ISSN 0376-5561
Geophytology 46(2): 105-111
November 2016

Anatomical traits of the Coral Vine - *Antigonon leptopus* Hooker & Arnott of the family Polygonaceae

Manju Sahney* and Vibhasa

Department of Botany, University of Allahabad, Allahabad - 211002, U.P. India
*Corresponding author's email: msahney.au@gmail.com

Manuscript received : 14 July 2016
Accepted for publication : 24 September 2016

ABSTRACT

A detailed anatomical investigation on *Antigonon leptopus* was done to determine the diagnostic traits of root, tendril, petiole, leaf and stem. *Antigonon leptopus* is a shrubby climber characterized by the presence of tendrils and root tubers. All the aerial parts of *Antigonon leptopus* show presence of two types of hairs and glandular trichomes (peltate glands). Presence of intraxylary phloem is a characteristic feature of the stem, petiole and tendril. Root is tetrarch and shows presence of large patches of fibres outside the secondary vascular tissues. Findings are correlated with the habit of the plant.

Key-words: Anatomy, intraxylary phloem, hairs and peltate glands, calcium oxalate crystals

INTRODUCTION

The genus *Antigonon leptopus* Hooker & Arnott popularly known as coral vine or Mexican creeper is a native of Mexico and Central America. It is cultivated as an ornamental plant in India. *Antigonon leptopus* belongs to the family Polygonaceae. Polygonaceae is a small family comprising of 43-46 genera and 1100-1200 species distributed worldwide especially in northern temperate hemisphere (Michael & Simpson 2010). Polygonaceae consists mostly of herbs but also includes shrubs, small trees and climbers. *Antigonon leptopus* is a shrubby climber with pink, red or white flowers and is characterized by presence of tendrils and absence of ocrea.

Some of the anatomical characters of aerial parts of *Antigonon leptopus* have been reported in the anatomical descriptions of family Polygonaceae (Solereder 1908, Metcalfe & Chalk 1950). Carlquist (2003) presented anatomical data for woods of family Polygonaceae. Further investigations on *Antigonon leptopus* were aimed at the origin and function of cambial variant (Rao & Rajput 2000) and on the epidermal characters of leaf (Ayodele & Olowokudejo 2006). Primary anatomical structure of the young stem of *Antigonon leptopus* has been investigated by Sahney and Shukla (2013). However, no anatomical information on other vegetative parts viz., tendril, leaf, petiole, root and tubers is available. Thus, the present investigation on *Antigonon leptopus* has been undertaken to present a detailed anatomical description of leaf, petiole, tendril, root, tuber and old stem. Such anatomical investigations are important in establishing the botanical identity of plant or plant parts. Mode of secondary growth and anatomical features of the wood have also been investigated and correlated with those of stem and habit of plant.

MATERIAL AND METHODS

Fresh material of *Antigonon leptopus* was collected from the plants growing in the Roxburgh Botanical Garden, University of Allahabad and in other localities of Allahabad (25°27'56.84"N, 81°51'37.20"E). For anatomical studies, samples of root, tendril, petiole, leaf and stem were cut into small

© The Palaeobotanical Society, Lucknow, India

pieces and fixed in a mixture of Formaldehyde-Acetic acid-Alcohol (Berlyn & Miksche 1976). Both microtome and hand sections were prepared. For microtomy, the materials were dehydrated in Tertiary Butyl Alcohol (TBA) series. The dehydrated material segments were gradually infiltrated with paraffin wax (58°C) for one to three days and finally embedded in paraffin wax. Transverse and longitudinal sections (15-20 μm thick) of the embedded materials were obtained using rotary microtome (MT-1090A), stained with safranin and fast green and mounted in canada balsam (Johansen 1940). Small pieces of stems and roots were macerated using Jaffrey's method (Johansen 1940). For the measurement of vessels and xylem fibres, thirty random measurements were taken using an ocular micrometer scale to obtain the mean. Olympus binocular compound microscope (CX2i, with camera attachment) has been used to investigate the anatomy and for photography.

RESULTS

Stem

Stem of *Antigonon leptopus* shows five large and five small vascular bundles which alternate with each other and show presence of intraxylary phloem. During secondary growth in the stem, the secondary vascular tissues are formed in the fascicular region only (Plate 1, Fig. A). Relatively old stem shows presence of second ring of vascular bundles below the pericyclic sclerenchyma. Another concentric ring of vascular bundles is formed in much older stem (Plate 1, Fig. B). Secondary xylem is composed of dimorphic vessels, vasicentric tracheids, fibriform vessels, nucleated fibres, axial and ray parenchyma cells (Plate 1, Figs. C-E). Vessels are mostly solitary, sometimes in groups of two to three. Vessel elements are 75-170μm in length and 35-150μm in diameter. Perforation plate is simple on the transverse end walls, occasionally sub-terminal. Fibriform vessels are 5-8-13μm in diameter with tapering ends and subterminal perforation plate, which appear on lateral wall. The intervascular pits are alternate. Calcium oxalate crystals are present. Secondary phloem is composed of sieve tube elements, companion cells and parenchyma cells. Sieve plates are simple, slightly oblique to transverse.

Leaf

The epidermis is single layered and is covered by a thin layer of cuticle. Stomata are amphistomatic and anomocytic. Epidermis shows presence of hairs (unicellular and multicellular) and glandular trichomes (peltate glands). Glandular trichomes have small stalk and peltate head. Peltate head is divided by vertical walls (Plate 1, Fig. I). Midrib and lamina regions are very distinct. Upper epidermal cells are 22-75μm in lamina region and 7-25μm in midrib region. Cells of lower epidermis are 17-50μm in lamina region and 5-15μm in midrib region. In lamina, mesophyll cells are differentiated into palisade and spongy parenchyma. Palisade parenchyma present below the upper epidermis consists of two to four layered vertically elongated cells. Spongy parenchyma lies below the palisade parenchyma and show loosely arranged cells. In midrib region below the epidermis, 4 to 6 layers of collenchyma cells are present on the adaxial side. Vascular bundles are collateral and endarch. One large vascular bundle is present on the adaxial side, which is opposed by smaller bundles of the abaxial side forming a ring (Plate 1, Fig. F). Calcium oxalate crystals (druses and styloids) are present in the leaf. Druses show variation in size (10-27.5 μm).

Petiole

Epidermis is covered by a thin layer of cuticle and consists of compactly arranged radially flattened cells as seen in transverse section. Epidermis shows presence of two types of hair (unicellular and multicellular) and glandular trichomes (peltate glands). Next to epidermis are two to four layers of collenchyma. Ground tissue is parenchymatous and shows presence of calcium oxalate crystals (druses and styloids). Vascular bundles (usually 10 in number) are arranged in an arc and two large vascular bundles (sometime united into one bundle) are present in somewhat middle position on adaxial side. Thus, the arc is converted into a ring (Solereder 1908, Metcalfe & Chalk 1950). Some of the bundles of the arc are of unequal size, while some bundles are not fully differentiated. Vascular bundles are collateral and endarch, show presence of intraxylary phloem (Plate 1, Fig. G).

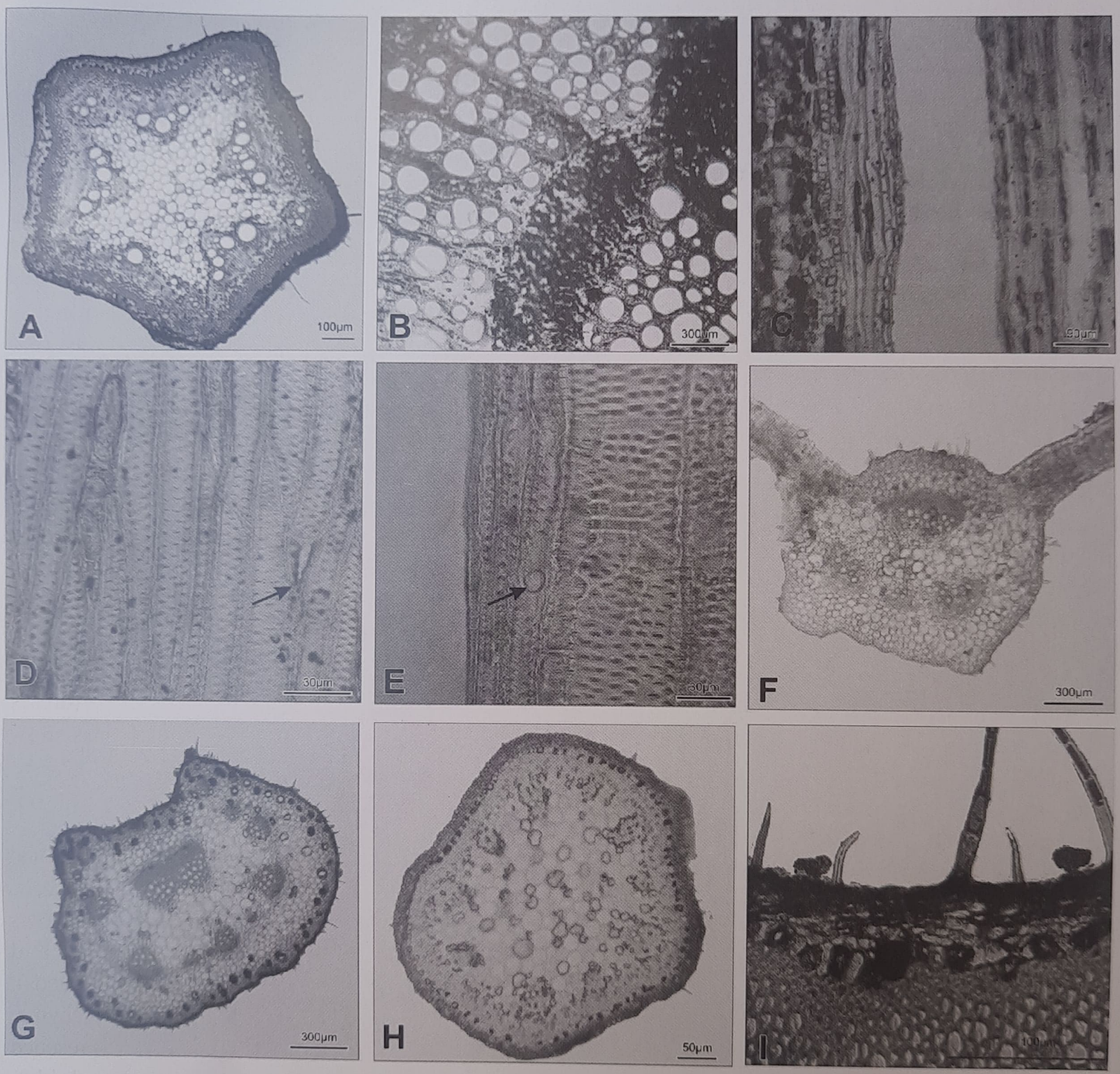

Plate 1

A. Transverse section of stem showing five large and five small vascular bundles alternate with each other., B. Transverse section of old stem showing successive ring of cambia., C. TLS of stem showing a wide vessel and uniseriate xylem rays. D. TLS of stem showing vascular tracheids (arrow), E. TLS of stem showing fibriform vessel (with simple perforation plate – arrow) and a wide vessel with alternate pits. F. Transverse section of leaf showing vascular bundles, G. Transverse section of petiole, H. Transverse section of tendril, I. Magnified portion showing hairs and peltate glands.

Tendril

The epidermis is single layered, covered by a thin layer of cuticle. Epidermis shows presence of stomata, hairs (unicellular and multicellular) and glandular trichomes (peltate glands). Cortex is narrow, three to four cells wide. Endodermis is single layered and pericycle is sclerenchymatous. Vascular bundles are ten in number. Some of the bundles are not fully differentiated, only phloem is seen. Fully developed vascular bundles show presence of intraxylary phloem. Pith is parenchymatous with intercellular spaces and shows presence of calcium oxalate crystals i.e., druses and styloids (Plate 1, Fig. H).

Root and Tuber

Transverse section of young root shows single layered epidermis with unicellular hairs. The cortex consists of eight to ten layers of parenchyma cells with intercellular spaces. Endodermis is distinguishable by its large cells. Pericycle is parenchymatous and single layered. Young root (at seedling stage) shows four well developed and one under developed xylem strands with five alternate strands of phloem (Plate 2, Figs. A & B). However, a mature root is tetrarch (Plate 2, Figs. C & D). Pith is well developed at young stage (Plate 2, Fig. C). In mature root, the vascular cylinder is solid without pith. Secondary xylem is composed of vessels, fibres, parenchyma and thin medullary rays. Vessels are mostly solitary, occasionlly in radial multiples of 2 to 4. The individual vessel elements are oval to circular in outline, 50-145µm in length and 15-95µm in diameter. Perforation plate is simple on the transverse end walls. In the old roots, outside the vascular cylinder, large fibrous patches with small strands of vascular bundles are seen (Plate 2, Figs. E-I). Fibres are 200-580 µm in length. Secondary phloem is composed of sieve tube elements, companion cells and parenchyma cells. Periderm is formed in the old root. Phellem is two to three layered. Its cells are dark coloured, crushed and sometimes broken. Secondary cortex is parenchymatous.

A transverse section of the tuber shows enormous increase in parenchyma tissues. The vascular cylinder is divided into four parts separated by broad parenchymatous rays and pith in the centre. Fibrous patches are divided into small patches separated by parenchyma (Plate 2, Fig. K).

In the old root as well as in the tuber, tannin and calcium oxalate crystals (styloids) are frequently observed in the parenchymatous cells (Plate 2, Figs. J-L).

DISCUSSION

The present work provides a detail anatomical description of vegetative parts of the shrubby climber *Antigonon leptopus*, which includes leaf, petiole, tendril, root, tuber and old stem also.

Our findings on the vegetative parts of *Antigonon leptopus* are in agreement with the previous description (Solereder 1908, Metcalfe & Chalk 1950, Carlquist 2003, Rao & Rajput 2000, Sahney & Shukla 2013). Previously reported features like presence of hairs and glandular trichomes, calcium oxalate crystals, presence of simple perforation plate in the vessels, alternate pits (Solereder 1908, Metcalfe & Chalk 1950, Sahney & Shukla 2013) and successive cambia (Carlquist 2003, Rao & Rajput 2000) have also been observed in the present work.

All the aerial parts of plant viz., tendril, petiole and leaf are characterized by the presence of two types of epidermal appendages i.e., hair and glandular trichomes (peltate glands) and two types of calcium oxalate crystals i.e., druses and styloids. Hairs and glandular trichomes are present in abundance in the aerial region. The glandular trichomes secrete mucilage along with the hook-like hairs may help the plant to climb.

Petiole and tendril of *Antigonon leptopus* show presence of intraxylary phloem. The stem of *Antigonon leptopus* also has intraxylary phloem (Carlquist 2003, Sahney & Shukla 2013). All the vascular bundles do not show full development in the tendril and petiole. Some of the bundles are represented by phloem only. This feature has also been reported in the young stems of *Rumex dentatus* (Joshi 1936), *R. hastatus* (Sahney & Vibhasa 2012) and *Antigonon leptopus* (Sahney & Shukla 2013).

Antigonon leptopus is a shrubby climber which shows secondary wood. During secondary growth in the stem the secondary vascular tissues are formed in the fascicular region only. Old stem shows presence of

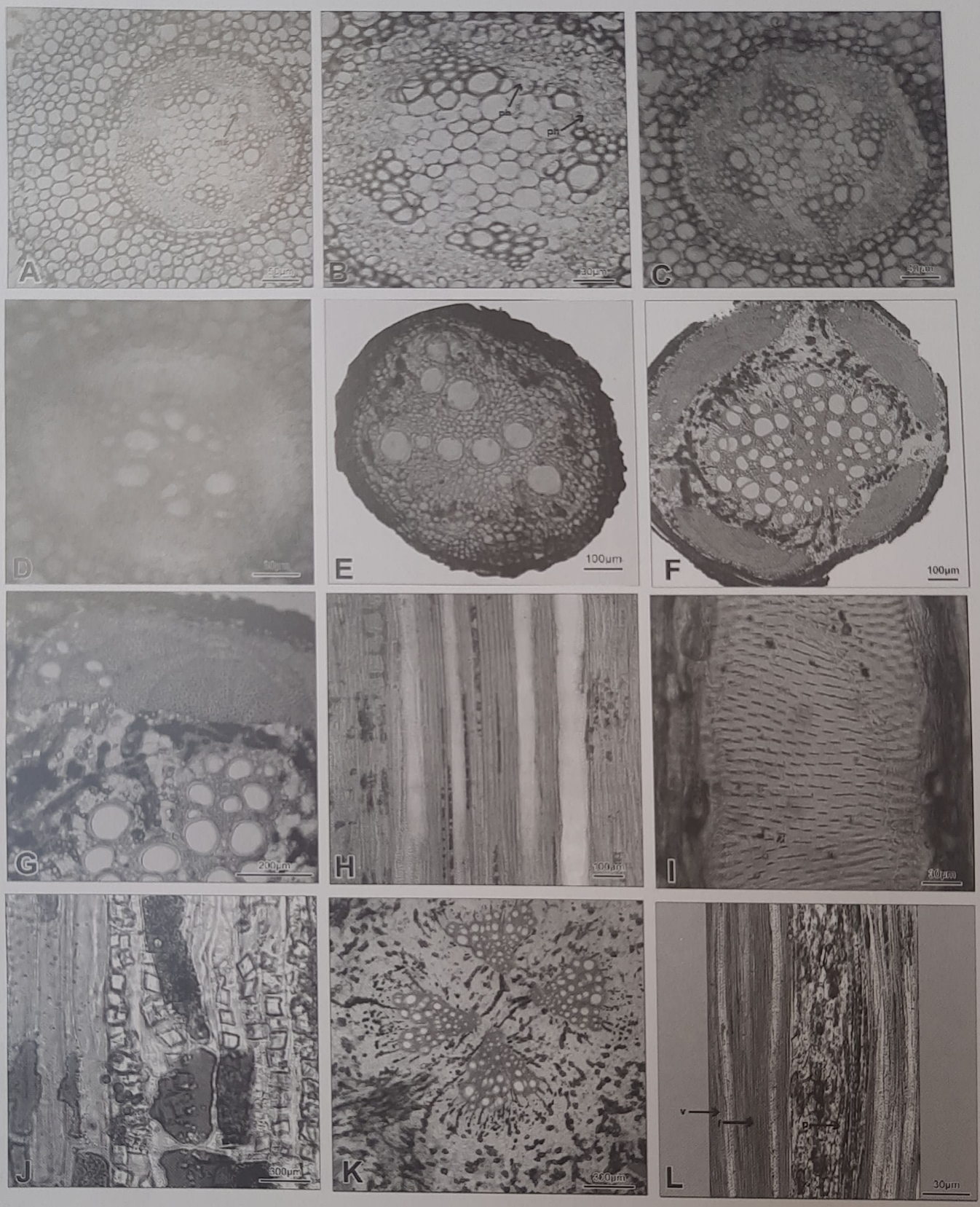

Plate 2

Antigonon leptopus – Root (A to G - Transverse section, H to J - longitudinal section) and tuber (K - Transverse section, L - longitudinal section). A. Root at seedling stage showing fifth xylem strand (arrow), B. Magnification portion of pith of seedling stage showing four well developed and one undeveloped xylem strand with five alternate strands of phloem (arrow). C. Young root showing four xylem strands, D. Root showing tetrarch condition, E. F. G. Old root showing secondary vascular tissues and fibres, H. Old root showing vessels and fibres in longitudinal section, I. Magnified portion of vessel, J. Old root showing calcium oxalate crystals in longitudinal section, K. Tuber showing abundent parenchyma and small patches of fibres, L. Tuber showing vessels, fibres and calcium oxalate crystal. Abbreviations: ph-phloem, p-parenchyma, f-fibre, v-vessel.

second and third ring of vascular bundles below the sclerenchymatous pericycle. The second ring of vascular bundles has been formed due to the activity of lateral meristem originated in the parenchyma region of pericycle (Solereder 1908, Carlquist 2003, Pfeiffer 1926) or of cortex (Rao & Rajput 2000). Pfeiffer (1926) cited *Antigonon leptopus* as an excellent example of successive cambia (Carlquist 2003).

Transverse section of an old stem of *Antigonon leptopus* shows concentric rings of vascular bundles (separated by narrow medullary rays) formed by the activity of successive cambia. This results in the formation of alternating bands of lignified xylem elements and soft phloem tissue. The intermixing of hard and soft tissues enhances flexibility of the climbing woody axis of *Antigonon leptopus*.

Our findings on the secondary xylem are in agreement with Carlquist (1985, 2003)who reported occurrence of dimorphic vessels and vasicentric tracheids in the wood of *Antigonon leptopus*. He mentioned about the diameter (average-10µm) of the narrow vessel elements (Carlquist 2003). Narrow vessels in the secondary xylem of *Antigonon leptopus* reported in the present work (average ~ 8µm) have pointed ends with subterminal laterally placed perforation plate. Thus, for such vessels the term fibriform vessel has been used in the present work.

Root at seedling stage has four well developed and one under developed xylem strands which alternate with five phloem strands. It may be mentioned here that young stem has ten bundles of which two are under developed and are represented by phloem only (Sahney & Shukla 2013). Thus, the root shows half the vascular bundle strands as compared to those of the stem. It is known from the studies on root-stem transition that continuous strands of xylem and phloem are produced in the root-stem axis. In the stem their number may remain the same or may be doubled or reduced to half (Artschwager 1926, Crooks 1933, Esau 1965, Hayward 1938, Mauseth et al. 1985, Pyykko 1974, Scheirer & Hillson 1973, Sundberg 1983).

The root wood shows absence of vessel dimorphism and has vessels which are narrow in diameter as compared to those of the stem wood. Wide vessels of liana stem compensate for the narrow stems by enhancing conductive efficiency per stem xylem cross sectional area (Ewers et al. 1990, 1991, 1997, Fisher & Ewers 1995). However, wide vessels are in danger of being damaged when twisting of liana stem occurs. In such condition small vessels along with fibriform vessels may help in conduction.

In the old root, presence of large patches of fibres with small vascular bundles outside the first formed secondary vascular tissue is the most characteristic feature. The origin of fibrous patches with vascular tissues may be similar to the formation of second ring of vascular bundle in the stem of *Antigonon leptopus*.

The findings of the present study fill the gaps in the knowledge of the anatomy of *Antigonon leptopus*. Presence of two types of epidermal appendages (hairs and glandular trichomes) and calcium oxalate crystals (druses and styloids) in the aerial parts of plant (stem, tendril, petiole and leaf), presence of intraxylary phloem in stem, petiole and tendril, alternate arrangement of five small and five large vascular bundles below ridges and furrows respectively, in stem and formation of concentric rings of secondary vascular bundles and large patches of fibres in old stem and root respectively, are the diagnostic anatomical traits of *Antigonon leptopus* which can serve as a possible tool for establishing botanical identity of the plant or plant part.

Further, presence of hairs and glandular trichomes, dimorphic vessels, concentric rings of secondary vascular tissues and presence of wider vessels in stem axis than those of root are the features which can be correlated with the climbing habit of the *Antigonon leptopus*.

ACKNOWLEDGEMENTS

We are thankful to the Professors Nupur Bhowmik and D.K. Chauhan, Department of Botany, University of Allahabad, for their helpful suggestions.

REFERENCES

Artschwager E. 1926. Anatomy of the vegetative organs of the sugar beet. Journal of Agricultural Research 33: 143-176.

Ayodele A.E. & Olowokudejo J.D. 2006. The family Polygonaceae in West Africa: taxonomic significance of leaf epidermal characters. South African Journal of Botany 72: 442-459.

Berlyn G.P. & Miksche J.P. 1976. Botanical Microtechnique and Cytochemistry. The Iowa State University, Press. Ames, Iowa. pp. 326.

Carlquist S. 1985. Observation on functional wood histology of vines and lianas: vessel dimorphism, tracheids, vesicentric tracheids, narrow vessels and parenchyma. Aliso. 11: 139-157.

Carlquist S. 2003. Wood anatomy of Polygonaceae: analysis of a family with exceptional wood diversity. Botanical Journal of the Linnean Society 141: 25-51.

Crooks D. M. 1933. Histological and regenerative studies on the flax seedling. Botanical Gazette 95: 209-239.

Esau K. 1965. Vascular differentiation in plants. Holt, Rinehart and Winston: New York. USA. pp. 160.

Ewers F.W., Fisher J.B. & Chiu S.T. 1990. A survey of vessel dimensions in stems of tropical lianas and other growth forms. Oecologia 84: 544-552.

Ewers F.W., Fischer J.B. & Fichtner K. 1991. Water flux and xylem structure in vines. In: The biology of vines Putz F.E. & Mooney H.A. (eds). Cambridge University Press, Cambridge, UK 13: 127-160.

Ewers F.W., Carlton M.R., Fisher J.B., Kolb K.J. & Tyree M.T. 1997. Vessel diameters in root versus stem of tropical lianas and other growth forms. IAWA Journal 18: 261-279.

Fisher J.B. & Ewers F.W. 1995. Vessel dimensions in lianas and tree species of *Gnetum* (Gnetales). American Journal of Botany 82: 1350-1357.

Hayward H.E. 1938. The Structure of Economic Plants. Mac-millan: New York, USA. pp. 295.

Johansen D.A. 1940. Plant Microtechnique, MacGraw-Hill, New York, USA. pp. 523.

Joshi A.C. 1936. The anatomy of *Rumex* with special reference to the morphology of the internal bundles and the origin of the internal phloem in the Polygonaceae. American Journal of Botany 23: 362-369.

Mauseth J.D., Montenegro G. & Walckowiak A.M. 1985. Host infection and flower formation by the parasite *Tristerix aphyllus* (Loranthaceae). Canadian Journal of Botany 63: 567-581.

Metcalfe C.R. & Chalk L. 1950. The Anatomy of the Dicotyledons, Oxford: Clarendon Press, 2, pp. 1207.

Michael G. & Simpson 2010. Plant Systematics. Elsevier Academic Press, 2, pp. 752.

Pfeiffer H. 1926. Das abnorme Dickenwachstum. Handbuch der Pflanzenanatomie 9(2): Berlin: Gebruder Borntraeger, pp. 1-272.

Pyykko M. 1974. Developmental anatomy of the seedling of *Honkenya peploides*. Annales Botanici Fennici 11: 253-261.

Rao K.S. & Rajput K.S. 2000. Cambial variant in the stem of *Antigonon leptopus* (Polygonaceae). Phyton (Horn, Austria) 40: 201-208.

Sahney M. & Shukla V. 2013. On the stem anatomy of *Antigonon leptopus* H. and A. (Polygonaceae). Phyton (Horn, Austria) 53(1): 163-168.

Sahney M. & Vibhasa 2012. Stem anatomy of medicinally important *Rumex hastatus* D. Don (Polygonaceae). Research Journal of Agriculture Biological Science 8(2): 154-157.

Solereder H. 1908. Systematic Anatomy of the Dicotyledons. Oxford, Clarendon Press, 2, pp. 669-674.

Scheirer D.C. & Hillson C.J. 1973. The vascular transition region of *Helianthus annuus*. I. Bilateral and unilateral patterns of differentiation. American Journal of Botany 60: 242-246.

Sundberg M.D. 1983. Vascular development in the transition region of *Populus deltoides* Bartr. Ex Marsh. Seedlings. American Journal of Botany 70: 735-743.