

ANATOMICAL STUDIES IN *TEPHROSIA VOGELII* HOOK.F.

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ABSTRACT

Tephrosia vogelii Hook.f. is a rare species of family Fabaceae. The plant has noted medicinal value, pods and leaves are diuretic, expectorant, sedative, used for parasitic skin diseases, cough etc. Present investigation deals with morphology, stem and leaf anatomy, to standardize the species.

Keywords: *Tephrosia*, anatomy, Fabaceae.

Introduction: The genus *Tephrosia* Pers. of Fabaceae (Papilionoideae tribe Millettieae) comprises c. 345 species (Mabberley, 2008). Being one of the largest genera in the family Fabaceae (Geesink, 1984) it enjoys pantropical distribution. The genus is represented in India by 27 species and one variety (Sanjappa, 2010).

Tephrosia vogelii Hook.f. is a rare species of family Fabaceae. It is medicinally important species. Pods and leaves diuretic, expectorant, sedative, used for parasitic skin diseases, cough etc. Leaves used as an abortifacient, bactericide, emetic and purgative, molluscicide, for skin diseases, schistomiasis; and weak infusion of the leaves taken as an anthelmintic; dry crushed leaves insecticide, against lice, fleas, ticks. Leaves and young stems fish and arrow poison (Quattrochhi U., 2012).

Materials and Methods: The plant specimens were collected from area near Pullivasal Teaestate, Munnar, Kerala, field number 2021. Herbarium specimens were deposited in BAMU herbarium, Dept of Botany, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad. Stem and leaf material was preserved in 70% alcohol for anatomical studies. Free hand sectioning method was used to take transverse sections of stem and leaf followed by double staining and permanent mounting. Trichomes and stomata studied by scraping and peeling method. The materials of the stem were also studied by maceration techniques. The pieces of stem were boiled in Jeffery's fluid (Chromic acid 10% and Nitric acid 10% in 1:1 proportion) the macerated cells were studied in detail (Johanson, 1940; Choudhary et al. 1992

and Khandelwal, 2006). Labomed Lx-400 microscope attached to Pixel-pro software was used for microphotography and dimensions.

Results and Observations:

I) Morphology:

Tephrosia vogelii Hook. f., Fl. Niger 296. 1849; Sebast., Bull. Bot. Surv. India 2: 3. 1960.
Cracca vogelii Kuntze, Revis. Gen. Pl. 1: 175. 1891.

Vernacular Names: English: Fish poison bean, Fish poison Tree, Vogel's Tephrosia; Portuguese: *Tefrosia*; Spanish: *barbasco guineano*.

Soft, woody branched shrub or small tree, 0.5 – 4 m tall, with dense foliage, indumentums velvety- silky. Stems and branches tomentose with long and short white or rusty-brown hairs. Leaves arranged spirally, imparipinnate; stipules 10 - 22 × 3 - 3.5 mm, lanceolate, early caducous; rachis 5 - 25 cm long, including a petiole of 1 – 3 cm; including petiolule 2 -5 mm long; prolonged 2 – 7 mm; leaflets 11-29, narrowly elliptic to elliptic-oblong, up to 2.7 - 8 × 1 - 2 cm, base acute to obtuse, apex rounded to emarginate, venation most prominent on abaxial surface, silky tomentose. Inflorescence a terminal or axillary pseudo-raceme, 8-26 cm long, rusty tomentose; basal bracts leaflike, caduceous, ovate, acuminate, upto 12 × 9 mm; peduncle stout, at least 2.5 mm or as long as pseudo-raceme; flower 17- 26 mm; Fragrant when fresh, white, pedicel up to 23 mm long, pubescent; calyx brown tomentose, tube 4 mm, lobes 5 - 10 mm long, 2 upper lobes oblong, united almost to tip, rounded at apex; lateral lobes oblong, rounded at tip, upto 7 × 4 mm, lower lobe, narrow, boat-shaped, acute, upto 10 mm long. Standard white silky 24 - 35 mm, wings 20 - 28 mm and keels 20-28 mm, pubescent at margins; stamens 28-32 mm long; upper filament lightly attached, strongly dilated upto 2 mm, above the base; staminal sheath upto 19 mm; free parts 4 – 8 mm, anthers 1.7 mm long. Carpel 25 mm long, style 10 mm long, shortly pubescent on both sides, incurved at the tip. Pods linear, slightly turgid, 6.5 - 11 × 0.8 – 1.8 cm. Rusty brown tomentose, woolly to soft silky, 6 – 11 seeded. Seed ellipsoid to reniform, 5 – 7 × 3 – 5 mm, dark brown to black, smooth (Table-I) (Plate – I).

Fl. & Fr.: September – October.

Exsiccata: TAG, 2021, Munnar (Kerala).

Distribution.: India (Introduced in Tamil Nadu) - a native of tropical Africa.

Localities: Munnar (Pullivasal Tea Estate), Kerala.

Status: Occasional.

II) Anatomy of Stem:The transverse section of stem showed wavy outline. Epidermis is the outer most layer. It is uniseriate; cells are upright, squarish, vertically elongate, or papillate, measured average $9.199 \times 7.463 \mu\text{m}$ and range $5.48 - 10.97 \times 5.77 - 9.06 \mu\text{m}$. Epidermis showed on its external side very thick cuticle and high density of non-glandular and glandular trichomes, measured average $c. 53.21 \times 18.165 \mu\text{m}$ and range $30.26 - 85.87 \times 14.41 - 23.01 \mu\text{m}$. Cortex is differentiated into outer collenchymatous and inner parenchymatous. The outer cortex or hypodermis is single layered angular collenchyma cells, oval, polygonal, elliptic-oblong, measured average $10.765 \times 5.00 \mu\text{m}$ and range $6.54 - 18.66 \times 3.09 - 18.34 \mu\text{m}$. Inner cortex 3 layered; cells oval, polygonal, elliptic. Starch grains reported filled in some inner cortical cells. Endodermis is inconspicuous. Below the endodermis, pericycle found in sclerenchymatous patches of 10 – 12 layered separated by parenchyma. Pericycle fibres circular, ovate-elliptic, polygonal, measured average $17.945 \times 12.692 \mu\text{m}$ and range $4.23 - 56.43 \times 2.63 - 42.96 \mu\text{m}$.

Phloem found below pericycle fibres, 7 – 8 layered, with rectangular, squarish, polygonal cells, average $10.645 \times 4.527 \mu\text{m}$ and range $6.20 - 14.38 \times 2.10 - 6.71 \mu\text{m}$. Vascular cambium in a 3 layers of rectangular cells, measured average $10.106 \times 3.385 \mu\text{m}$ and range $5.64 - 14.47 \times 2.01 - 5.27 \mu\text{m}$. Metaxylem 3– 4 layered, situated towards the periphery. Vessels circular, oblong-elliptic, polygonal, average $52.646 \times 37.686 \mu\text{m}$ and range $32.89 - 76.17 \times 29.45 - 51.96 \mu\text{m}$. Protoxylem 1 – 2 layered, situated towards the centre. Vessels oval, rectangular, polygonal, average $21.139 \times 21.023 \mu\text{m}$ and range $8.04 - 35.60 \times 12.61 - 28.16 \mu\text{m}$. Xylem is separated by uni to biseriate medullary rays. In the centre, large pith region observed. Cells thin walled parenchymatous, oval or circular, average $34.966 \times 25.352 \mu\text{m}$ and range $10.10 - 52.57 \times 9.47 - 41.44 \mu\text{m}$. Tannin reported from some of the pith cells (Table-II, Plate-II).

III) Anatomy of Leaf:The transverse section of the leaf showed typical dorsiventral structure. The epidermis of both the surfaces single layered, covered with thick cuticle. The upper epidermal cells composed of upright, squarish, rectangular, papillate cells. These cells measured, average $23.326 \times 12.628 \mu\text{m}$ and range $15.14 - 37.14 \times 8.18 - 21.33 \mu\text{m}$. The cells

of lower epidermis oval, circular, rectangular or irregular shaped, comparatively smaller in size than upper ones, average $8.910 \times 6.378 \mu\text{m}$ and range $6.54 - 14.84 \times 2.87 - 8.01 \mu\text{m}$. The cells of epidermis at the midrib portion are oval, circular or polygonal and smaller than those in the lamina portion. A high density of glandular trichomes with bulbous head reported from the lower epidermis which measured, average $35.42 \times 16.156 \mu\text{m}$ and range $21.89 - 55.65 \times 13.80 - 22.46 \mu\text{m}$.

The mesophyll is differentiated into palisade and spongy parenchyma. The upper epidermis is followed by 1 – 2 layers of columnar, vertically elongated, compactly arranged, thin walled palisade parenchyma cells which measure, average $13.211 \times 7.256 \mu\text{m}$ and range $9.68 - 15.34 \times 5.19 - 9.52 \mu\text{m}$. The cells of spongy mesophyll oval, circular, polygonal or irregular with wavy cell wall, thin walled, loosely arranged, average $18.378 \times 9.503 \mu\text{m}$ and range $10.74 - 27.31 \times 6.73 - 13.43 \mu\text{m}$. Some mesophyll cells showed starch grains.

At the midrib region the lower epidermis followed by 3 – 5 layers of thin walled, circular, polygonal to irregular, with wavy cell wall, parenchymatous cells. Some of these cells filled with tannin. These tanniniferous cells measured average $20.174 \times 8.255 \mu\text{m}$ and range $8.97 - 32.25 \times 4.25 - 12.91 \mu\text{m}$. This region followed by 3 – 5 layered sclerenchymatous patch composed of compactly arranged, circular, oval to polygonal cells, average $10.90 \times 7.84 \mu\text{m}$ and range $2.95 - 13.69 \times 3.07 - 11.25 \mu\text{m}$. Sclerenchymatous patch followed by 4 – 7 layered phloem of squarish, rectangular to polygonal cells, average $8.181 \times 4.928 \mu\text{m}$ and range $4.92 - 16.36 \times 3.35 - 7.23 \mu\text{m}$. Metaxylem of 3 – 4 layers found below phloem. Cells circular to polygonal, thick walled, situated towards periphery, average $59.85 \times 42.559 \mu\text{m}$ and range $36.33 - 76.96 \times 29.42 - 55.03 \mu\text{m}$. Protoxylem circular to polygonal, situated towards centre, average $20.694 \times 22.476 \mu\text{m}$ and range $13.55 - 32.63 \times 14.03 - 31.68 \mu\text{m}$. Centrally located 2 – 5 layers of pith composed of thin walled, circular, oval parenchyma cells, average $17.437 \times 9.034 \mu\text{m}$ and range $8.60 - 24.23 \times 4.43 - 14.01 \mu\text{m}$ (Table-III, Plate-II).

IV) Micromorphology of Leaves: Leaf showed presence two types of trichomes viz. simple, unicellular, trichomes with thick wall and pointed, slightly curved end, their average length is $406.10 \mu\text{m}$ and range $230 - 751 \mu\text{m}$ and glandular trichomes with bulbous head reported from the lower epidermis which measured, average $35.42 \times 16.156 \mu\text{m}$ and range $21.89 - 55.65 \times 13.80 - 22.46 \mu\text{m}$, present on both the surfaces, but however, they are of high density on lower surface.

Stomata paracytic (Rubiaceous), hypostomatic, $22.50 \times 10.00 \mu\text{m}$ in average and range $9.00 - 26.00 \times 8.00 - 19.00 \mu\text{m}$.

Upper epidermal cells much larger (average $23.326 \times 12.628 \mu\text{m}$ and range $15.14 - 37.14 \times 8.18 - 21.33 \mu\text{m}$.) than lower epidermal cells (the average cell size $8.910 \times 6.378 \mu\text{m}$ and range $6.54 - 14.84 \times 2.87 - 8.01 \mu\text{m}$ (Plate-II).

V) Maceration:

Parenchyma cells are of two types:

- Parenchyma with few pits: Cells are oblong, rectangular, thin walled, occur in rows, pits few, $35.00 - 55.00 \times 8.00 - 11.00 \mu\text{m}$.
- Parenchyma without pits: Cells are rectangular, squarish, thin walled, arranged in vertical rows, pits not observed, $39.00 - 54.00 \times 8.00 - 15.00 \mu\text{m}$.

Fibres are of two types:

- Simple fibres, short, slender, thick walled, pointed sharp and tapering at both ends, outline entire, measured range $320.0 - 350.0 \times 8.00 - 14.00 \mu\text{m}$.
- Simple fibres longer, broader lumen, thick walled, tapering and sharply pointed at both the ends, outline entire, measured range $420.0 - 540.0 \times 6.00 - 10.00 \mu\text{m}$.
- Tracheids shorter than fibres, slender, tapering at one end and blunt at the other, with few simple pits $220.0 - 270.0 \times 10.00 - 16.00 \mu\text{m}$.
- Vessel elements longer, thick walled, with spiral thickening, $230.0 - 280.0 \times 8.00 - 16.00 \mu\text{m}$ (Fig. 1).

Table I: Morphological Characters:

	Characters	Observation in <i>Tephrosia vogelii</i> Hook.f.
Vegetative	Habit	Shrub/small tree
	Plant Height	2.45 m
	Life Form	Erect
	Surface	Smooth
	Number	11 - 29

Leaflets	Shape	Elliptic-elliptic oblanceolate
	Dimensions (cm)	2.7 – 8.0 × 1.0 – 2.0
	Apex	Rounded-emarginate
	Upper Surface	Silky tomentose
	Lower Surface	Dense silky tomentose
Stipules	Length (mm)	10.0 – 22.0
	Shape	Lanceolate
	Apex	Acute
	Pubescence	Tomentose
Stalk	Petiole length (mm)	10.0 – 30.0
	Petiolule length (mm)	4.5
Inflorescence	Length (cm)	26
	Position/Type	Terminal/axillary, pseudoraceme
	Peduncle (cm)	2.5
	No. of flowers	c. 22
Bracts	Shape	Ovate
	Pubescence	Silky
Calyx	Calyx Tube (mm)	1.0
	Upper Sepal (mm)	7.0
	Lower Sepal (mm)	10.0
	Teeth Shape	Oblong, boat-shaped
	Apex	Rounded, acute
	Pubescence	Tomentose
Corolla	Colour	White
	Standard Size (mm)	30.0 × 12.5
	Standard Shape	Orbicular
	Wing Size (mm)	26.0 × 9.6
	Keel Size (mm)	25.5 × 13.5
Androecium	Staminal Sheath Length (mm)	19.0
	Filament Length (mm)	8.0
Gynoecium	Ovary Length (mm)	25.0
	Style Length (mm)	10.0

	Style Pubescence	Pubescence
Pods	Size (cm)	10.5× 1.5
	Shape	Linear
	No. of Seeds	6 – 11
Seeds	Size (mm)	7.0 × 5.0
	Shape	Ellipsoid-reniform
	Colour	Dark brown to black

Table II: Stem Anatomy

Cell Type	Dimensions in <i>Tephrosia vogelii</i> Hook.f.	
	Average (µm)	Range (µm)
Epidermis	9.199 × 7.463	5.48 – 10.97 × 5.77 – 9.06
Hypodermis	10.765 × 5.00	6.54 – 18.66 × 3.09 – 8.34
Pericycle Fibres	17.945 × 12.692	4.23 – 56.43 × 2.63 – 42.96
Phloem	10.645 × 4.527	6.20 – 14.38 × 2.10 – 6.71
Vascular Cambium	10.106 × 3.385	5.64 – 14.47 × 2.01 – 5.27
Metaxylem	52.646 × 37.686	32.89 – 76.17 × 29.45 – 51.96
Protoxylem	21.139 × 21.023	8.04 – 35.60 × 12.61 – 28.16
Pith	53.21 × 18.165	30.26 – 85.87 × 14.41 – 23.01

Table III: Leaf Anatomy

Cell Type	Dimensions in <i>Tephrosia vogelii</i> Hook.f.	
	Average (µm)	Range (µm)
Upper Epidermis	23.326 × 12.628	15.14 – 37.14 × 8.18 – 21.33
Lower Epidermis	7.844 × 4.731	5.34 – 11.05 × 3.60 – 6.51
Angular Collenchyma	11.131 × 6.888	6.28 – 18.43 × 3.13 – 11.87
Palisade Mesophyll	13.211 × 7.256	9.68 – 15.34 × 5.19 – 9.52
Spongy Mesophyll	18.378 × 9.503	10.74 – 27.31 × 6.73 – 13.43
Phloem	8.181 × 4.928	4.92 – 16.36 × 3.35 – 7.23
Metaxylem	59.85 × 42.559	36.33 – 76.96 × 29.42 – 55.03
Protoxylem	20.694 × 22.476	13.55 – 32.63 × 14.03 – 31.68

Table IV: Micromorphology of Leaves

Cell Type	Dimensions in <i>Tephrosia vogelii</i> Hook.f.	
	Average (μm)	Range (μm)
Simple Trichomes	406.1	230 – 751
Glandular Trichomes	35.42 \times 16.156	21.89 – 55.65 \times 13.80 – 22.46
Stomata Type	Paracytic (Rubiaceous)	-----
Stomata Dimensions	22.50 \times 10.00	9.00 – 26.00 \times 8.00 – 19.00
Stomata Presence	Hypostomatic	

(Note: Average and range calculated by taking 10 readings for each parameter. – sign indicates absence of trichomes as leaves are glabrous.)

Table V: Maceration of Stem

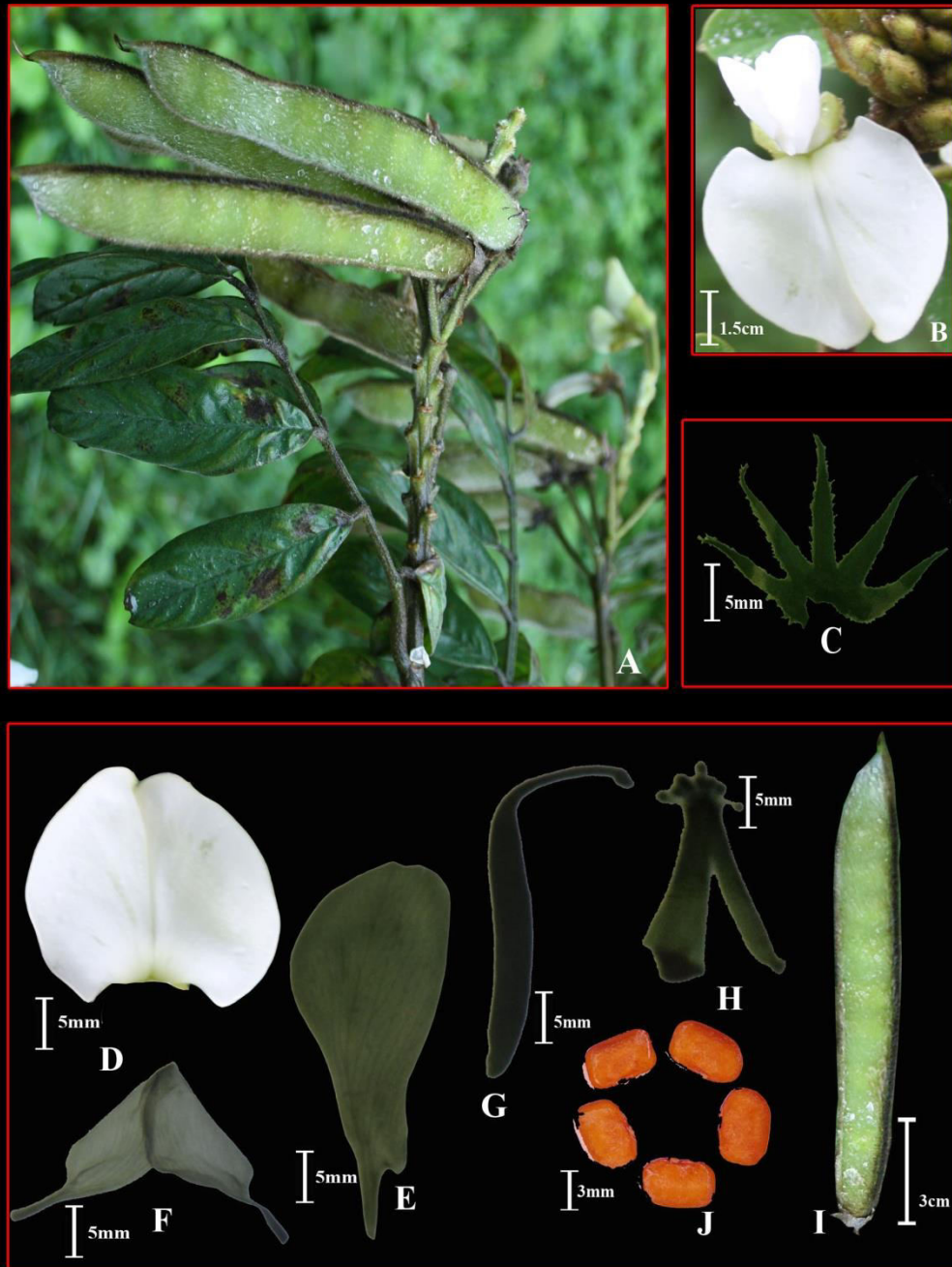
Cell Type	Dimensions in <i>Tephrosia vogelii</i> Hook.f.	
	Range (μm)	
Parenchyma	35.00 – 55.00 \times 8.00 – 11.00	
Tracheids	220.0 – 270.0 \times 10.00 – 16.00	
Fibres	420.0 – 540.0 \times 6.00 – 10.00	
Vessels	230.0 – 280.0 \times 8.00 – 16.00	

Conclusion: Pods linear, slightly turgid, style shortly pubescent. Stem revealed pericycle fibres 7 – 8 layered. Tannin reported in pith cells. Trichomes of two types viz. simple, unicellular, thick-walled, pointed, slightly curved end; glandular trichomes with bulbous head. Stomata paracytic (Rubiaceous), hypostomatic. Macerated stem shows two types of fibres simple short, slender and simple longer with broader lumen. These features of morphology, leaf anatomy, micromorphology and maceration are diagnostic to *Tephrosia vogelii* Hook.f. which may be employed to reinforce its classification as well as to standardize the species.

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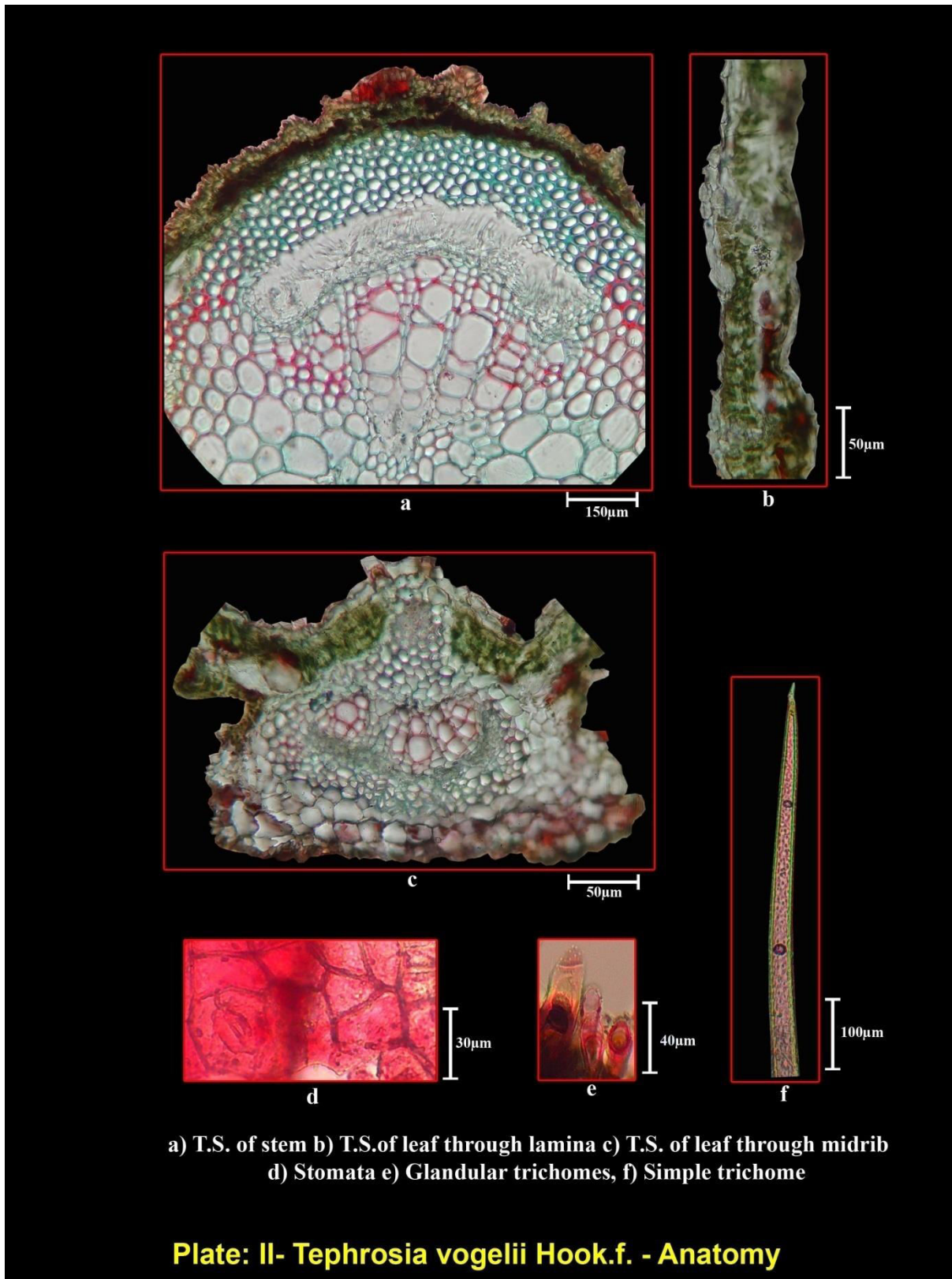
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A-Habit, B-Flower, C-Calyx, D-Standard, E-Wing, F-Keel, G-Gynoeceium, H-Androecium, I-Pod, J-Seeds

Plate: I - *Tephrosia vogelii* Hook.f. - Morphology



MACERATED CELLS OF TEPHROSIA VOGELII

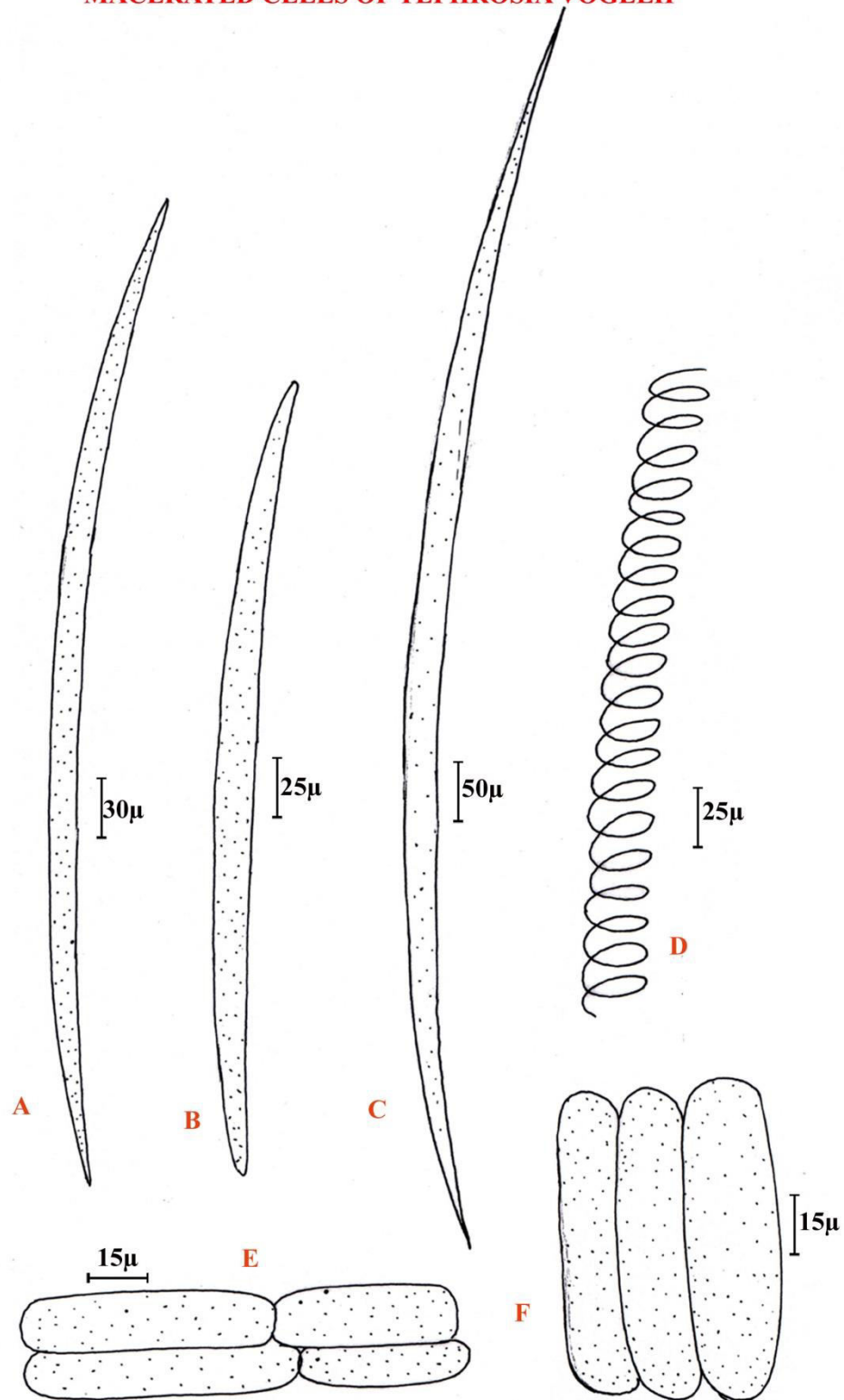


Fig. 1 - A&C-Fibers, B- Tracheid, D- Spiral vessel, E&F- Parenchyma cells