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Structure of stem and cambial variant in *Spatholobus parviflorus* (Fabaceae)

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स्पैथोलोबस पार्विफ्लोरस (फेबेसी) में तने की संरचना एवं कैम्बियल विभेदन

वी. एस. उषा एवं एल. लुईस जेसूदास

सारांश

स्पैथोलोबस पार्विफ्लोरस एक उष्णकटिबंधीय काष्ठीय आरोही लता है जो कैम्बिया के निर्माण एवं क्रमिक गतिशीलता के कारण असामान्य द्वितीयक वृद्धि दर्शाती है। पैरेनकाइमा कोशिकाओं के समूह के स्केलिरेड फाइबर बैंड के बाहर से कोशा पुर्नविदलन के फलतः कैम्बियल रिंग बनते हैं। स्केलिरेड बैंड मुख्यतः प्राथमिक बार्क फाइबर के मध्य बनता है। निर्मित होने वाला प्रत्येक क्रमिक कैम्बियम सर्वप्रथम स्केलिरेड फाइबर की परत बनाता है, जो कैम्बियम गतिविधि के कारण संवहनी (वेस्कुलर) ऊतक से अलग होती है। ऊपरी परत इपीडर्मिस पेरिडर्म से प्रतिस्थापित होती है। यह पेरिडर्म तने के कुण्डलन होने पर वाहिकाओं को क्षति होने से बचाने में सहायता करता है।

ABSTRACT

Spatholobus parvifloru (DC.) Kuntze. is a tropical woody climber which shows abnormal secondary growth in thickness, due to the formation and activity of successive cambia. By the dedifferentiation of groups of parenchyma cells outside the band of sclereid fibers, the cambial rings are formed. The sclereid band is formed between the primary bark fibers. Each successive cambium first produces a layer of sclereid fibers which separate the vascular tissue produced by cambial activity. The epidermis is replaced by the periderm. This periderm helps the vessel segments to remain undamaged when the woody stem twist around the support.

Keywords: *Spatholobus partiflorus,* cambium, Fabaceae

INTRODUCTION

Spatholobus parviflorus (DC.) Kuntze. is a densely foliacous massive liana in the hills of Western Ghats. Liana differs from other plants in possessing large diameter vessels and abundant soft tissue in the xylem (Carlquist, 1991) although some species are very tree like in their cross section. Having large vessels, lianas compared to trees, have high xylem conducting capacities, high sap flow and transpiration rates, compared to trees (Ewers & al., 1991). Consequently, per unit cross section, liana stem can hydraulically support much larger total leaf area than trees. The difference in allometry helps to explain, how in tropical forest, liana constitute 40% of total forest area (Schnitzer & Bongers, 2002). The abundance of soft tissue in liana stem adds to their flexibility, helps them to avoid mechanical damage and speeds the rate of recovery when damage does occur (Fischer & Evens, 1989, Putz

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and Holbrook, 1991) recovery when does occur (Fisher & Ewers, 1989; Putz and Holbrook, 1991).

The flexibility increases the likelihood of survival, when they fall with their host trees. Consequently, many lianas that proliferate in tree fall gaps are tree resprouts which must have other other physiological consequences but these have apparently not been studied (Zhi-quan Cai, 2007).

In some plants with anomalous growth in thickness the vascular cambium occurs in normal position, but the secondary body shows an unequal distribution of xylem and phloem (Easu, 1965).

Quantity, patterns of distribution and dimensions of xylem and ray parenchyma are important adaptive peculiarities in climbers, whether secondary growth in thickness is 'normal' or 'abnormal'. Also when randomly selected trees and lianas are compared, as observed by Rodriquez (2005), liana vessels are about 3 times larger and about 3.7 times greater in proportion than in tree species.

Though present studies are not extended to any comparison to trees, regarding dimensions and frequency of xylem vessels in climbers *per se*, present results support references to the presence of larger vessels in climbers than in trees, as is observed in *Spatholobus parviflorus* (Metcalfe and Chalk, 1950; Carlquist, 1975 & 1984) in having larger proportion of vessels (Carlquist, 1975 & 1984).

Although liana vessels are considered to be the largest and widest in the plant kingdom (Zimmerman, 1983; Ewers and Fisher, 1989 a, b), there is no experimental evidence to demonstrate a developmental link between the parameters, many variation in vessels dimensions also occurs such as, (1) narrow vessels of smaller length than wider vessels; (ii) the vessel dimensions will increase with the stem age; (iii) and an individual vessel can vary in diameter along its length (Akuchuka, 1987).

Carlquist (1975) refers to the greater proportion of ray tissue in lianas exhibiting normal secondary growth than in other plant forms. Rays and their height seem to be significant when one considers their climbing habit. The ray height seems to be two-to-six times higher compared to the trees.

MATERIALS AND METHODS

An individual of *Spatholobus parviflorus* in Ponmudi covers about 8 to10 trees stretching to a distance of several hundred meters. Vouchers were deposited in Jawaharlal Nehru Botanical Garden and Research Institute Herbarium, Kerala. Analysis of the stem were made with fresh and fixed (FAA) material. The stem was sectioned by hand as well as rotary microtome. The cross sections were stained using safranin and astra blue (manual sections) (Souz & al., 2005) toludine blue (Microtome sections) (Brien & al., 1965), in agreement with usual techniques in plant anatomy (Guerrits 1991). The sections were viewed under polarised light microscope attached with olympus digital camera.

OBSERVATION

External Features (Plate 1.A)

The plant is a densely foliaceous, massive liana in the hills. The branches are softly tomentose.Inflorescences are axillary and terminal panicles. Flowers are whitish purple.

Anatomy of the Stem (Plate 1-3)

The stem has narrow periderm of less than 100 µm in thickness; lenticels are sparsely seen along the periderm zone (Plate 1.B). Cortex is fairly wide and the cells are parencymatous thick walled, compact and tangentially oblong. It is nearly 200 µm in width. The inner boundary of the cortex is a thick perivascular (pericyclic) cylinder of fibers (Plate 1.B). The fiber cylinder is continuous and is up to 100 µm in thickness. It consists of alternate blocks of gelatinous fibers and sclereides. The gelatinous fibers have outer lignified walls and inner cellulosic mucilaginous walls (Plate 3). Secondary phloem zone is wide measuring 400 µm in radial plane. It is differentiated into outer collapsed phloem and inner non collapsed (intact) phloem.

The collapsed phloem consists of dark, tangential lines of crushed obliterated sieve elements, phloem sclerenchyma and dilated cells containing large masses of tannin. The tanniniferous idioblasts are in clusters (Plate 3) and they get reduced in size from periphery to the interior (Plate 2.2). The non-collapsed phloem is a narrow zone of thick clusters of sieve elements (Plate 3).

Secondary xylem is a dense, solid and circular cylinder. No growth rings are evident. The vessels are diffused in distribution; they are either solitary or in short radial multiples of 2-4. The vessels are mostly angular or circular and thin walled (Plate 3). The widest vessel is 100 µm in diameter.

The ground tissue of the secondary xylem comprises of xylem fibres and xylem axial parenchyma, apart from

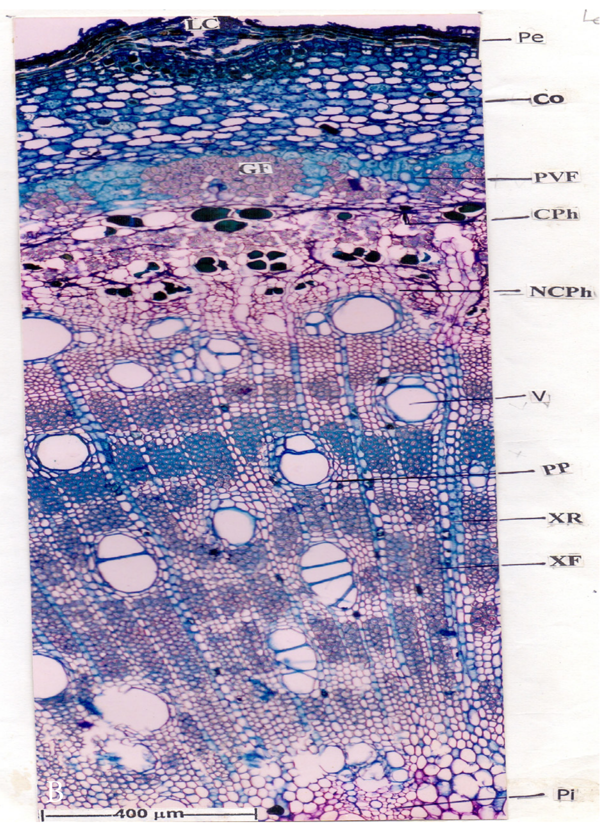

Plate -1: **A.** Habit of *Spatholobus parviflorus;* **B.** Structure of cortex, secondary phloem and secondary xylem.C-cortex, Cp -Collapsed phloem, Le-Lenticels, Pe-Periderm; Pp-Parenchyma Pvf-pericyclic fibers, Neph-Noncollapsed phloem;V-Vessell; Xf-Xylem fibers ; Xr- Xylem ray

the ray parenchyma. Axial parenchyma is abundant, it is paratrachial bearded; it ensheathes the vessels and extend laterally into thin or thick continuous cylinders (Plate-2). The parenchyma cells are thin walled and radially oblong. The xylem fibers are predominantly of gelatinous type with inner mucilaginous walls (Plate-3).

The pith is fairly wide and parenchymatous. The cells are thin walled and compact. Distributed among the pith parenchyma are dilated parenchymatous cells which are filled with dark tannin masses (Plate-3). These tannin bearing cells are similar to those in the secondary phloem.

When the cross section of the stem is viewed under the polarized light microscope, isolated, solitary circular sclereides are seen scattered in the cortex (Plate 1.2). Within the collapsed phloem zones, are seen minute prismatic calcium oxalate crystals. Fairly large rhomboidal crystals are also seen in this perivascular sclerenchymatous zone.

CONCLUDING REMARKS

To conclude, the climbers, especially lianas represent a later stage of plant evolution, as they require trees to support their growth. Adaptation in the anatomy of these plants are (a) marked increase in the incidence of anomalous secondary growth, (b) an increase in vessel diameter and proportion, (c) an increase in both ray size and proportion, (d) a decrease in proportion of fiber, (e) an increase in quantity of phloem elements. In fact, in many of these climbers, the anomalous tissue, in the form of unthickened and unlignified parenchyma makeup the ground mass of "woody" stem. Also significant is the increased conductive capacity of the stems of climbers as a consequence of the increased diameter and proportion of vessels.

The adaptive significance of increased rays is worthy of mention. As the walls between rays and vessels are invariably profusely pitted, the most obvious functional adaptation of high rays would appear to facilitate axial conduction by providing additional inter vessel pathways. Because many cells overlap axial cells, increased ray size could provide strength in the radial direction, of course, an advantage of stem of a climber or any weak- stemmed plant, in view of considerable bonding to which such flexible structures are subjected to

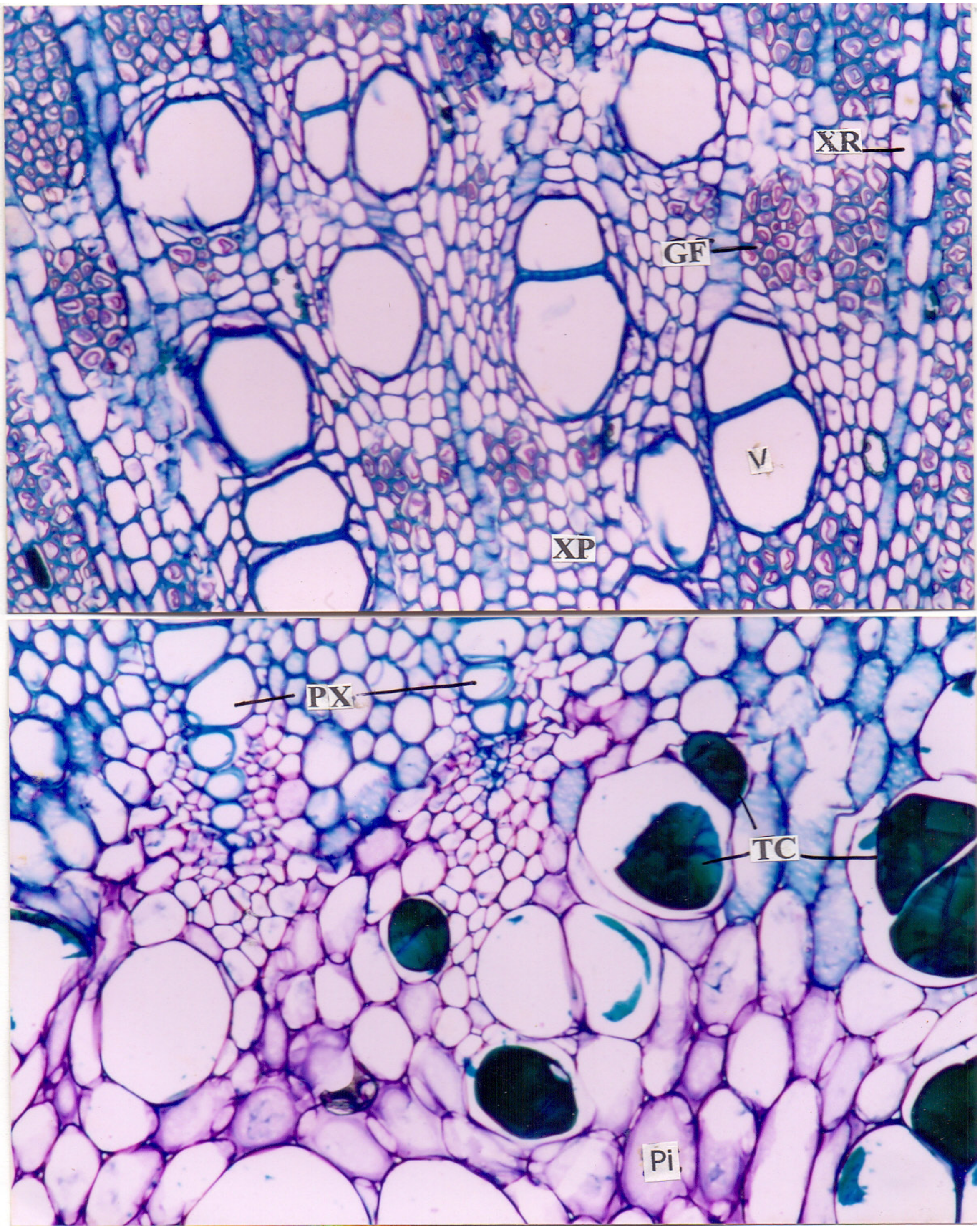

Plate-2: Secondary xylem pith enlarged. Gf- Gelatinous fibers; Pi-Pith, Px-Primary xylem, Tc-Tanniniferous cells, V. Vessel, Xp Xylem parenchyma, Xy-xylem ray.

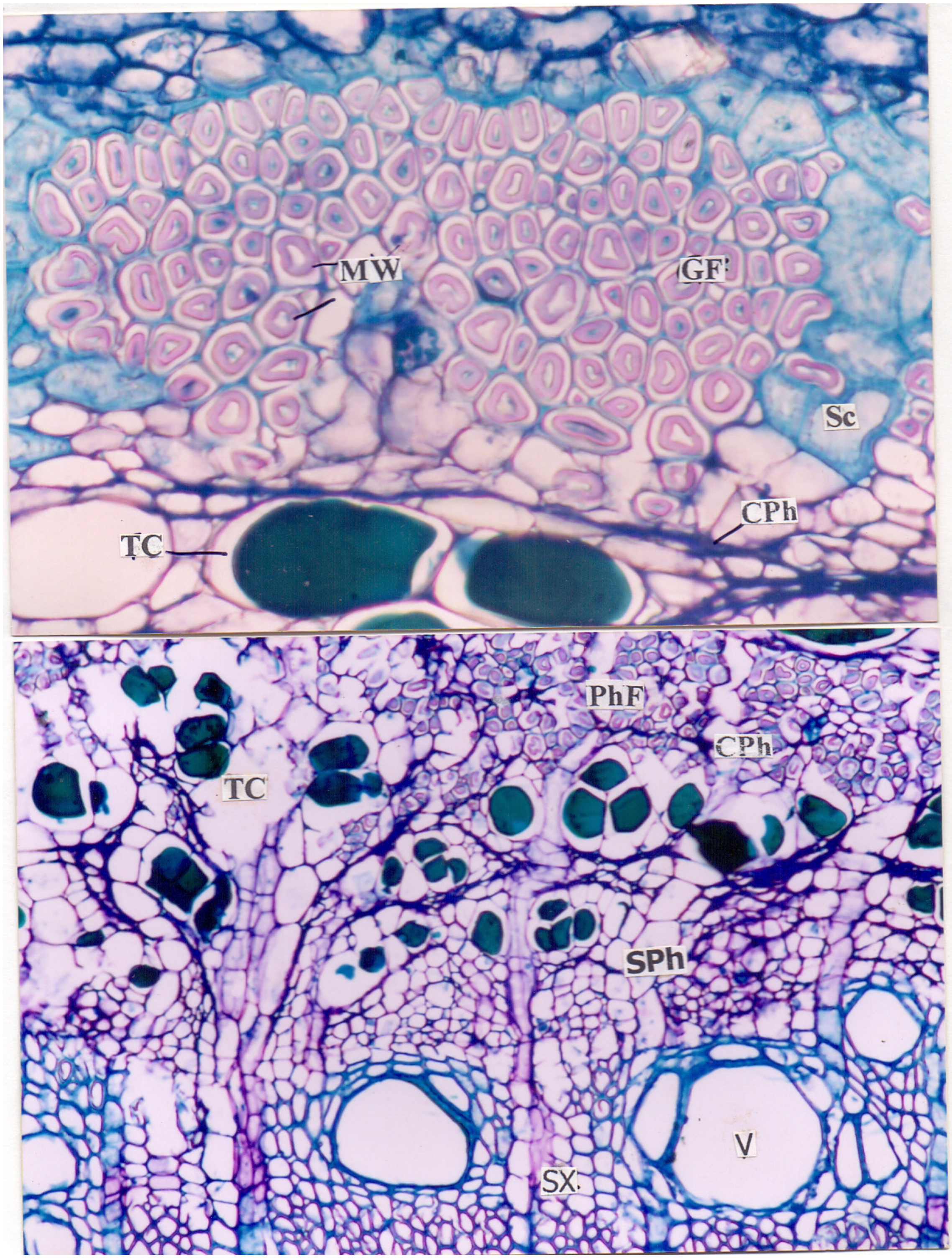

Plate-3: Structure of gelatinous fibers and Tanniferous cells.Gf-Gelatinous fibers, Cph-Collapsed phloem; Phf-Phloem fibers; Sc-Sclerides;Sph-Secondary phloem ; Sx-Secondary xylem; Mw-Mucilagewall; Tc-Tanincells; V-Vessel

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