspera* | Unicostate | 4 to 6 pairs, brochidodromous | 5th | 3rd & 4th or 4th category | Quadrangular to irregular | 1 | 1-2 | Straight or curved, swollen, branched or unbranched | Nearly complete, looped |
| 14. | *Desmodium gangeticum* | Unicostate | 6-10 pairs, reticulodromous | 6th | 4th & 5th | Quadrangular to Polygonal | 0-1 | 1-2 | Not swollen, pointed, curved | Complete fimbrial vein formed |
| 15. | *D. triflorum* | Unicostate | 4-6 pairs, brochidodromous | 6th | 4th & 5th | Very variable or irregular | 0-1 | 1-2 | Not swollen, diminishes into fine reticulum, curved, branched or unbranched | Nearly complete, looped |

**Table 2**— (*Contd.*)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 16. | *Alysicarpus vaginalis* | Unicostate | 5-8 pairs, eucamptro-dromous | 6th | 4th & 5th | Quadri-angular to polygonal | 1 | 1-2 | Swollen, somewhat pointed, curved or branched | Complete. looped |
| 17. | *Abrus precatorius* | Unicostate | 6-10 pairs, brochidodro-mous | 5th | 3rd & 4th | Quadri-angular | 1 | 1-2 | Swollen, tapering, curved sometimes branched | Complete, looped |
| 18. | *Teramnus labialis* | Unicostate | 5-7 pairs, eucamptodro-mous | 6th | 4th & 5th | pentagonal | 1 | 2-3 | Swollen, straight or curved | Complete, looped |
| 19. | *Erythrina indica* | Unicostate | 4-8 pairs, brochidodro-mous | 6th or more | 5th & 4th | Quadri-angular to polygonal | 1 | 2-3 | Not swollen, straight, unbranched | Complete, looped |
| 20. | *Mucuna pruriens* | Unicostate | 7-10 pairs, reticulo-dromous | 6th or 7th | 5th category or 4th & 5th or 5th & 6th | Quadri-angular | 1 | 1-2 | Swollen, tapering towards the end, straight or curved, branched or unbranched | Complete fim-brial vein formed |
| 21. | *Butea superba* | Unicostate | 7-10 pairs, brochidodro-mous | 6th or more | 5th category or 5th & 4th or 5th 6th | Quadri-angular or various types | 0-1 | 1-3 | Straight or curved, slightly swollen | Complete thick fimbr'al vein formed |
| 22. | *B. monosperma* | Unicostate | 7-10 pairs, eucampto-dromous | 6th or more | 5th category or 5th & 4th | Quadri-angular or rectangular | 1 | 1-3 | Slightly swollen, curved | Complete, fimbrial vein formed |
| 23. | *Phaseolus trilobus* | Unicostate | 4-6 pairs, brochidodro-mous | 6th | 4th & 5th | Irregular | 1-2 | 1 | Swollen, curved, mostly branched or unbranched | Complete, looped |

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|---|---|---|---|---|---|---|---|---|---|---|
| 24. | *Vigna luteol* | Unicostate | 6-8 pairs, brochidodromous | 6th or more | 4th & 5th | Various types | 0-1 | 2-3 | Swollen, straight or curved, rarely branched | Complete, looped |
| 25. | *Clitoria ternatea* | Unicostate | 6-8 pairs, eucamptomous | 6th | 4th & 5th | Irregular and large | 1-2 | 1-2 | Simple, tapering, unbranched or rarely branched | Nearly complete, looped |
| 26. | *Psophocarpus tetragonolobus* | Unicostate | 8-12 pairs, reticulodromous | 6th or more | 5th & 6th or 4th & 5th | Quadrangular or various types | 1-0 | 1-3 | Slightly swollen, straight or curved, branched or unbranched | Complete fimbrial vein formed |
| 27. | *Dalbergia sissoo* | Unicostate | 12-20 pairs, brochidodromous | 5th | 3rd & 4th | Pentagonal large | 1 | 2-8 | Not swollen. straight or rarely curved, unbranched | Complete thick fimbrial vein formed |
| 28. | *D. lanceolaria* | Unicostate | 10-16 pairs, brochidodromous | 6th | 4th & 5th | Quadrangular to polygonal | 1 | 2-3 | Swollen, mostly curved, branched or unbranched | Incomplete |
| 29. | *Pangamia pinnata* | Unicostate | 8-10 pairs, brochidodromous | 6th | 4th category or 4th & 5th | Quadrangular | 0-1 | 2-3 | Straight, not swollen | Complete, looped |

**Table 3. Cuticular feature of Papilionaceae**

| S. No. | Name of plant | Amphistomatic hypostomatic | Type of stomata and their distribution pattern; arrangement, orientation and stomatal index (S. I.) | | Shape and nature of epidermal cell-wall | | Trichome and its nature | |
|---|---|---|---|---|---|---|---|---|
| | | | Lower surface | Upper surface | Lower surface | Upper surface | Lower surface | Upper surface |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Tribe : Genisteae | | | | | | | | |
| 1. | *Crotalaria prostrata* | Amphistomatic | Anisocytic; stomata all over except on midvein, irregularly arranged, variously oriented, S. I. 53. 80 | Similar type and distribution pattern, S. I. 29. 81 | Polygonal or irregular straight or undulated | Polygonal or irregularly undulated | Unicellular, nonglandular; ring-like ornamentation present at the base of trichome | Similar |
| 2. | *C. retusa* | Amphistomatic | Anisocytic; stomata all over except on midvein and primary lateral veins, irregularly arranged, variously oriented, S. I. 41.02 | Anisocytic; stomata all over, irregularly arranged, variously oriented, S. I. 46. 4 | Irregular, sinuous | Irregular, straight or undulate | 1-2 celled, uniseriate, nonglandular, broad, slightly fusiform at tip; thin walled, base narrow, all facing leaf-apex | |
| Tribe : Trifolieae | | | | | | | | |
| 3. | *Melilotus indica* | Amphistomatic | Anisocytic to anomocytic; stomata all over except on midvein and primary lateral veins irregularly arranged, variously oriented, S. I. 30.63 | Mostly anomocytic, rarely anisocytic; stomata all over irregularly arranged, variously oriented, S. I. 46.47 | Irregular, undulated | Irregular, slightly undulated | Uniseriate, nonglandular mostly two short basal cells accompanied by an elongated terminal cell; glandular shaggy hairs also present | Similar |

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|---|---|---|---|---|---|---|---|
| 4. *M. alba* | Amphistomatic | Anomocytic to anisocytic; stomata all over except on midvein and primary lateral veins irregularly arranged, variously oriented, S. I. 19.73 | Anomocytic to anisocytic, stomata all over, irregularly arranged, variously oriented, S. I. 30. 73 | Irregular, undulated | Irregular, slightly undulated | Uniseriate, nonglandular, usualy 2 basal cells accompanied by an elongated terminal cell; glandular hairs absent | Similar |
| 5. *Medicago lupulina* | Amphistomatic | Anomocytic to anisocytic; stomata all over except on midvein and primary lateral veins, irregularly arranged, variously oriented, S. I. 27.02 | Anisocytic to anomoeytic similar distribution pattern, S. I. 33.24 | Polygonal, slightly undulated, rod-like ornamentation present | Pentagonal to hexagonal or irregular, slightly undulated | Uniseriate, nonglandular or glandular with one or two basal cells | Similar |
| 6. *M. denticulata* | Amphistomatic | Anomocytic to anisocytic; stomata all ove except on midvein and primary lateral veins, irregularly arranged, variously oriented, S. I. 20.70 | Similar type and distribution pattern, S. I. 23.34 | Irregular, slightly undulated, rod-like ornamentation present | Pentagonal, hexagonal or polygonal | Nonglandular unicellular, short | Absent |
| Tribe : Galegeae | | | | | | | |
| 7. *Indigofera trita* L. f. var. *trita* | Amphistomatic | Anomocytic to anisocytic; stomata all over except on midvein and primary lateral veins, irregularly arranged, variously oriented, S. I. 8.53 | Similar type & distribution pattern | Irregular, undulated | Similar | Nonglandular, thin walled, tapering towards the end, without prominent bases, multicellular glandular spherical hairs also present | Similar |
| 8. *Millettia ovalifolia* | Hyposto-matic | Paracytic; stomata all over, except on midvein, irregularly arranged, variously oriented, S. I. 21.4 | Nil | Polygonal, straight | Similar, but rod-like ornamentation present | Uniseriate, 2-celled, fusiform | Similar |

**Table 3**—(*Contd.*)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| 9. | *Tephrosia purpurea* | Amphistomatic | Anomocytic and anisocytic; stomata all over except on midvein, irregularly arranged, variously oriented, S. I. 32.33 | Anomocytic and anisocytic; stomata all over, irregularly arranged, variously oriented S. I. 19.04 | Polygonal, straight | Similar | Nonglandular, unicellular | Similar |
| 10. | *Sesbania aegyptica* | Amphistomatic | Anomocytie to anomocytic; stomata all over except on midvein, irregularly arranged, variously oriented, S. I. 14.46 | Similar, stomata all over, irregularly arranged, variously oriented, S. I. 10.24 | Irregular, undulated | Irregular, undulated, dot-like ornamentation present | Nonglandular, uniseriate with a number of short basal cells accompanied by an elongated terminal cell | Similar |
| 11. | *S. grandiflora* | Amphistomatic | Anisocytic and anomocytic; stomata all over except on midvein, irregularly arranged, variously oriented, S. I. 34.6 | Similar, stomata all over, irregularly arranged, variously oriented, S. I. 30.50 | Hexagonal or polygonal, straight | Hexagonal, straight | Nonglandular, uniseriate with a number of short basal cells accompanied by a flattened cell | Nonglandular, 2-celled |
| Tribe : Hedysareae | | | | | | | | |
| 12. | *Aeschynomene indica* | Amphistomatic | Anisocytic, paracytic and anomocytic; stomata all over except on midvein, irregularly arranged, variously oriented, S. I. 29.74 | Similar; stomata all over, irregularly arranged, variously oriented, S. I. 27.17 | Irregular undulated rod-like ornamentation present | Irregular or polygonal, straight or slightly undulated, rod-like ornamentation present | Nonglandular, lar 2-called; thin walled | Similar but very rare |
| 13. | *A. aspera* | Amphistomatic | Anomocytic, anisocytic and rarely paracytic; stomata all over except on madvein, irregularly arran- | Similar; stomata all over, irregularly arranged, variously oriented S.I. 30.06 | Irregular, sinuous | Irregular, sinuous and cutinised | Nonglandular, 2-celled, thin walled | Similar but very rare |

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|---|---|---|---|---|---|---|---|
| | | ged, variously oriented, S.I. 30.00 | | | | | |
| 14. *Alysicarpus vaginalis* | Amphistomatic | Hemiparacytic; paracytic, anomocytic and anisocytic; stomata all over except on midvein and primary lateral veins, irregularly arranged, variously oriented. S.I. 21.58 | Similar in type and distribution pattern, S.I. 9.24 | Polygonal, straight | Polygonal, straight | Nonglandular, unicellular; and glandular, 2-celled, cyclindrical bent or hooked | Only glandular type |
| 15. *Desmodium gangeticum* | Amphistomatic | Paracytic, stomata all over except on midvein, irregularly arranged, variously oriented, S.I. 15.0 | Paracytic; stomata only either side of the midvein, irregularly arranged | Irregular, undulate | Irregular, sinuous | Nonglandular, unicellular and multicellular glandular | glandular only, uniseriate hairs present |
| 16. *D. triflorum* | Amphistomatic | Paracytic; stomata all over except on midvein, irregularly arranged, variously oriented, S.I. 14.8 | Similar type and distribution pattern, S.I. 10.00 | Irregular, straight | Irregular, straight | Nonglandular, unicellular and glandular, 2-celled cylindrical bent or hooked | — |
| Tribe: Vicieae | | | | | | | |
| 17. *Abrus precatorius* | Amphistomatic | Anomocytic and paracytic; stomata all over except on midvein, irregularly arranged, variously oriented, S. I. 31.35 | Anomocytic; stomata confined to midvein, irregularly arranged, variously oriented | Irregular, sinuous | Irregular, sinuous | Nonglandular, unicellular, thin walled | Similar |
| Tribe: Phaseoleae: | | | | | | | |
| 18. *Teramnus labialis* | Amphistomatic | Paracytic; stomata all over except | Similar type and distribution pat- | Irregular, sinuou | Irregular, undulate | Nonglandular, uniseriate with a number of | Similar |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | ged, variously oriented, S.I. 39.75 | | | | by elongated terminal cells and glandular uniseriate club-shaped | present |
| 23. | *Phaseolus trilobus* | Amphistomatic | Paracytic; stomata all over, except on midvein and primary lateral veins, irregularly arranged, variously oriented, S. I. 61.67 | Similar type and stomatal distribution pattern, S.I. 49.18 | Polygonal, straight | Polygonal, straight | Nonglandular, uniseriate with two-short basal cells accompanied by elongated terminal cells and multicellular glandular type | Similar |
| 24. | *Vigna luteola* | Amphistomatic | Paracytic; stomata all over, except on midvein and primary lateral veins, irregularly arranged, variously oriented, S.I. 35.52 | Paracytic, stomata all over, irregularly arranged, variously oriented, S.I. 12.36. | Polygonal, straight | Polygonal, straight | Nonglandular, unicellular and glandular multicellular | Similar |
| 25. | *Clitoria ternatea* | Amphistomatic | Paracytic and anisocytic; stomata all over except on veins irregularly arranged, variously oriented, S.I. 34.48 | Similar type; stomata all over, except on midvein and primary lateral veins, irregularly arranged, variously oriented, S.I. 29.05 | Irregular, undulated | Irregular, undulated | Nonglandular, uniseriate and glandular uniseriate | Similar |
| 26. | *Psophocarpus tetragonolobus* | Hypostomatic | Paracytic to amphiparacytic; stomata all over except on veins, irregularly arranged, variously oriented, S. I. 25.0 | — | Irregular, sinuous | Irregular, sinuous | Nonglandular, uniseriate with two basal cells accompanied by an elongated terminal cell | Similar |

**Table 3**—(*Contd.*)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Tribe: Dalbergieae: | | | | | | | | |
| 27. | *Dalbergia sissoo* | Amphistomatic | Paracytic and amphiparacytic; stomata all over except on veins, irregularly arranged, variously oriented, S.I. 23.70 | Paracytic; stomata only on either side of mid-vein, irregularly arranged, variously oriented | Pentagonal or polygonal; straight | Pentagonal or polygonal; straight, cells larger than those of of lower surface | Nonglandular, uniseriate with 3-basal cells, accompanied by an elongated terminal cell | Similar very rare |
| 28. | *D. lanceolaria* | Hypostomatic | Paracytic and rarely anisocytic; stomata all over except on veins, irregulary arranged, variously oriented, S.I. 20.30 | — | Irregular, rod-like ornameatation present sinuous | Pentagonal to polygonal, rod-like ornamentation present, straight | Nonglandular, unicellular horn-like | Similar type present only on the mid-vein |
| 29. | *Pongamia pinnata* | Hypostomatic | Paracytic; stomata all over except on veins, irregularly arranged, variously oriented, S.I. 14.3 | — | Irregular, sinuous or undulated | Irregular, sinuous or undulate, dot-like ornamentation present in the cell wall | Nonglandular, uniseriate and and glandular uniseriate | Only glandular lar |

**Table 4. Correlation between basic chromosome number and secondary venation pattern**

| Basic chromosome number | Secondary venation pattern | Name of plant |
|---|---|---|
| 6, 7, 8, 10, 11 | Brochidodromous | *Crotalaria prostrate*, *C. retusa*, *Indigofera trita* L. f. var. *trita*, *Sesbania aegyptica*, *S. grandiflora*, *Aeschynomene indica*, *A. aspera*, *Desmodium triflorum*, *Abrus precatorius*, *Erythrina indica*, *Butea superba*, *Phaseolus trilobus*, *Vigna luteola*, *Dalbergia sissoo*, *D. lanceolaria*, *Pongamia pinnata* |
| 12 | Parallel but arranged in brochidromous fashion | *Tephrosia purpurea* |
| 16, 24 (32) | Craspidodromous | *Melilotus indica*, *M. alba* |
| 16, 32 | Mixed-craspidodromous | *Medicago lupulina*, *M. denticulata* |
| 8, 20 | Eucamptodromous | *Millettia ovalifolia*, **Alysicarpus vaginalis*, *Teramnus labialis*, **Butea monosperma*, *Clitoria ternatea* |
| 11 & 22 | Reticulodromous | *Desmodium gangeticum*, *Mucuna pruriens*, *Psophocarpus tetragonolobus*. |

*Basic chromosome numbers were not available to the authors from the literatures.

craspidodromous, mixed-craspidodromous, eucamptodromous, reticulodromous) and in cuticular features. Out of the 21 genera and 29 species, only *Crotalaria prostrata*, *Alysicarpus vaginalis* and *Desmodium gangeticum* have simple leaves. The rest of the species having compound leaves are either odd pinnate or evenly pinnate or trifoliate or bipinnate.

The authors have taken into consideration the following parameters to study the leaf architectural patterns :
(i) leaf pinna, unicostate or multicostate, (ii) number of secondry veins and their nature, (iii) level of reticulation, (iv) level of areole formation by veins, (v) shape of the areole, (vi) number of veins ending within an areole, (vii) number of rows of tracheids in the vein ending, (viii) nature of the vein ending and nature of sheath cells and (ix) type of ultimate marginal venation. The terminology used in describing architectural pattern is based on those used by Hickey (1973) and Dilcher (1974).

In the family Papilionaceae the number of pairs of secondary veins varies from 4 to 6 as lowest number and 12 to 20 pairs as the highest numbers. There are other combinations like (6-8) pairs, (7-10) pairs, (5-7), (5-8) and (9-10) pairs. The formation of reticulation occurs between 5th and 6th level (Table 2).

There are variations also in regard to the level of areole formation. It occurs between 3rd, 4th & 5th level. Similarly the shape of the areole varies from irregular to quadriangular or polygonal. Each areole mostly has one vein ending, but occasionally there may be two or three. It is noteworthy that the leaf pinna in the taxa investigated are uniformly unicostate reticulate. However, the nature of secondaries varies from brochidodromous, mixed-craspidodromous, reticulodromous, eucamptodromous. Brochidodromous is the dominant type of secondary veins (13 genera, 16 species) followed by eucamptodromous (5 genera, 5 species), craspidodromous(1 genus, 2 species), mixed-craspidodromous (1 genus, 2 species) and reticulodromous (2 genera, 2 species).
Other features of leaf architectural patterns are also variable and all these combinations can also be successfully used in the identi fication of different taxa (Table 2; Artificial key-1).

**Artificial Key for identification of some genera and species of Papilionaceae on the basis of leaf characters**

| | | |
|---|---|---|
| I | Leaves simple | .. *Crotalaria prostrata, Alysicarpus vaginalis, Desmodium gangeticum* |
| (i) | Secondary veins reticulodromous | .. *Desmodium gangeticum* |
| (ii) | Secondary veins eucamptodromous | .. *Alysicarpus vaginalis* |
| (iii) | Secondary veins brochidodromous | .. .. *Crotalaria prostrata* |
| II | Leaves compound | |
| (ia) | Unipinnate | *Millettia ovalifolia* |
| (ib) | Odd pinnate | *Tephrosia purpurea, Aeschynomene indica, A. aspera, Pongamia pinnata, Dalbergia lanceolaria, D. sissoo* |
| (ii) | Unicostate : | |
| (iii) | Secondary veins brochidodromous | .. *Aeschynomene indica, A. aspera, Dalbergia lanceolaria, D. sissoo, Pongamia pinnata* |
| (iv) | Marginal ultimate venation complete and looped | .. *Aeschynomene indica, Pongamia pinnata* |
| (v) | Hairs 2-celled, thin walled, base prominent, nonglandular with pointed apex | .. *Aeschynomene indica* |
| (vi) | Hairs multicellular, glandular or nonglandular | .. *Pongamia pinnata* |
| (iv) | Marginal ultimate venation complete and fimbrial vein formed | .. *Dalbergia sissoo* |

(iv) Marginal ultimate venation incomplete .. *Dalbergia lanceolaria*
(iv) Marginal ultimate venation nearly complete and looped .. *Aeschynomene aspera*
(iii) Secondary veins eucamptodromous .. *Millettia ovalifolia*
(iii) Secondary veins parallelly oriented but arranged in brochidodromous fashion .. *Tephrosia purpurea*

(ia) Unipinnate

(ib) Even pinnate .. *Sesbania aegyptica, S. grandiflora*

Unicostate,

Brochidodromous

(vi) Hairs multicellular, nonglandular, with a number of short basal cells accompanied by an elongated terminal cell .. *Sesbania aegyptica*
(vi) Hairs nonglandular, 2 celled, a short basal cell and a terminal cell .. *Sesbania grandiflora*

(ia) Leaves bipinnate .. *Abrus precatorius*
Leaves pinnately 3-foliolate .. *Melilotus indica, M. alba, Medicago lupulina, M. denticulata, Teramnus labialis, Mucuna pruriens, Phaseolus trilobus, Butea superba, B. monosperma, Vigna luteola, Erythrina indica, Clitoria ternatea* (3-7 foliolate), *Desmodium triflorum, Psophocarpus tetragonolobus, Indigofera trita* L. f. var. *trita*

(ii) Unicostate :

(iii) Secondary veins brochidodromous .. *Phaseolus trilobus, Butea superba, Vigna luteola, Erythrina indica, Desmodium triflorum, Indigofera trita* L. f. var. *trita.*
(iv) Marginal vein complete and looped .. *Erythrina indica, Vigna luteola, Phaseolus trilobus, Indigofera trita* L. f. var. *trita.*
(viia) Stomata paracytic, present on either side of the midvein (in upper surface of the leaflet) .. *Erythrina indica*
(viia) Stomata paracytic, present all over, except on midvein and primary lateral veins (in the upper surface of the leaflet) .. *Phaseolus trilobus*
(viia) Stomata paracytic, present all over (in the upper surface of the leaflet) .. *Vigna luteola*
(viia) Stomata mostly anomocytic .. *Indigofera trita* L. f. var. *trita*
(iv) Marginal vein nearly complete and looped .. *Desmodium triflorum*
(iv) Marginal vein complete, fimbrial vein formed .. *Butea superba*
(iii) Secondary veins eucamptodromous .. *Butea monosperma, Clitoria ternatea, Teramanus labialis*
(iv) Marginal vein complete, fimbrial vein formed .. *Butea monosperma*
(iv) Marginal vein nearly complete and looped .. *Clitoria ternatea*

(iv) Marginal vein complete and looped .. *Teramnus labialis*
(iii) Secondary veins reticulodromous .. *Psophocarpus tetragonolobus*, *Mucuna pruriens*

(vii) Leaves hypostomatic .. *Psophocarpus tetragonolobus*
(vii) Leaves amphistomatic .. *Mucuna pruriens*

(iii) Secondary veins craspidodromous .. *Medicago lupulina*, *M. denticulata*
(iv) Marginal vein complete and looped .. *Medicago lupulina*
(iv) Marginal vein nearly complete and looped .. *M. denticulata*
(iii) Secondary veins mixed-craspidodromous .. *Melilotus indica*, *M. alba*

(iv) Marginal vein complete and looped .. *Melilotus indica*
(iv) Marginal vein nearly complete and looped. .. *M. alba*

(ia) Leaves digitately 3-foliolate .. *Crotalaria retusa*

While studying cuticular features 7 different parameters (Table 3) have been used for detailed analysis. Out of 29 species 23 are amphistomatic and 6 are hypostomatic. The stomata are of two types-anisocytic and paracytic. The paracytic type is dominant occurring in 16 species and the rest are anisocytic. It has been observed that the cuticular features are so variable that it is not possible to identify the species of genus by cuticular features alone unless the other epidermal characters are taken into consideration.

Senn (1938, 1943) and Darlington and Wylie (1955) have discussed the significance of basic chromosome number in plant taxonomy. The basic chromosome number in Papilionaceae varies from 6, 7, 8, 10, 11 and there are multiples of the numbers such as 16, 20, 22, 24 and 32. We have seen that those taxa which have brochidodromous type of secondaries have basic chromosome numbers 6, 7, 8, 10 and 11; craspidodromous have 16, 24, 32; mixed-craspidodromous 16 and 32, eucamptodromous 8, 20; and reticulodromous 11 and 12. The vasculature in plants is a conservative feature similar to the basic chromosome numbers. Therefore, both these features probably can be used with greater significance for evaluating taxonomic status. Thus the correlation between basic chromosome numbers and the dominant type of secondary veins is a significant observation. For Example, in *Tephrosia purpurea* unlike the other taxa, the basic chromosome number is 12. The secondary vein pattern is also different in this species that is parallelly oriented but arranged in brochidodromous fashion (Table 4).

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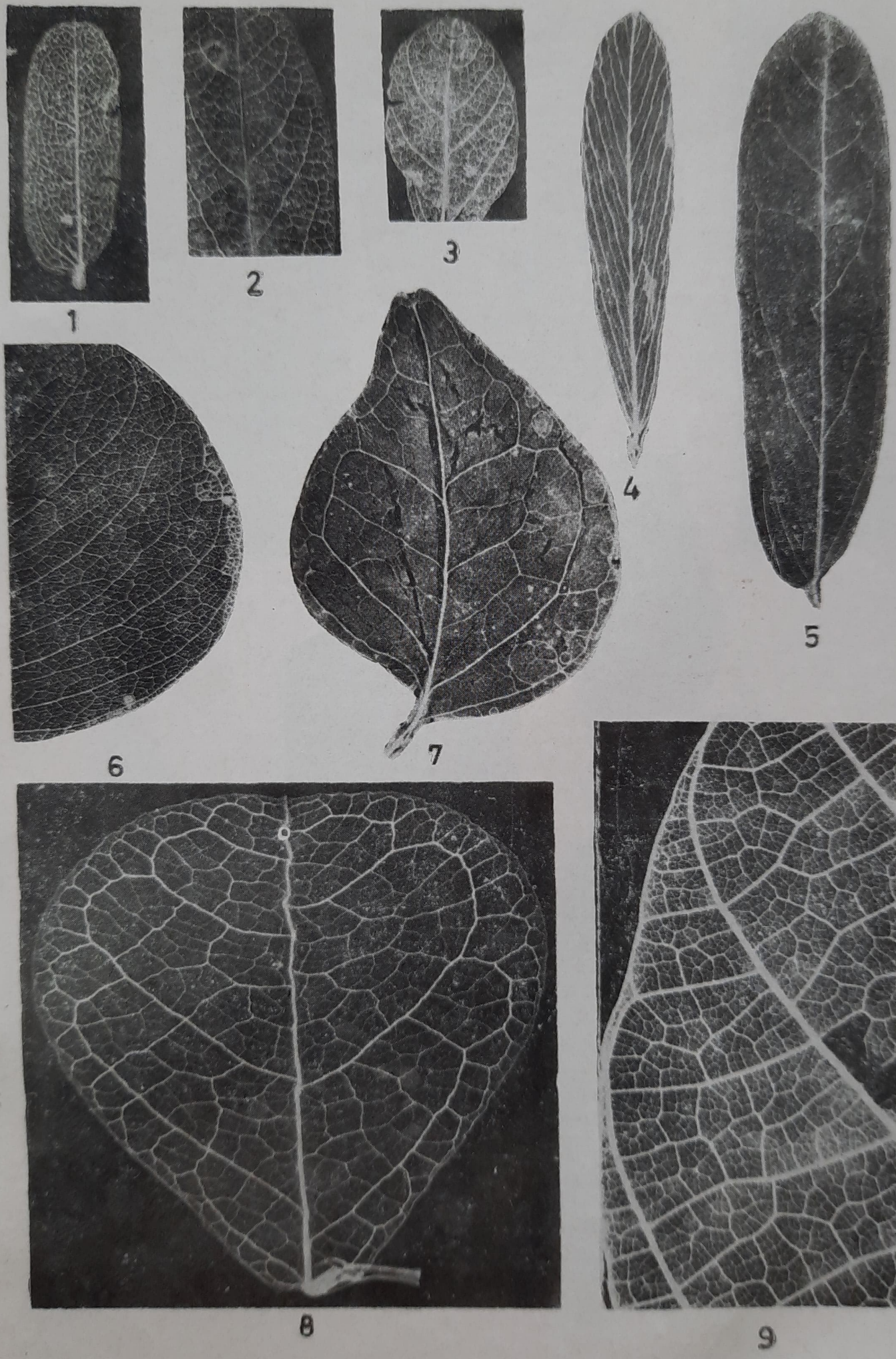
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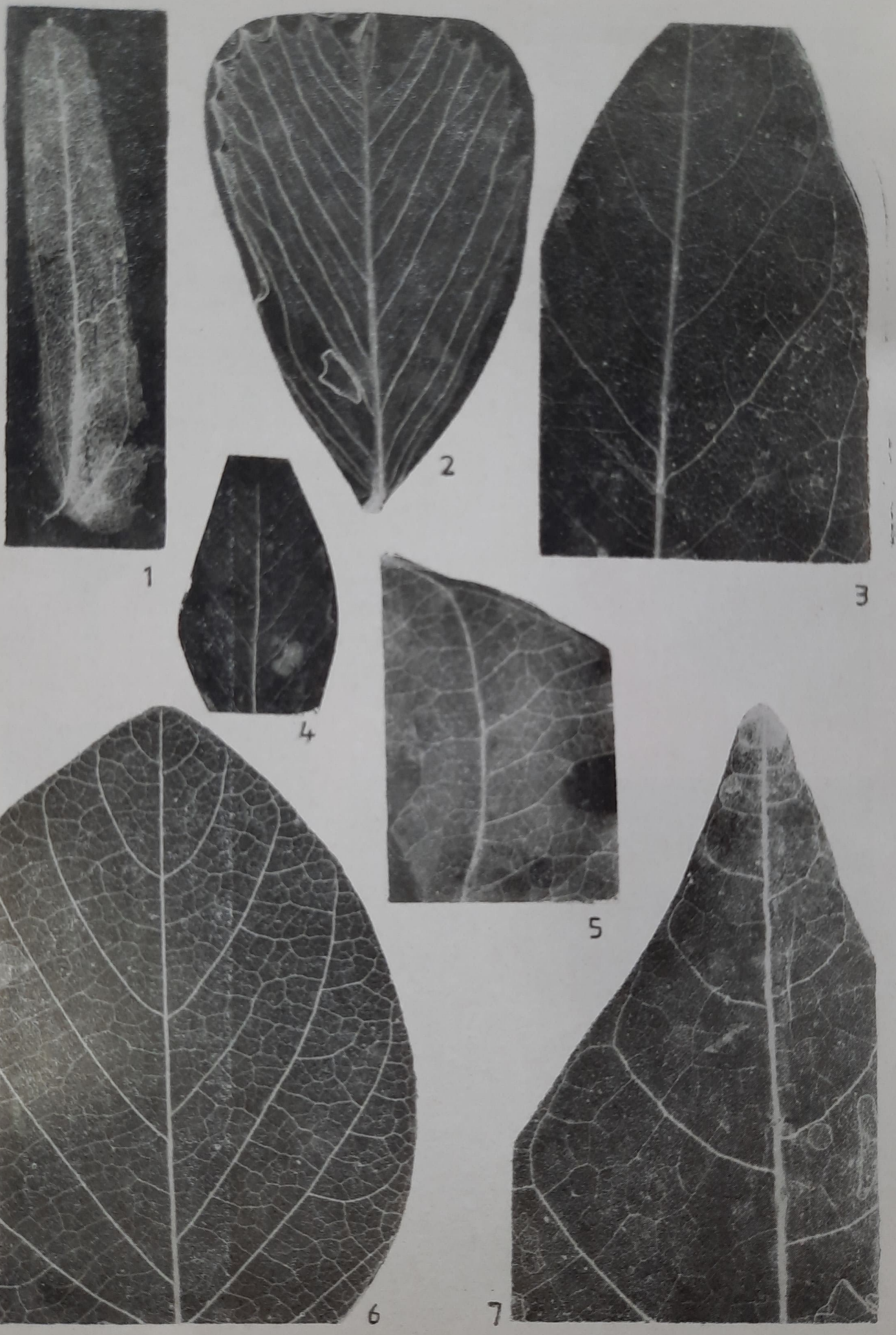
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## Explanation of plates

(Leaves showing venation patterns)

### Plate 1

1. *Aeschynomene aspera* × 10
2. *Alysicarpus vaginalis* × 2
3. *Teramnus labialis* × 2
4. *Tephrosia purpurea* × 8
5. *Sesbania aegyptica* × 8
6. *Dalbergia sissoo* × 2
7. *Dalbergia lanceolaria* × 4
8. *Desmodium triflorum* × 10
9. *Butea superba* × 4

### Plate 2

1. *Aeschynomene indica* × 8
2. *Midicago denticulata* × 8
3. *Milletia ovalifolia* × 4
4. *Melilotus indica* × 4
5. *Mucuna pruriens* × 4
6. *Desmodium gangeticum* × 4
7. *Erythrina indica* × 4