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STEM ANATOMY OF *PERSICARIA* MILL. (POLYGONACEAE)

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ABSTRACT

The paper presents a comparative account of stem anatomy of the five species of *Persicaria* viz. *Persicaria capitata*, *Persicaria emodi*, *Persicaria glabra*, *Persicaria hydropiper* and *Persicaria maculosa*. Presence of collenchymatous hypodermis, sclerenchymatous pericycle, intraxylary phloem in some of the vascular bundles and presence of one or more patches of interfascicular phloem are the common features observed in all the species. Among the five species investigated *Persicaria emodi*, *Persicaria glabra* and *Persicaria hydropiper* show similarity in their stem anatomy including the presence of hollow pith. *Persicaria capitata* and *Persicaria maculosa* show solid pith delimited by sclerenchymatous zone. Further, in *Persicaria maculosa* a sclerenchymatous sheath is also present around each vascular bundle. Findings are correlated with the habit of the plant and compared with the available data on the stem anatomy of other members of family Polygonaceae.

Key Words: Polygonaceae, Stem Anatomy, Sclerenchyma, Interfascicular Phloem, Intraxylary Phloem

INTRODUCTION

Persicaria Mill. is a genus of herbaceous plants belonging to family Polygonaceae. The *Persicaria* was formerly included in the genus *Polygonum*. Many authors treat *Persicaria* as a section of *Polygonum* s.l. (Dammer, 1892; Steward, 1930; Anjen *et al.*, 2003). However, systematic studies of *Persicaria* based on palynological (Hedberg, 1946), anatomical (Haraldson, 1978) and Rbcl phylogenetic analysis (Lamb and Kron, 2003) suggest that the *Persicaria* should be recognized as a separate genus. *Persicaria* currently comprises 150 species worldwide (Michael and Simpson, 2010).

General information on the stem anatomy of Polygonaceae was given by early workers Solereder (1908) and Metcalfe and Chalk (1950). However, no anatomical information exclusively on the stem anatomy *Persicaria* is available. Thus, the present work is undertaken to provide characteristic anatomical features of five species of *Persicaria* viz. *Persicaria capitata*, *Persicaria emodi*, *Persicaria glabra*, *Persicaria hydropiper* and *Persicaria maculosa*. A comparative account of stem anatomy of the five species of *Persicaria* has been presented and compared with the available anatomical data of other members of family Polygonaceae. *Persicaria emodi*, *Persicaria glabra* and *Persicaria hydropiper* frequently grow in riverbanks, streamsides and wet valleys. *Persicaria capitata* grows in mountain slopes and shaded places in valleys while *Persicaria maculosa* grows in shaded places in the valleys (Hinds and Freeman, 2005).

MATERIALS AND METHODS

Fresh materials of *Persicaria glabra* and *Persicaria hudropiper* were collected from the plants growing in the Roxburgh Botanical Garden, University of Allahabad and in other localities of Allahabad (25°27'N, 81°51'E). *Persicaria capitata*, *Persicaria emodi* and *Persicaria maculosa* were collected from Almora and adjoining localities (29°37'N, 79°40'E). For anatomical studies samples of stem were cut into small pieces and fixed in FAA (Berlyn and Miksche, 1976). Both microtome and hand sections were prepared. For microtomy, the materials were dehydrated in tertiary butyl alcohol 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 (Johanson, 1940).

Olympus binocular compound microscope (CX2i, with camera attachment) has been used to investigate the anatomy and for photography.

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RESULTS AND DISCUSSION

Stem anatomy of *Persicaria capitata*, *Persicaria emodi*, *Persicaria glabra*, *Persicaria hydropiper* and *Persicaria maculosa* as seen in transverse sections: Epidermis is single layered covered with thin layer of cuticle. Epidermal cells have small papillae like projections and show slight differences in their shape and size in different species. The epidermal cells are rectangular in *Persicaria emodi*, *Persicaria glabra* and *Persicaria hydropiper* and oval in *Persicaria capitata* and *Persicaria maculosa* (Figures 1B, 2B, 3B, 4A & 4D). Below the epidermis, collenchymatous hypodermis is present. It is 1-2 layered in *Persicaria capitata*, *Persicaria emodi*, *Persicaria glabra* and *Persicaria hydropiper* while in *Persicaria maculosa* it is 2-4 layered. Cortex is parenchymatous, 3-5 layered in *Persicaria emodi*, *Persicaria glabra* and *Persicaria hydropiper*, 7-9 layered in *Persicaria capitata* and 12-14 layered in *Persicaria maculosa*. Cortical cells are compactly arranged in *Persicaria capitata* while in other species small intercellular spaces are present. In *Persicaria maculosa* and *Persicaria hydropiper* cortex also shows presence of large airspaces. Endodermis is not distinguishable in any species while a sclerenchymatous pericycle is present in all the species of *Persicaria*. Thickness of pericycle varies from 1-3 layers except in *Persicaria maculosa* in which pericycle may be upto 4 layered (Figures 1B, 2B, 3B, 4A & 4D). Ring of vascular bundle consists of open, conjoint, collateral and endarch bundles of different sizes. Ring is somewhat wavy in *Persicaria capitata* (Figure 1A). In all of the five species investigated in the present study it is observed that in young stage one or more patches of phloem are formed in the interfascicular region which are without primary xylem (Figures 1D, 2C, 3C, 3F & 4E). During the secondary growth a few secondary xylem elements are formed inner to phloem strands in *Persicaria hydropiper* (Figure 4A) while in *Persicaria capitata* and *Persicaria maculosa*, secondary xylem is formed only in some of phloem strands (Figures 1E & 2E) and other patches remain as interfascicular phloem patches (Figures 1F & 2F). In *Persicaria glabra* and *Persicaria emodi* no secondary xylem is formed and interfascicular patches of phloem remain without xylem (Figures 3C & 4E). In all the species intraxylary phloem is found present in some of fully developed vascular bundles (Figures 1C, 2D, 3D, 4B & 4F). In *Persicaria capitata* continuous zone of fibres is present at the inner margin of vascular bundles delimiting the pith (Figures 1A & 1D). While in *Persicaria maculosa*, fibres form a more or less complete sheath around each vascular bundle (Figure 2B). Pith is parenchymatous with small intercellular spaces in *Persicaria capitata* and *Persicaria maculosa* while other three species show hollow pith (Figures 1A, 2A, 3A, 3E & 4C). Calcium oxalate crystals (druses) of various sizes are present in the four of the investigated species of *Persicaria* except *Persicaria capitata*. Calcium oxalate crystals (druses) are present in the cortical cells of *Persicaria emodi*, *Persicaria glabra* and *Persicaria hydropiper*. While in *Persicaria maculosa* both cortical cells and pith cells show presence of calcium oxalate crystals (druses). Pith cells of *Persicaria capitata* show presence of abundant starch grains.

The present work provides comparative account of stem anatomy of five species of *Persicaria* viz. *Persicaria capitata*, *Persicaria emodi*, *Persicaria glabra*, *Persicaria hydropiper* and *Persicaria maculosa*. Presence of collenchymatous hypodermis and sclerenchymatous pericycle are the family characters of Polygonaceae as reported by Solereder (1908) and Metcalfe and Chalk (1950). These features have also been observed in the present study. Among the five species investigated *Persicaria emodi*, *Persicaria glabra* and *Persicaria hydropiper* show similarity in their stem anatomy including the presence of hollow pith. *Persicaria capitata* and *Persicaria maculosa* show solid pith delimited by sclerenchymatous zone. Further, in *Persicaria maculosa* a sclerenchymatous sheath is also present around each vascular bundle. Pith is parenchymatous with intercellular spaces in *Persicaria capitata* and *Persicaria maculosa* while in other three species of *Persicaria* pith is hollow. Presence of additional sclerenchymatous zone around the pith in *Persicaria capitata* and *Persicaria maculosa* and absence of pith in *Persicaria emodi*, *Persicaria glabra* and *Persicaria hydropiper* may be correlated with their terrestrial and aquatic habit respectively.

Presence of sclerenchymatous sheath around each vascular bundle is also reported in *Rumex dentatus* and *Rumex orientalis* (Joshi, 1936). In all of the five species one or more interfascicular phloem patches have

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been observed. No primary xylem is found present opposite such bundles. During secondary growth, secondary xylem elements are formed in some of the interfascicular phloem patches. Similar development has also been observed in *Rumex dentatus* (Joshi, 1936), *Rumex hastatus* (Sahney and Vibhasa, 2012) and in *Antigonon leptopus* (Sahney and Shukla, 2013).

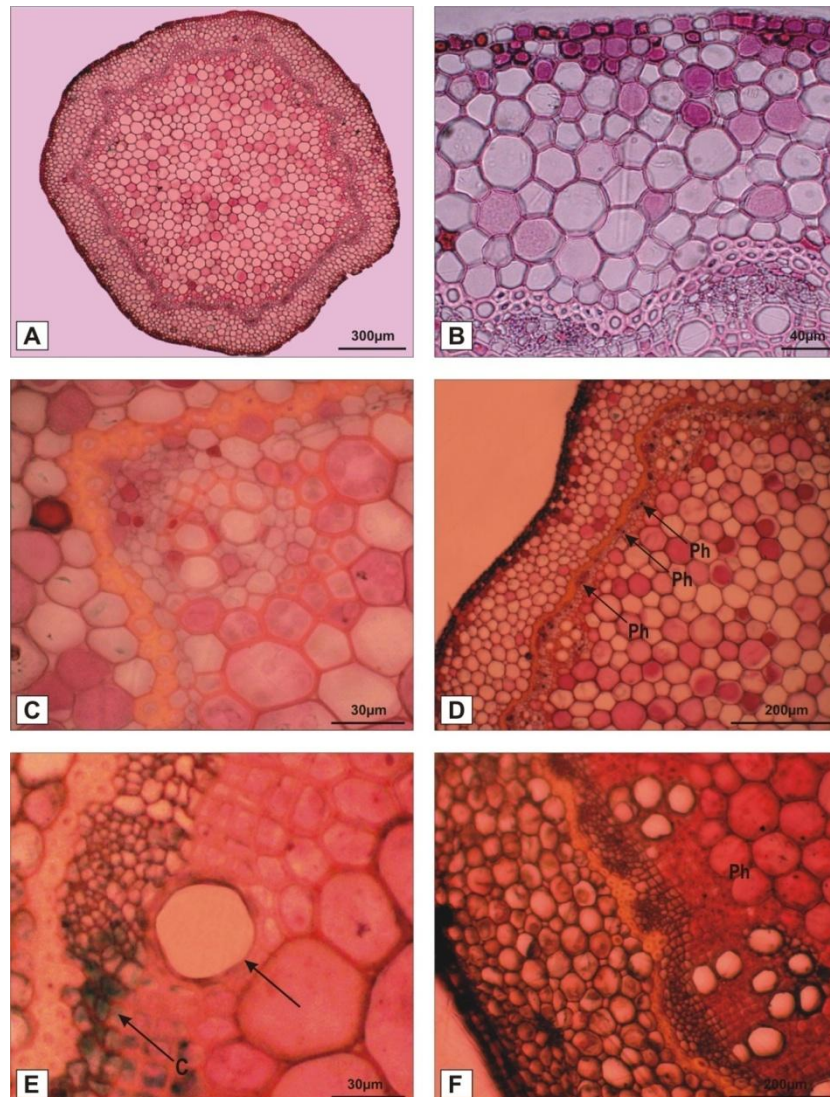


Figure 1(A-F): *Persicaria capitata* (Buch.-Ham.ex.D.Don)

- A. T.S. of young stem showing solid pith**
 - B. Magnified portion of stem**
 - C. Vascular bundle showing intraxylary phloem**
 - D. Magnified portion of stem showing interfascicular phloem patches (in between the vascular bundles), arrow**
 - E. Secondary xylem formed (from cambium) opposite the phloem patch**
 - F. Magnified portion of stem showing secondary growth, some interfascicular phloem patch remains without developing secondary xylem (arrow)**
- (Abbreviation C- cambium, Ph- phloem)

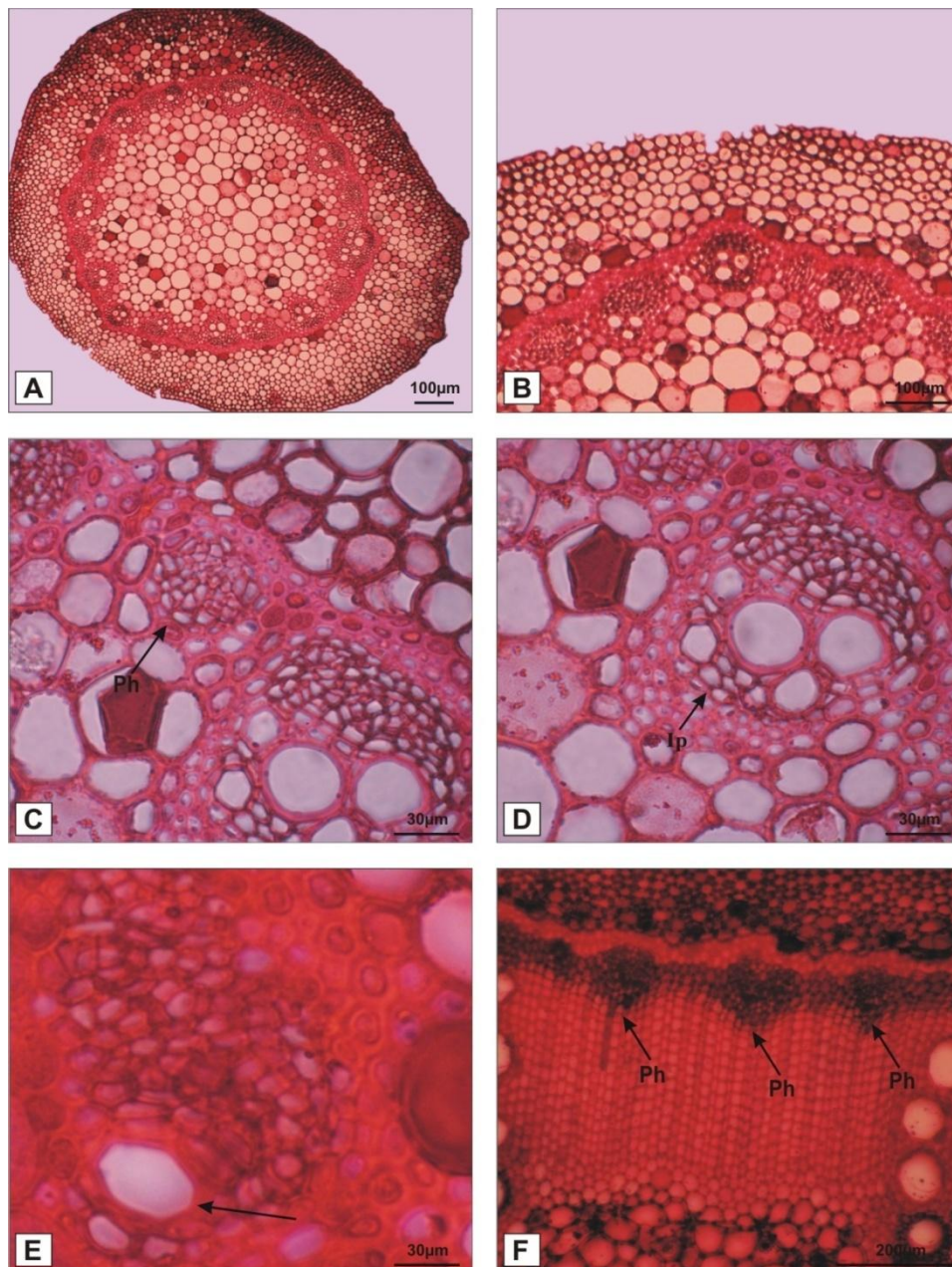


Figure 2 (A-F): *Persicaria maculosa* S.F.Gay

- A. T.S. of young stem showing solid pith**
 - B. Magnified portion of stem showing sclerenchymatous sheath around each vascular bundles**
 - C. Magnified portion of stem showing interfascicular phloem patch (in between the vascular bundles), arrow**
 - D. Vascular bundle showing intraxylary phloem (arrow)**
 - E. Vascular bundle showing xylem formed opposite the phloem patch**
 - F. Magnified portion of stem showing secondary growth, some interfascicular phloem patches remain without developing secondary xylem (arrow)**
- (Abbreviation Ip- intraxylary phloem, Ph- phloem)

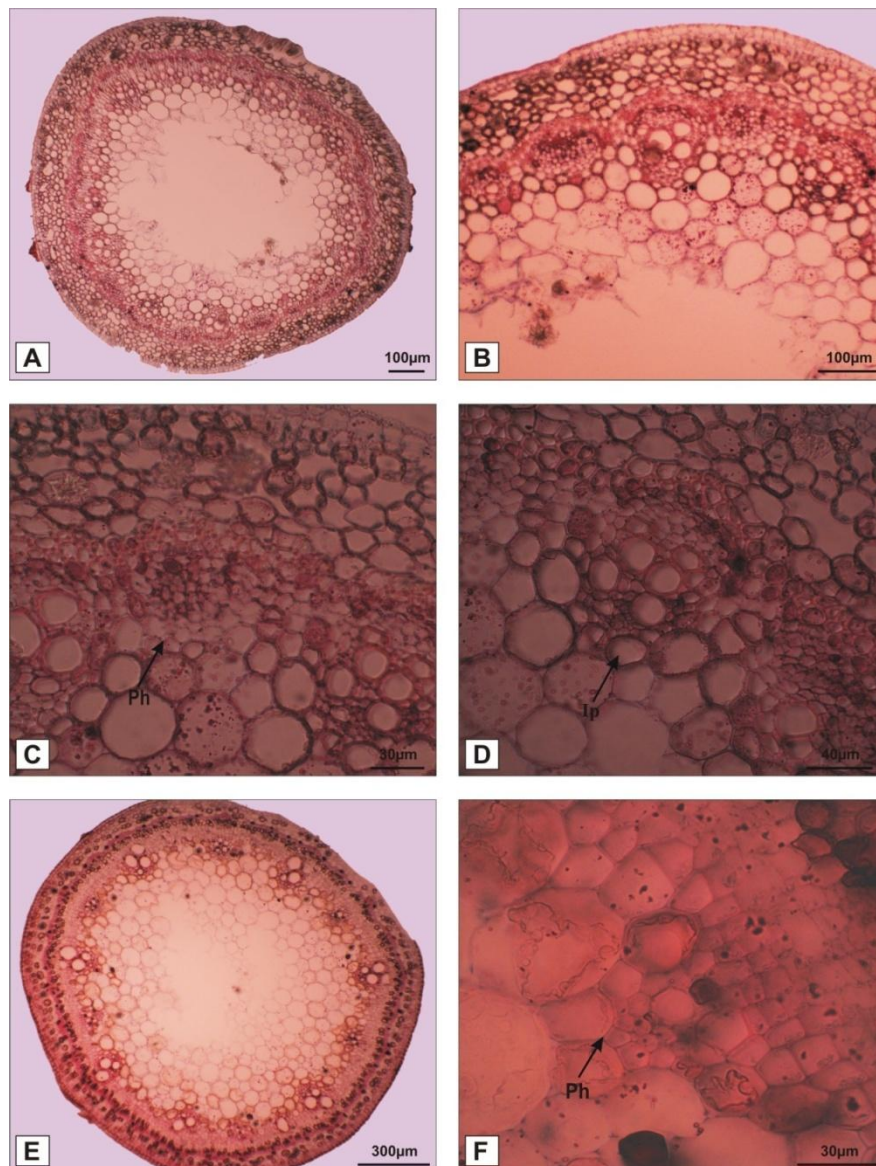


Figure 3(A-D): *Persicaria glabra* (Willd.) and 3(E-F): *Persicaria hydropiper* (L.)

A. T.S. of young stem showing hollow pith

B. Magnified portion of stem

C. Magnified portion of stem showing inter fascicular phloem patch (in between the vascular bundles), arrow

D. Vascular bundle showing intraxylary phloem (arrow)

E. T.S. of young stems showing hollow pith

F. Magnified portion of stem showing inter fascicular phloem patch (in between the vascular bundles)

(Abbreviation Ip- intraxylary phloem, Ph- phloem)

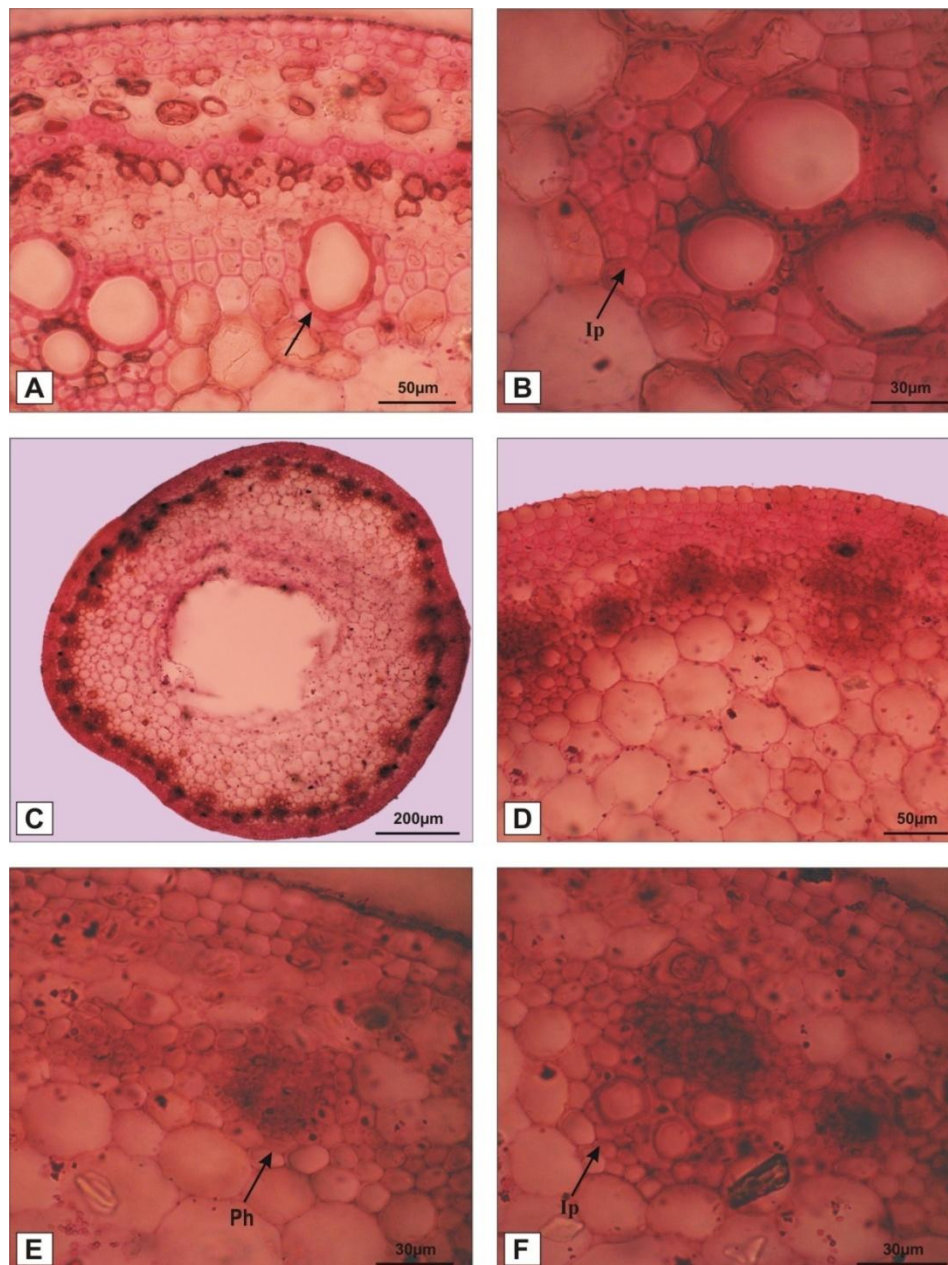


Figure 4(A-B): *Persicaria hydropiper* (L.) and 4(C-F): *Persicaria emodi* (Meisn.)

- A.** Magnified portion of stem showing secondary xylem (from cambium) opposite the phloem patch
 - B.** Vascular bundle showing intraxylary phloem (arrow)
 - C.** T.S. of young stem showing hollow pith
 - D.** Magnified portion of stem
 - E.** Magnified portion of stem showing interfascicular phloem patches in between the vascular bundles (arrow)
 - F.** Vascular bundle showing intraxylary phloem (arrow)
- (Abbreviation Ip- intraxylary phloem, Ph- phloem)

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It may be mentioned here that in *Rumex hastatus* and *Antigonon leptopus* secondary xylem is formed opposite to all the phloem patches. In *Persicaria hydropiper*, a few secondary xylem elements are formed inner to phloem strands. While in *Persicaria capitata* and *Persicaria maculosa*, secondary xylem is formed only in some of phloem strands and other patches remain as interfascicular phloem patches. In *Persicaria glabra* and *Persicaria emodi* no secondary xylem is formed and interfascicular patches of phloem remain without xylem. In all the five species, intraxylary phloem is found present in some of the vascular bundles. Intraxylary phloem has also been reported in *Polygonum*, *Rheum*, *Emex spinosa*, *Centropodium* (Solereider, 1908; Metcalfe and Chalk, 1950) and in *Antigonon leptopus* (Carlquist, 2003; Sahney and Shukla, 2013).

All the species of *Persicaria* are herbs showing little secondary growth. Collenchyma and sclerenchyma tissues present in the plant axis are the effective mechanical tissues providing strength to the herbaceous stems.

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