"Anatomical pecularities of *Indigofera parviflora* - New addition in Amravati flora"

Miss. Komal P. Chinchamalatpure[1], Dr. D. M. Ratnaparkhi[2], Dr. P. N. Pawade[3]

[1] Research Scholar, Department of Botany, Smt. Narsamma Arts, Commerce & Science College, Kiran Nagar, Amravati, Maharashtra, India
[2] Assistant Professor, Department of Botany, Smt. Narsamma Arts, Commerce & Science College, Kiran Nagar, Amravati, Maharashtra, India
[3] Associate Professor, Department of Botany, Smt. Narsamma Arts, Commerce & Science College, Kiran Nagar, Amravati, Maharashtra, India

Abstract:

The present investigation has been carried out to determine the anatomical features of whole plant of *Indigofera parviflora* which is a new record to Amravati flora. The study was aimed to provide valuable and reliable illustrated anatomical description of *Indigofera parviflora.* The plant is characterized by 7-9 foliate, purple pods, subcylindric, hairy, 10-12 seeded. Anatomical studies of plant part shows various significant characters,

Keywords: Morphology and anatomy of *Indigofera parviflora*; Root, Stem, Leaf, Petiole and Rachis.

Introduction:

The Fabaceae or Leguminosae commonly known as the legume pea or bean family is a large and economically important family of flowering plants. Fabaceae is the most common family found in tropical rainforests and in dry forests in the Americas and Africa (Burnham R.J., and Johnson K. R. 2004). The family Papilionaceae is the largest of the three families of the order leguminales. According to Gundersen (1950), Papilionaceae is a family of dicotyledonous plants closely related to family Leguminosae. It has an essentially worldwide distribution being found everywhere except Antarctica and high altitudinal Arctic regions (Ali and Nasir 1995-2008). Genus *Indigofera* is a large genus of about 700 species of flowering plants belonging to the subfamily Papilionoideae in the family Leguminosae. The genus is one of the nine genera which are members of the tribe Galegeae (Nwachukwu and Mbagwu 2007) used as a green manure, with high nitrogen contents of 5 and 40 kg.N/ha in the leaves (Thoninsen *et.al*, 2008).

Amravati is one of the district of West Vidarbha regions of Maharashtra, forms a part of Deccan Plateau. The total area of Amravati district region is 12,210 sq. km. with its wealth of plant diversity. During collection of some *Indigofera* species (in Oct.-Nov.) one population of a papilionaceous legume species *Indigofera purviflora* Heyne ex Wight & Arm (Leguminosae-Papilionaceae) is found in Walgaon town of Amravati district and collected for further description. Based on further previous researches (Wight and Arm prodr. 1834, Baker 1876, Cooke 1958) this species has not been listed in Amravati flora. Therefore, this is a new record to Amravati flora. Description has been provided based on specimen collected.

Its morphological and anatomical features, illustrations are provided in this paper.

Material and Method:

Mature and fresh samples of root, stem, leaves, rachis & petiole were collected from grassland area in Amravati region.

Fresh materials were fixed in Formalin Acetic Acid (FAA) for 48 hrs,washed in several changes of distilled water, dehydrated through alcohol series (30%, 50%, 70%, 90% and 100%), 2hrs. in each solution and embedded in wax. Sections in each case were cut on a Leica 2125 rotary microtome at thickness 5µ. The sections were de-waxed with pure xylene and rehydrated in alcohol series following Cutler (1978) with modifications. Staining was achieved by dipping the slides in 1% alcian blue (light green) for about 5 min. washed with distilled water and counter stained with 1% safranin for 2 min. The stained sections were dehydrated through alcohol series and mounted permanently in DPX. Photomicrographs of anatomical sections were taken with a Coslab camera fitted with 4X, 10X, 40X microscopic objective lens.

For studying vessels, wood samples from thick woody branches (of 5-7cm in diameter) in case of woody and thickest portion of stem in herbaceous species were collected from plants. First the dried material of wood from stem was cut into small longitudinal pieces. The pieces were further cut into small thin slices or slivers and proceeded for maceration by (Jeffrey's Method: In plant Microtechnique by Johansen, 1940, P.104) using a mixture of equal parts of 2% aqueous nitric acid and 5% aqueous chromic acid. The softening time for wood varied according to material but in general, material was put into macerating mixture for about 24-72 hours. Softened material crushed very gently with the use of thick glass rod with rounded end. If material did not

crumble easily then macerating mixture was replaced with fresh fluid and process was continued separated elements thoroughly washed with water to remove the acid and stained with aqueous safranin (1%). Vessel elements were selected, dehydrated and mounted in glycerin. Observations have been confined to the late metaxylem elements. All measurements were taken by ocular lens scale for their size 15-20 vessels members of each type from root and stem were studied for their size.

Result & Discussion:

Morphological features: (Plate no.1)

A much branched annual diffuse herb 1-2 feet high, leaves 1-2 cm in long, petioles 0.2-0.5 mm in length, stipules minute, setaceous, leaflets opposite, 7-9 membranous, 0.3-0.4 mm in length, linear-oblong, elliptic or oblanceolate, rounded or subulate, shortly apiculate, petiolules of lateral leaflets about 0.2 mm in length those of terminal about 0.4 mm in length, flowers sessile, 6-12 flowered, racemes shorter than the leaves, calyx 0.5-0.2 mm in length, long, hairy, teeth linear, lanceolate, corolla 0.2-0.3 mm long, pods linear 2-3 cm long, clothed with appressed white hairs, straight, pointed, recurved at the tip, deflexed, 10-12 seeded.

Distribution: A long plane surface of field.

Fls & Frts: November

Anatomical features:

T - S of Root: (Plate no.2)

Cork cambium superficial 8-9 layered,(fig no.2); Cortex large, parenchymatous cells, thin walled, many layered rectangular, radially elongated, compactly arranged, squarish or angular, with small intercellular spaces; cortex containing starch grains, stone cells and rhombohedral crystals(fig no.3). Endodermis and pericycle indistrict. Secondary growth normal, phloem with dense amount of starch grains (fig no.4). formation of cambium strip takes place in xylem and phloem. Rays uniseriate or biseriate (fig no.5). Starch grains were present in medullary rays (fig no.5). Vessels were solitary or in groups very rarely in a series, oval or polygonal, roughly triangular in shape, irregular in size. Paratracheal parenchyma absent. Stele polyarch containing pigmented cells (fig no.6) Pith absent.

Root vessels: (Plate no.3)

Vessels cylindric, predominantly longer than broad. Perforation plates 2 per vessel, vessel with lateral perforation plate(fig no.1), simple, present on almost transverse or slight inclined end walls, mostly circular to quadrangular in shape, as broad as end walls, terminations horizontal, shortly or largely ligulate at one or both end(fig no.5). Sculpturing pattern on lateral walls – pitting, pits simple, mostly crowded, circular to elliptic, medium sized, moderate large, arrangement – in many rows.

T. S. of Stem

Primary growth: (Plate no.4)

Young stem roughly circular in outline, epidermis single layered, cells barrel shaped, uneven, smaller and roundish, outer and inner walls roundish, cuticle thick; (Fig no.3) Epidermis followed by hypodermis, single layered, cells small, roundish, barrel shaped outer and inner wall roundish. Cortex- collenchymatous 6-7 layered cells regular, thin walled, polygonal enclosing small intercellular spaces, cortical cells containing starch grains and rhombohedral crystals (fig no.4). Starch grains and rhombohedral crystals were found in endodermal cells (fig no.4). Pericycle containing isolated bundles of sclerenchymatous cells, 3-4 layered. Vascular cylinder-vascular bundles are conjoint, collateral and open, phloem in outer continuous ring, 4-5 layered. Xylem-inner to cambium in continuous cylinder, transversal by narrow rays. Vessels- in radial multiplies of 5-6, circular, angular or polygonal in outline, vessels containing rhombohedral crystal and sphaerocrystal (fig no.5). Pith-Narrow, homogenous, cells parenchymatous, thin walled, isodiametric, pentagonal, hexagonal, compactly arranged, cells adjoining xylem, small, compact (fig no.6).

Secondary growth: (Plate no.5)

Secondary growth normal. Cortex consists of 4-5 layered parenchymatous cells irregular, thin walled, oval, polygonal enclosing large intercellular space. Endodermis distinct, single layered, endodermal cells were oval or rounded, rhombohedral crystals found in endodermal cells(fig no.3), Pericycle homogenous, sclerenchymatous (fig no.2). Secondary anomalous cambium originates in secondary xylem in the outer layers of phloem and later on in innermost cortical layers. As a result of activity of this cambium patches of irregular thin walled cells produced. Cells of these patches continuous to divide some of the cells produce vascular tissue. Rhombohedral crystals were found in phloem region (fig no.3). Vessels were predominantly in a series, few scattered, polygonal or irregular in shape and size, rhombohedral crystals were found in vessels (fig no.4). Rays uniseriate or biseriate containing starch grains (fig no.5), Pith narrow, parenchymatous, cells were hexagonal,

polygonal or irregular in shape and size, compactly arranged, without intercellular spaces. Starch grains and rhombohedral crystals were found in pith region (fig no.6)

Wood vessels: (Plate no.6)

Vessels angular, predominantly longer than broad at both ends. Perforation plates commonly 2 per vessel, simple, present on almost transverse end, circular, few were quadrangular in shape(fig no.2), as broad as end walls, terminations horizontal few slightly oblique with very few ligulate at one end(fig no.4). Occassionally short vessels with perforation on lateral walls noticed. Scultpturing pattern on lateral walls – pitting, pits simple, mostly crowded, round, elliptic in outline; slightly vary in size, small to medium sized, arrangement – alternate or irregular in many rows.

T. S. of petiole: (Plate no.7)

Transectional outline wavy, roughly circular. Epidermis single layered, cells barrel shaped, squarish, radially elongated, outer and inner walls roundish, cuticle thick, trichomes absent. Ground tissue- parenchymatous, enclosing small intercellular spaces, cells polygonal wavy in outline (fig no.4), Pattern of vascular configuration in the form of crescent shaped (fig no.2). Vascular bundles conjoint, collateral and open. Perivascular sclerenchyma in the form of continuous ring 2-3 layered (fig no.3). Xylem facing towards vascular crescent; Rhombohedral crystals were present in phloem (fig no.3); Vessels were circular or oval with angular outline arranged in radial multiplies of 6-8, small, thick walled. At central region parenchymatous thick walled cells were present (fig no.2).

T - S of Rachis: (Plate no.8)

Transectional outline rounded abaxially, adaxial part ivaginated centrally and depressed margins on either sides. 5 vascular bundles were present. Two small vascular bundles in the wings. Two median vascular bundles were present in lateral sides containing rhombohedral crystal and a large vascular bundle was present at basal region (fig no.3). Epidermis single layered, cells were squarish, small. Epidermis follows 1-2 layered chlorenchymatous hypodermis; Ground tissue parenchymatous, hexagonal or polygonal, compactly arranged without intercellular space; Perivascular sclerenchyma 3-4 layered (fig no.3); Vascular bundles were conjoint, collateral and open, cambium strip was not well developed. Rhombohedral crystals found in phloem (fig no.3); Vessels were radially arranged 6-7 in numbers large, squarish, angular or polygonal; Wing bundles small covered by perivascular sclerenchyma containing rhombohedral crystal, xylem facing towards central region, phloem towards periphery (fig no.4).

T. S. of Leaflet: (Plate no.9)

Lamina: Epidermis single layered cutinised and cuticularised, epidermal cells on adaxial surface compactly arranged, parenchymatous, radially elongated, outer and inner walls rounded; Vein bundle differentiated into parenchymatous and sclerenchymatous cells surrounded by large stone cells containing rhombohedral crystals (fig no.6), parenchymatous cells were enclosed by two sclerenchymatous layers; Epidermal cells on abaxial surface angular or polygonal in shape, small in size; Leaflet isobilateral, mesophyll differentiated into palisade and spongy parenchyma; palisade 3-4 layered present on both surface, densely filled with chloroplasts. Palisade cells elongated tapering towards lower side. Spongy parenchyma single layered, oval, radially elongated, loosely placed with small intercellular space, Palisade cells on abaxial side 2-3 layered, shorter, compactly placed (fig no.3).

Midrib: Amphistomatic, Epidermis cutinised and cuticularised, sinuations absent. Epidermal cells on adaxial surface were large, radially elongated, Epidermal cells on abaxial surface were angular or polygonal in shape, small in size; Vasculature dumbell shaped, large, irregular parenchymatous ground tissue surrounds the vasculature to form bundle sheath (fig no.5), Ground tissue rounded, oval enclosing large intercellular spaces containing rhombohedral crystal (fig no.5) Cap formation of perivascular sclerenchyma towards the adaxial surface. Rhombohedral crystals were found in perivascular sclerenchyma (fig no.5). Phloem many layered, sclerenchymatous. Vessels in series, radial multiplies of 5-6, polygonal, flattened.

Margin: Epidermal cells on adaxial surface radially elongated, flattened, compactly arranged, Palisade zone continuous upto margin, 2-3 layered, ireregular in size and shape (fig no.4); Epidermal cells on abaxial surface small, oval or rounded.

Conclusion:

Anatomical plant parts show various significant characters. Root cortical region containing starch grains, stone cells and rhombohedral crystals. Starch grains found dense amount in phloem and medullary rays. Paractracheal parenchyma absent, starch grains and rhombohedral crystals are also found in stem cortical region and endodermal region. Pericycle containing isolated bundles of sclerenchymatous cells. Vessels containing rhombohedral crystals and sphaero crystals. Ground tissues in petiolar region wavy in outline, vascular configuration crescent shaped, perivascular sclerenchyma in the form of continuous ring. At central region parenchymatous thick walled cells are found 5 vascular bundles were present in rachis, two small vascular bundles in the wings, two median vascular bundles were present in lateral sides containing rhombohedral crystal and a large vascular bundle at basal region, epidermal cells squarish, hypodermis chlorenchymatous, Rhombohedral crystals found in phloem wing bundles covered by perivascular sclerenchyma containing rhombohedral crystals. In Leaflet upper epidermal cells compactly arranged, parenchymatous, radially elongated. Vein bundle differentiated into parenchymatous and sclerenchymatous cells surrounded by large stone cells containing rhombohedral crystals. Lower epidermal cells small in size, angular or polygonal in shape Leaflet isobilateral. Vasculature dumbell shaped. Ground tissue containing rhombohedral crystals were found in perivascular sclerenchyma.

Hence, by utilizing these anatomical features of the species will be useful in the identification, description and characterization of the species.

Plate No. 1

Habit : *Indigofera parviflora* Heyne ex Wight & Arn.

Plate No. 2

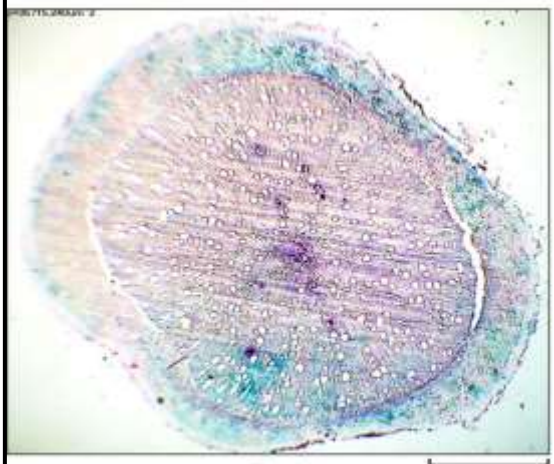

Fig. 1 35715.240 µm²
Entire View

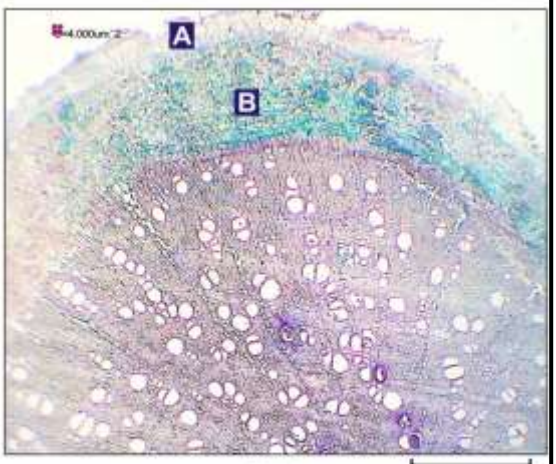

Fig. 2 31180.160 µm²
Cross view
A. Cork cambium B. Wide cortex

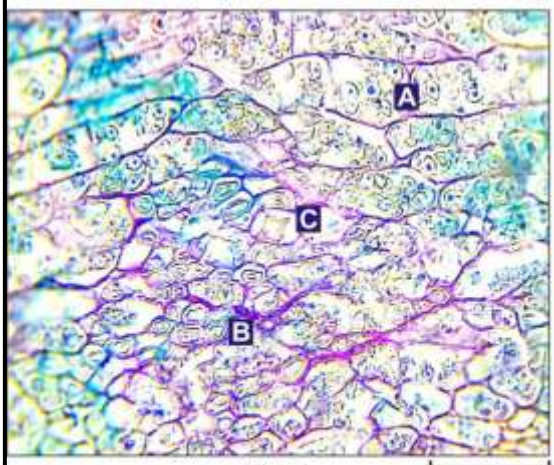

Fig. 3 45253.680 µm²
Cortex
A. Starch grains B. Stone cells
C. Rhombohedral crystal

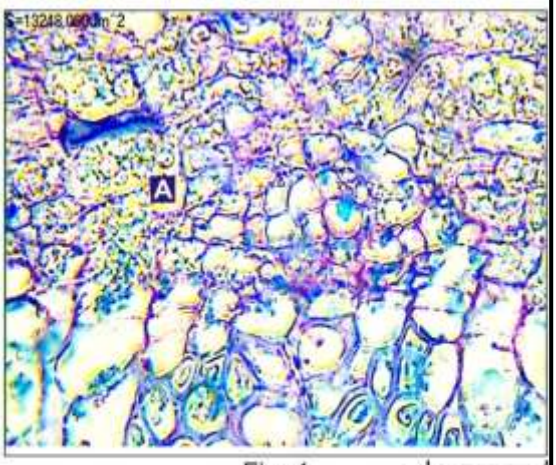

Fig. 4 13248.000 µm²
Phloem
A. Starch grains

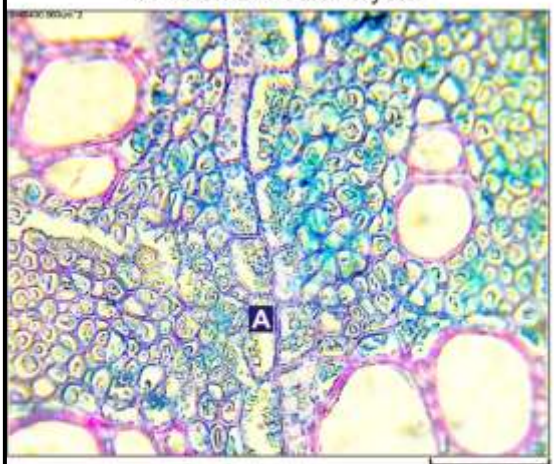

Fig. 5 45430.960 µm²
Biseriate medullary rays
A. Starch grains

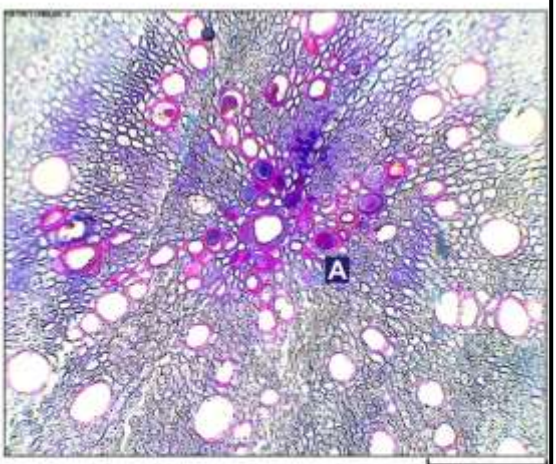

Fig. 5 47951.040 µm²
Polyarch stele
A. Pigmented cell

Root : *Indigofera parviflora* Heyne ex Wight & Arn.

Plate No. 3

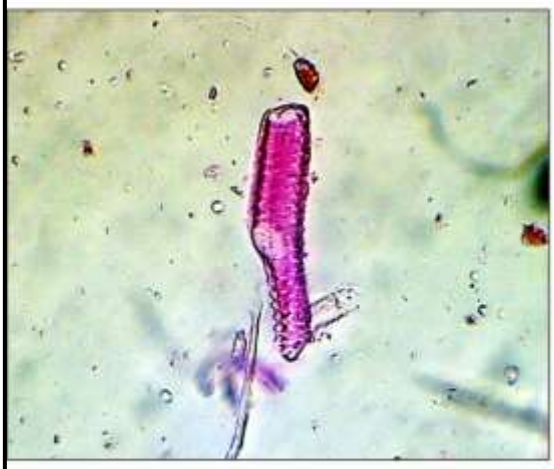

Fig. 1 : 56 × 12µm
Extremly small vessel with
lateral perforation plate

Fig. 2 : 64 × 16µm
Extremly small ligulate vessel
with two perforation plates

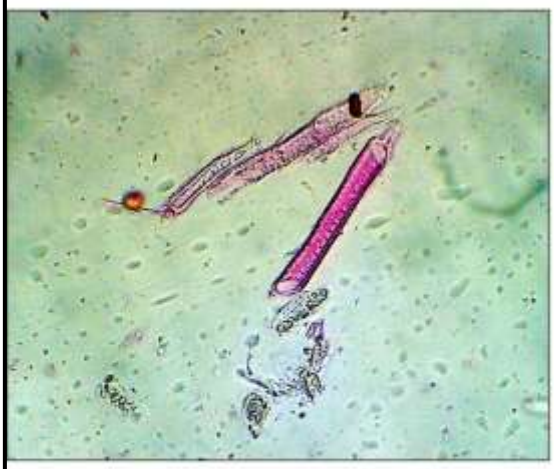

Fig. 3 : 66 × 8 µm
Extremly small ligulate vessel
with two perforation plates

Fig. 4 : 70 × 10 µm
Extremly small vessel
with two perforation plates

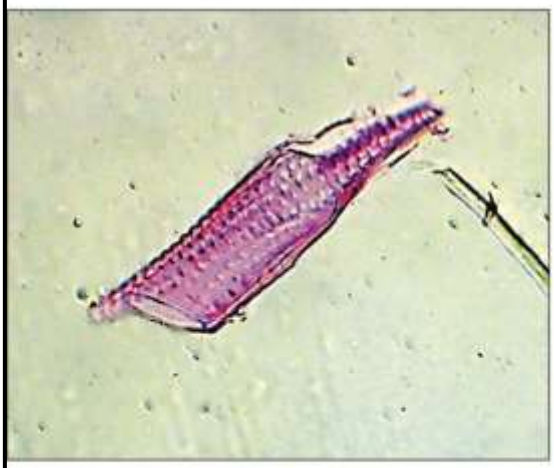

Fig. 5 : 72 × 16 µm
Extremly small ligulate vessel
with lateral perforation plates

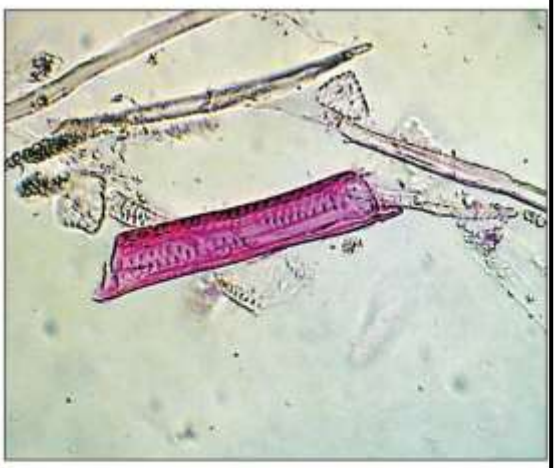

Fig. 6 : 74 × 12 µm
Extremly small vessel with
two perforation plates

Root vessels : *Indigofera parviflora* Heyne ex Wight & Arn.

Plate No. 4

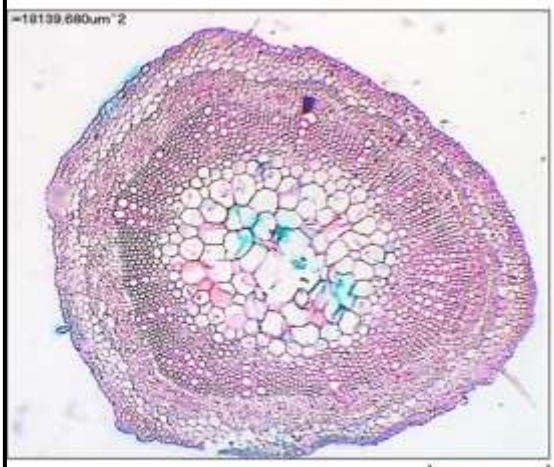

Fig. 1 : Entire view

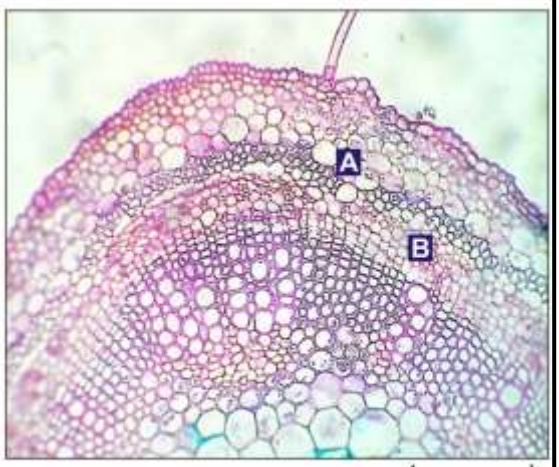

Fig. 2 Cross view
A. Distinct endodermis B. Pericycle

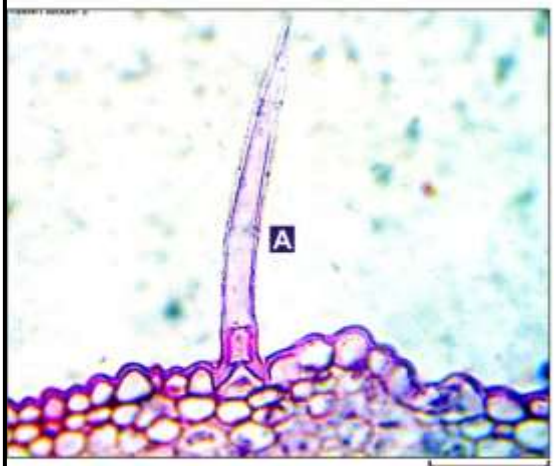

Fig. 3 Epidermis
A. Glandular trichome

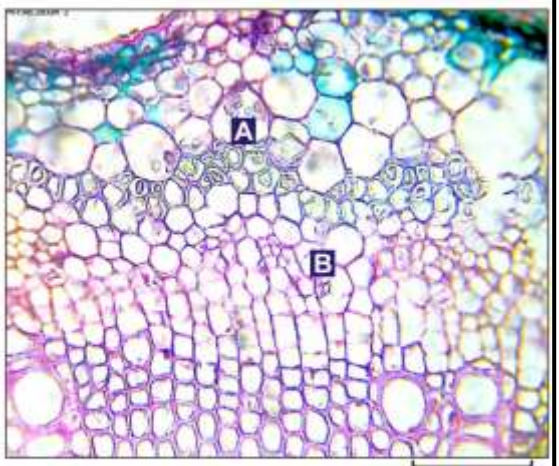

Fig. 4 Cortex
A. Starch grains B. Rhombohedral crystals

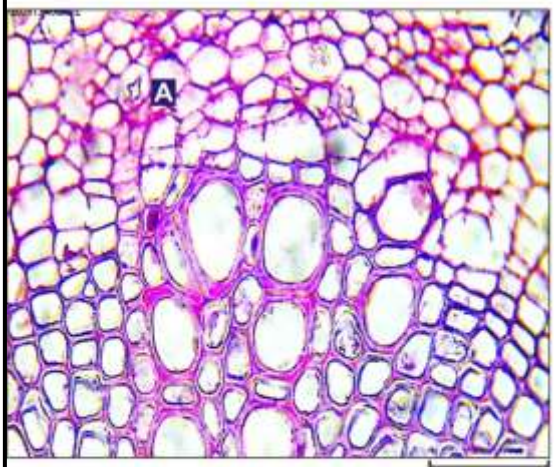

Fig. 5 Xylem vessels
A. Rhombohedral crystals

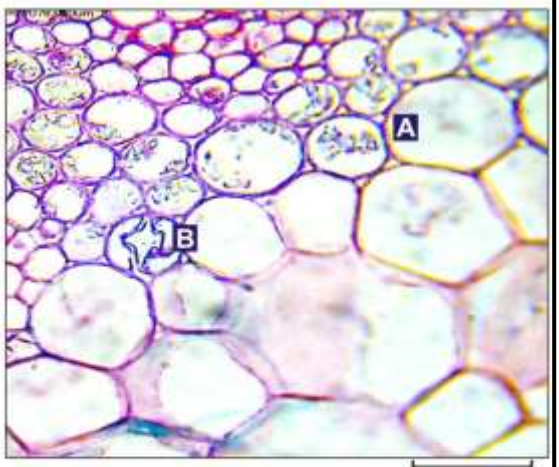

Fig. 6 Pith A. Starch grains
B. Rhombohedral crystals

Primary growth of stem : *Indigofera parviflora* Heyne ex Wight & Arn.

Plate No. 5

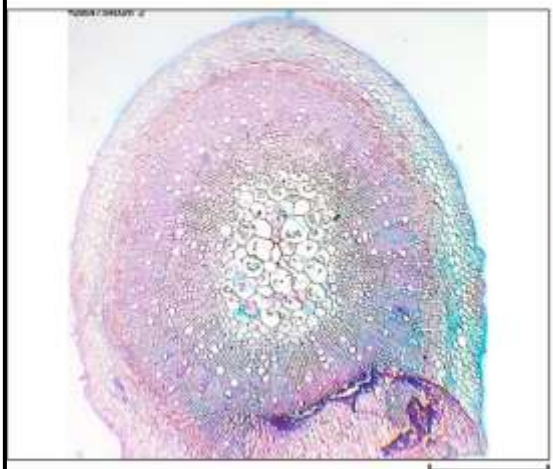

Fig. 1 : Entire view

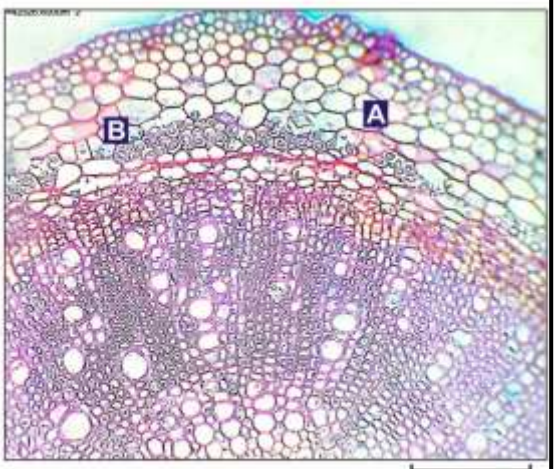

Fig. 2
Cross view
A. Distinct endodermis B. Pericycle

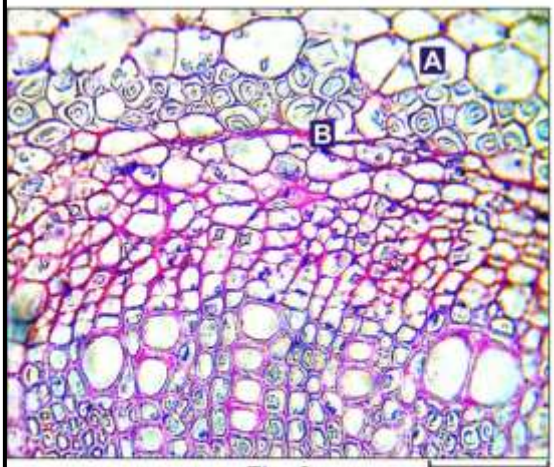

Fig. 3
Cortex
A. Endodermis B. Phloem

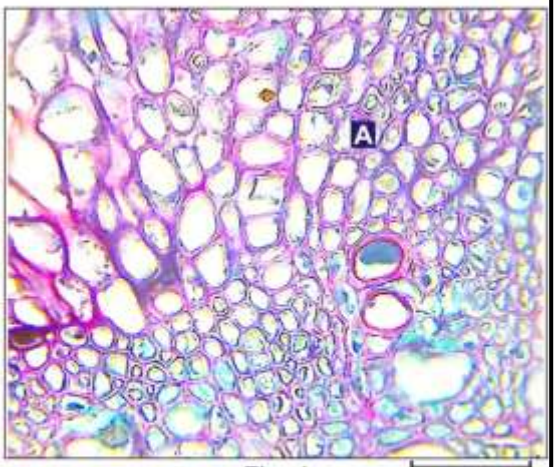

Fig. 4
Xylem vessels
A. Rhombohedral crystal

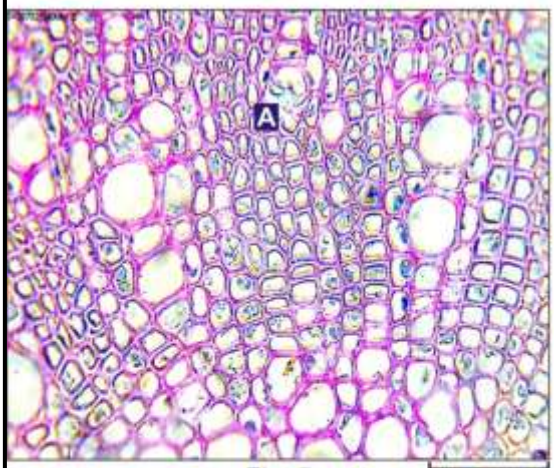

Fig. 5
Rays cells
A. Starch grains

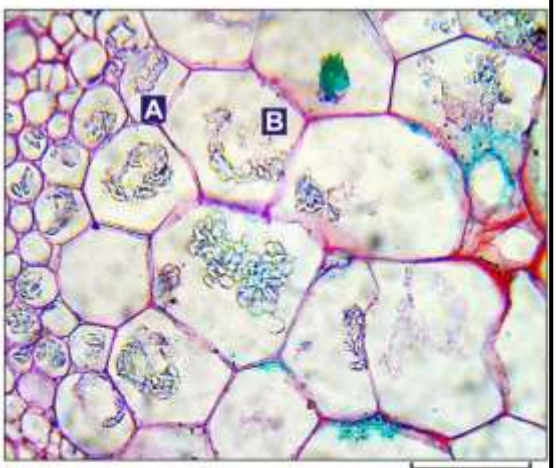

Fig. 6
Pith
A. Rhombohedral crystal B. Starch grains

Secondary growth of stem : *Indigofera parviflora* Heyne ex Wight & Arn.

Plate No. 6

Fig. 1 : 180 x 10 µm
Very Short vessle with
2 perforation plates

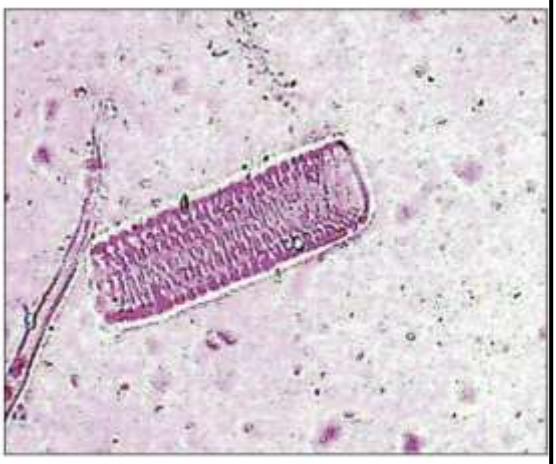

Fig. 2 : 64 × 12µm
Extremly small vessel with
two perforation plates

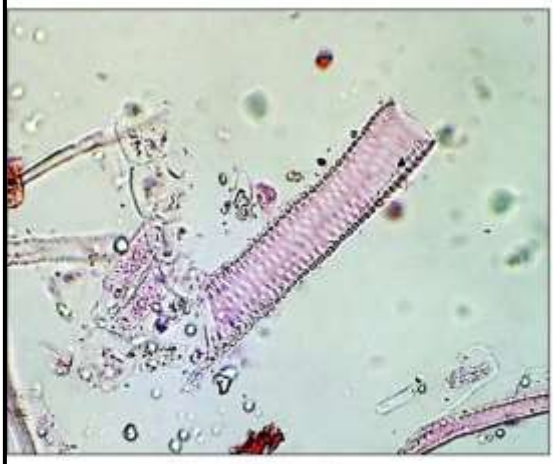

Fig. 3 80 × 16µm
Extremly small vessel with
two perforation plates

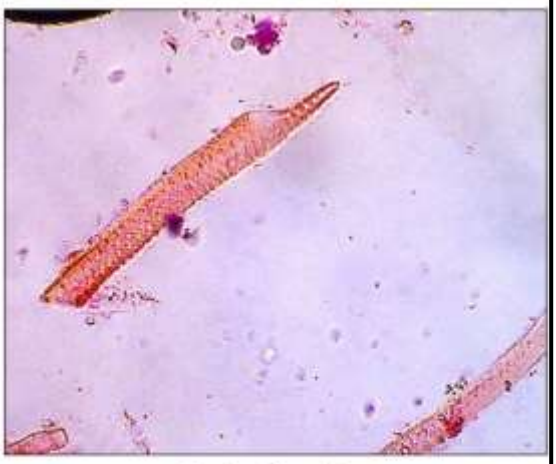

Fig. 4 86 × 10µm
Extremly small ligulate vessel
with two perforation plates

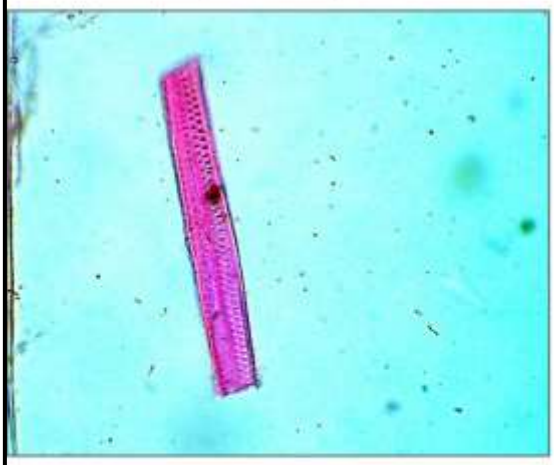

Fig. 5 114 ×,16µm
Extremly small vessel with
two perforation plates

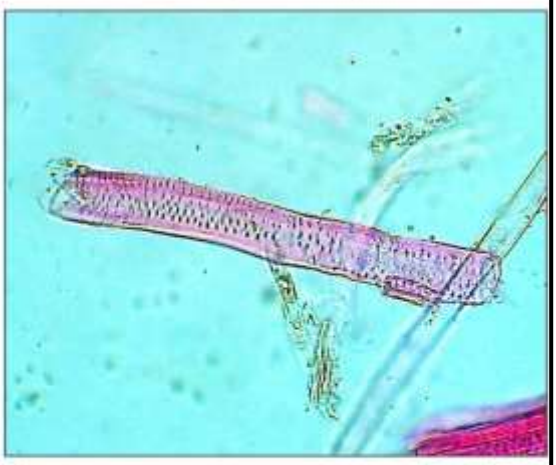

Fig. 6 124 × 14µm
Extremly small vessel with
two perforation plates

Wood Vessels : *Indigofera parviflora* Heyne ex Wight & Arn.

Plate No. 7

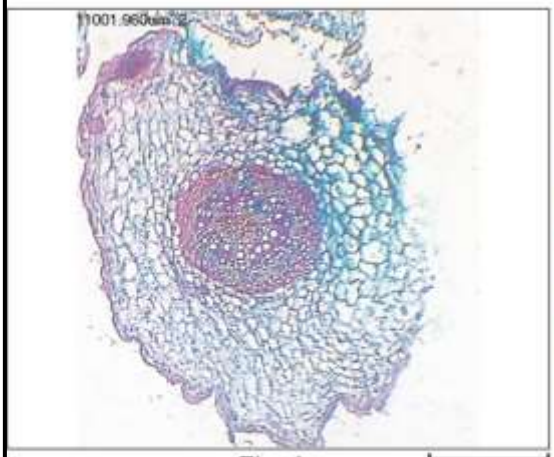

Fig. 1 : Entire view

11001.960 µm²

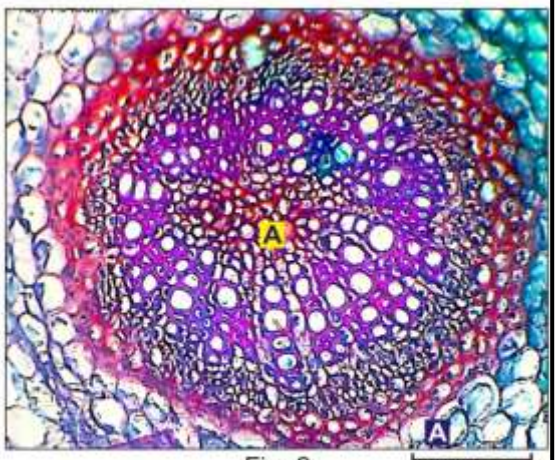

Fig. 2 Vasculature
A. Perivascular sclerenchyma
B. Central thick walled cell

18011.840 µm²

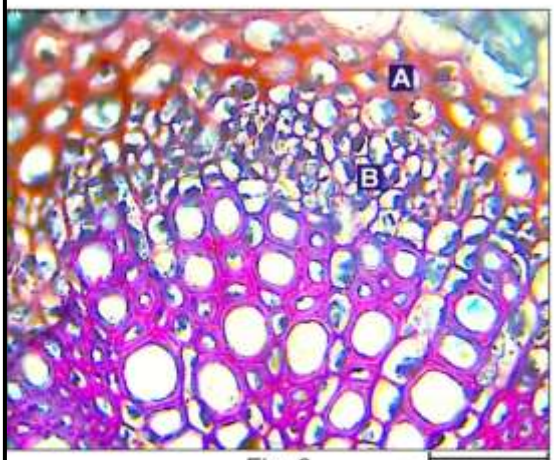

Fig. 3 Phloem
A. Perivascular sclerenchyma
B. Rhombohedral crystals

24780.800 µm²

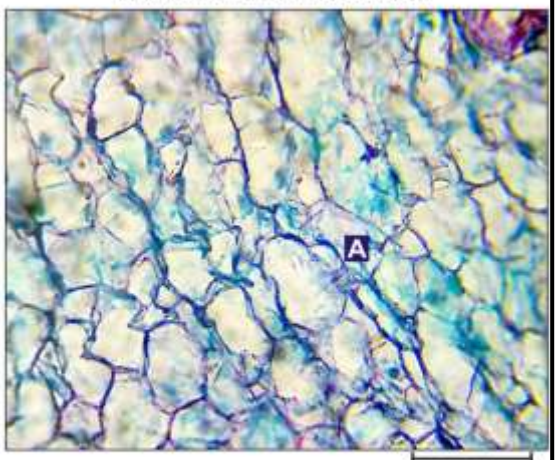

Fig. 4 Ground tissue
A. Irregular shaped

50409.640 µm²

Petiole : *Indigofera parviflora* Heyne ex Wight & Arn.

Plate No. 8

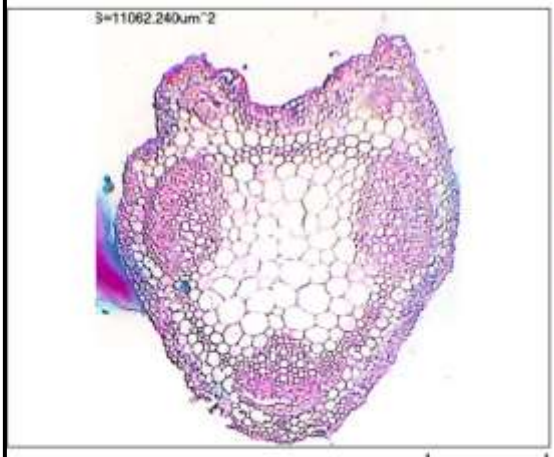

Fig. 1 11062.240 µm²
Entire view

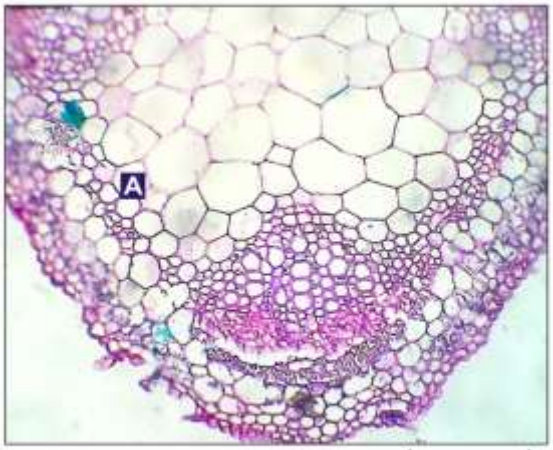

Fig. 2 : 46443.440 µm²
Cross view
A. Perivascular sclerenhyma

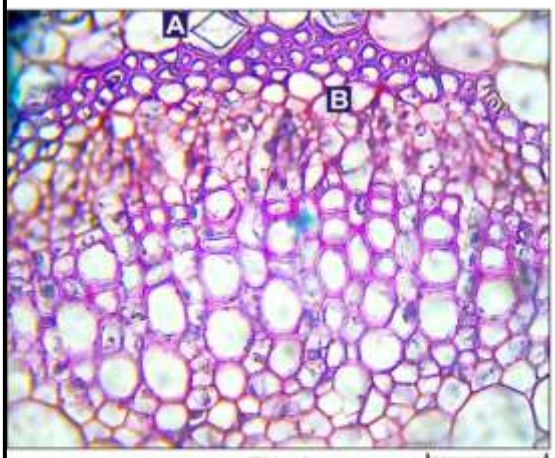

Fig. 3 51551.760 µm²
Vascular bundle
A. Rhombohedral crystal
B. Perivascular sclerenchyma

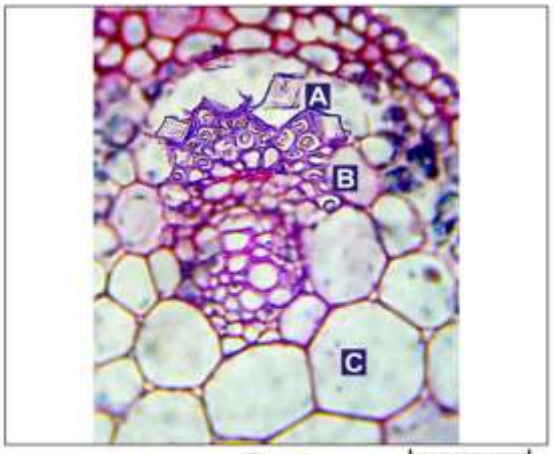

Fig. 4 30435.360 µm²
Wing vascular bundle
A. Rhombohedrak crystal
B. Perivascular sclerenchyma C. Ground tissue

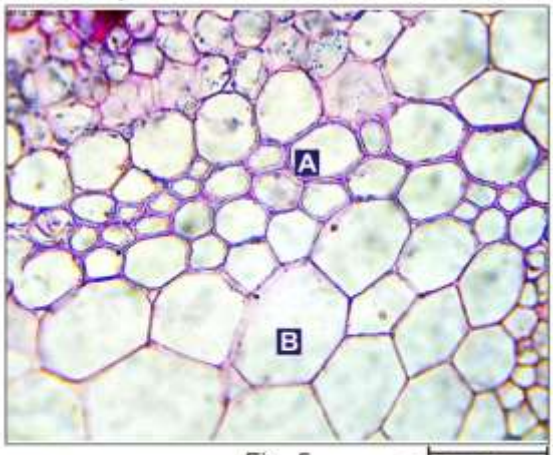

Fig. 5 50118.720 µm²
Central region
A. Perivascular sclerenchyma
B. Ground tissue

Rachis : *Indigofera parviflora* Heyne ex Wight & Arn.

Plate No. 9

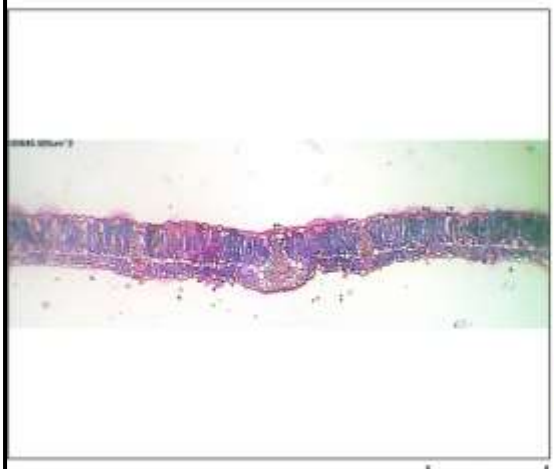

Fig. 1 20545.920 µm²
Entire View

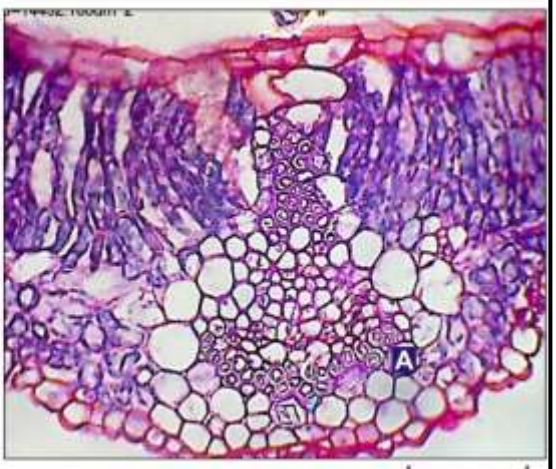

Fig. 2 : 14432.160 µm²
Leaflet midrib
A. Bundle sheath

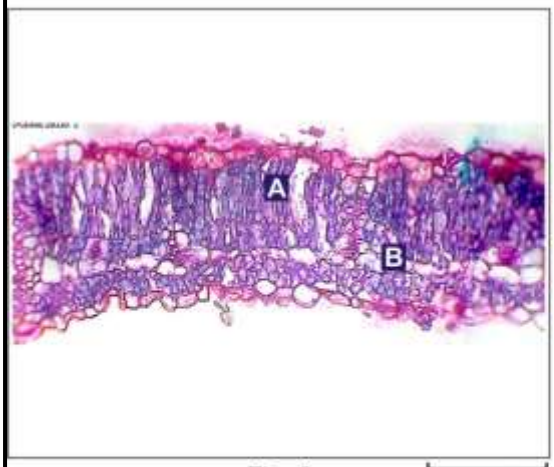

Fig. 3 26486.280 µm²
Leaflet lamina
A. Pigmented cell B. Vein bundle

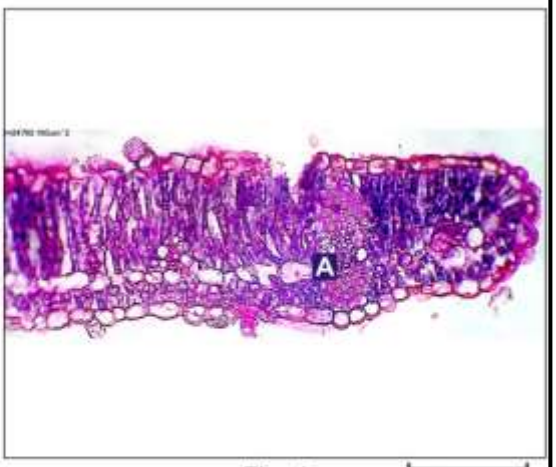

Fig. 4 24780.160 µm²
Leaflet margin
A. Vein bundle

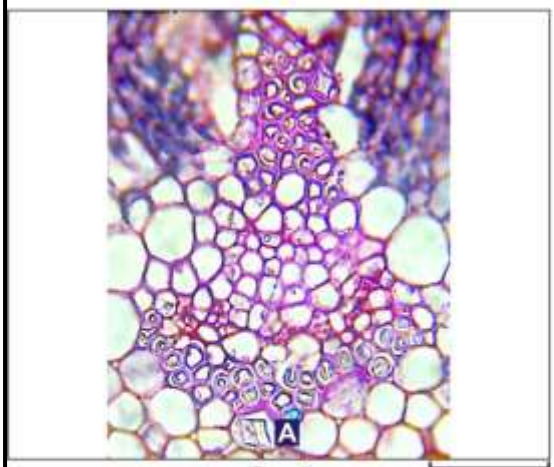

Fig. 5 29271.920 µm²
Bundle sheayh
A. Rhombohedral crystal in phloem

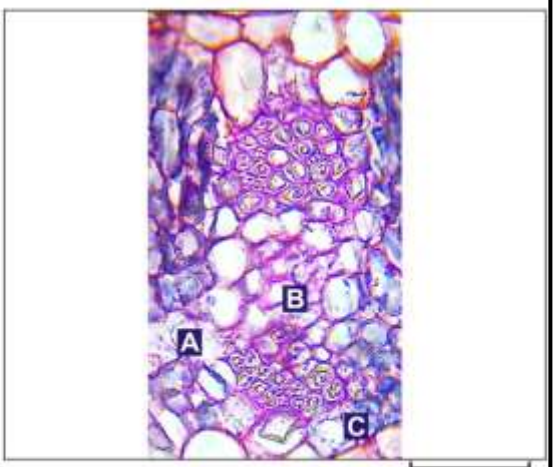

Fig. 6 22370.600 µm²
Vein bundle A. Sclerenchymatous cells
B. Parenchymatous cells C. Rhombohedral

Leaflet : *Indigofera parviflora* Heyne ex Wight & Arn.

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