Stelar System in Pteridophytes

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The conducting system of pteridophytes consists of xylem and phloem and associated parenchyma cells, all of which are organized into a stele (L. *stela*, rod of column) that is generally separated from the outer cortex by a layer of endodermis. The term 'stele' was interpreted as including the vascular tissues and the so-called conjunctive tissues associated with them, the pith (if present), and pericycle.

On the basis of the kind of stellar organization that occur in different pteridophytes, an evolutionary sequence can be recognized among different groups of them.

The following two types of stele occur in pteridophytes.

1. **Protostele:** Protostele is the simplest, and considered to be the most primitive type of stele. It consists of a solid core of xylem surrounded by a cylinder of phloem, enclosing no pith. All other types of steles have evolved from it in the course of evolutionary specialization. Protosteles are most common in psilophytes and lycophytes, but they occur also in the juvenile stems of ferns. Such a stele occurred in such primitive psilophytes as *Horneophyton* and *Rhynia*, and may be found in *Selaginella*, *Lycopodium*, *Gleichenia* and *Lygodium* among present day forms.

   Variations of the protostele include the *haplostele*, *actinostele*, *plectostele* and *mixed-protostele*.

   i. ***Haplostele*:** A protostele with central solid and smooth core of xylem surrounded by phloem is known as *haplostele*. This particular type of protostele has been regarded as the most primitive among the different types. It occurred in primitive psilophytes like *Horneophyton* and *Rhynia,* and is found in a number of living genera, e.g. *Lycopodium cernuum* and *Selaginella kraussiana*.

   ii. ***Actinostele*:** In a number of pteridophytes, the central xylem core of a protostele is not smooth but is thrown into radiating ribs with the protoxylems at the extremities and phloem alternating with its rays, when seen in a cross section. Such type of protostele is termed an *actinostele*. It is found in *Psilotum triquetrum* and *Lycopodium serratum*.

   iii. ***Plectostele*:** In the stems of some species of *Lycopodium*, e.g., *L. clavatum* and *L. volubile*, while seen in cross section, the xylem occurs in the forms of small parallel bands alternating with the phloem plates. This specialized form of protostele is termed a *plectostele*.

   iv. ***Mixed-protosteleI*:** In *Lycopodium cernuum*, the xylem when seen in a cross section, appears in the form of irregular groups that are embedded in the ground mass of phloem. This type of protostele is called the *mixed-protostele*.

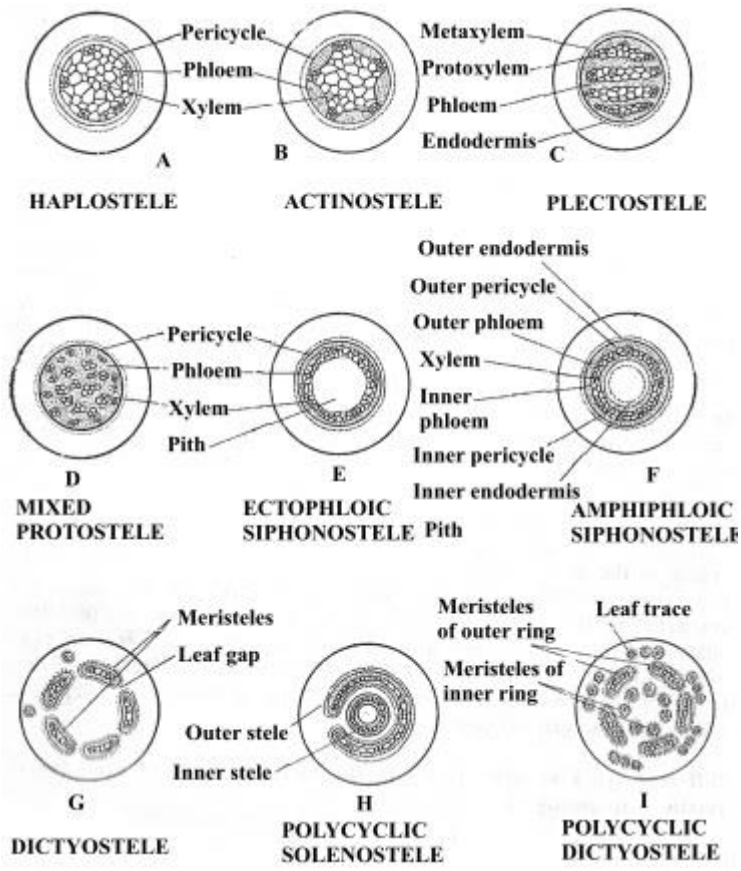

Fig: Diagrammatic views of various types of steles found in pteridophytes

2. **Siphonostele:** A kind of stele in which there is present a pith in the central region is called a *siphonostele* or *medullated protostele*. In *siphonostele*, the vascular tissues are arranged in the form of a hollow cylinder, with a distinct pith in the centre. The *siphonostele* and its variations are found frequently in the ferns.

<u>Origin of siphonostele</u>

There is a general acceptance that the siphonostele has evolved from a protostele. Two theories have been proposed accounting the phylogenetic origin of the pith: *intrastelar theory* and *extrastelar theory*.

Intrastelar theory, which is supported by Boodle (1901), Gwynne-Vaughan (1908), Bower (1911), Petry (1914), and others, holds that pith originates by metamorphosis of the inner vascular elements into parenchyma. Support for this theory is furnished by a number of

plants like Botrychium lunaria and Osmunda regalis, in which the central region of the protostele consists of both tracheids and parenchyma cells.

According to the extrastelar theory, which was put forth by Jeffrey (1897, 1902, 1917), the pith is extra stelar in origin. The theory holds that the pith originated as a result of the invasion of cortical tissues into the stele through the leaf gaps and branch gaps, in the course of phylogenetic development of the vascular plants. According to this theory, the pith is cortical in nature.

Types of siphonostele

According to the distributional patterns of the xylem and phloem, the siphonostele has been classified into following two types:

i. Ectophloic siphonostele
ii. Amphiphloic siphonostele

In the **ectophloic siphonostele**, the phloem occurs only on the outer surfaces of the xylem cylinder. It is found in *Equisetum* and some ferns, like *Osmunda* and *Schizaea*.

In the **amphiphloic siphonostele**, the phloem may be both external and internal. An amphiphloic siphonostele is also known as a *solenostele*. It is found in the ferns, like *Adiantum* and *Marsilea*.

A siphonostele, which has no leaf gap is termed as ***cladosiphonic siphonostele***. It is found in some species of *Selaginella*.

A siphonostele with gaps caused by leaf traces is termed ***phyllosiphonic siphonostele***. Among the simpler siphonostelic ferns, e.g. Marsilea, the leaf gaps are relatively small and do not overlap each other in the internodes. Such siphonosteles are called ***solenosteles***. In the more advanced siphonostelic ferns, the leaf gaps are large and overlap each other, and the vascular cylinder thus appeared to be dissected. A dissected siphonostele is known as a ***dictyostele***. In a transaction, the dictyostele appears as discrete strands or bundles, each with internal xylem and concentric phloem and is called ***meristele***, e.g., *Pteris*.

References:

1. S.N. Pandey, S.P. Misra, P.S. Trivedi. A textbook of Botany. Vikas Publishing House Pvt. Ltd.
2. P.C. Vashishta, A.K. Sinha, A. Kumar. Botany for degree students (Pteridophyta). S Chand & Company.