Essay

Unit - II

5. STELAR EVOLUTION IN PTERIDOPHYTES

5-1 INTRODUCTION

1st Vascular plants

The term stele is derived from Greek which means a central pillar. It is the conducting central cylinder of stem as well as root. The primary structure of stem and root are basically similar. The fundamental parts of stem and root are the epidermis, cortex and stele. The stele is the central cylinder and is separated from the cortex by the endodermis. The endodermis is the innermost layer of the cortex, and pericycle is the outermost portion of the stele. Basing on this a stelar theory was proposed by **Van Tiegham** and **Douliot** in 1886. According to this theory, the stele is the fundamental unit in the vascular system of pteridophytes. The term 'Stele' includes not only the primary vascular tissues but also the pericycle and pith (if present).

Stelar theory was widely accepted by many scientists as it was found to be useful in the comparative anatomical and phylo- genetic studies of the vascular plants.

5-2 TYPES OF STELES FOUND IN PTERIDOPHYTES

Two main types of steles are found in the pteridophytes. These are (i) the Protostele and (ii) the **Siphonostele.**

1. Protostele : The name Protostele was suggested by Jeffrey (1902) and he regarded it as the most primitive and simplest type of stele. It consists of a central solid mass of xylem surrounded by phloem. Such a stele occurs in the adult stems of *Lycopodium*, *Selaginella* etc.

Brebner (1902) recognised two types of protosteles.

(a) Haplostele : A protostele with central solid and smooth core of xylem surrounded by concentric layers of phloem is known as a Haplostele. This type of protostele has been regarded as the most primitive among all Protosteles. It is of common occurrence in primitive psilopsidales like *Rhynia* and *Horneophyton* and is found in a number of living genera e.g. *Lycopodium cernuum* and *Selaginella kraussiana*.

(b) Actinostele : It consists of xylem in the form of radiating arms (ribs) and the phloem in isolated patches alternating with the Xylem. Such a type of protostele is termed as *actinostele*. e.g. *Psilotum* and *Lycopodium serratum*.

Sometimes the actinostele may show variations due to breaking of xylem tissue into different forms. The common modifications of actinostele are :

(i) Plectostele : In this type of actinostele, the xylem occurs in the form of small parallel plates alternating with the phloem plates. e.g. *Lycopodium volubile* and *L. clavatum*.

(ii) Mixed protostele : In this form of actinostele, the masses of xylem and phloem are uniformly distributed. In a cross section of stele, xylem appears in the form of irregular groups that are embedded in the ground mass of phloem e.g. *L. cernuum, Hymenophyllum desmium* and *Gleichenia dichotoma*.

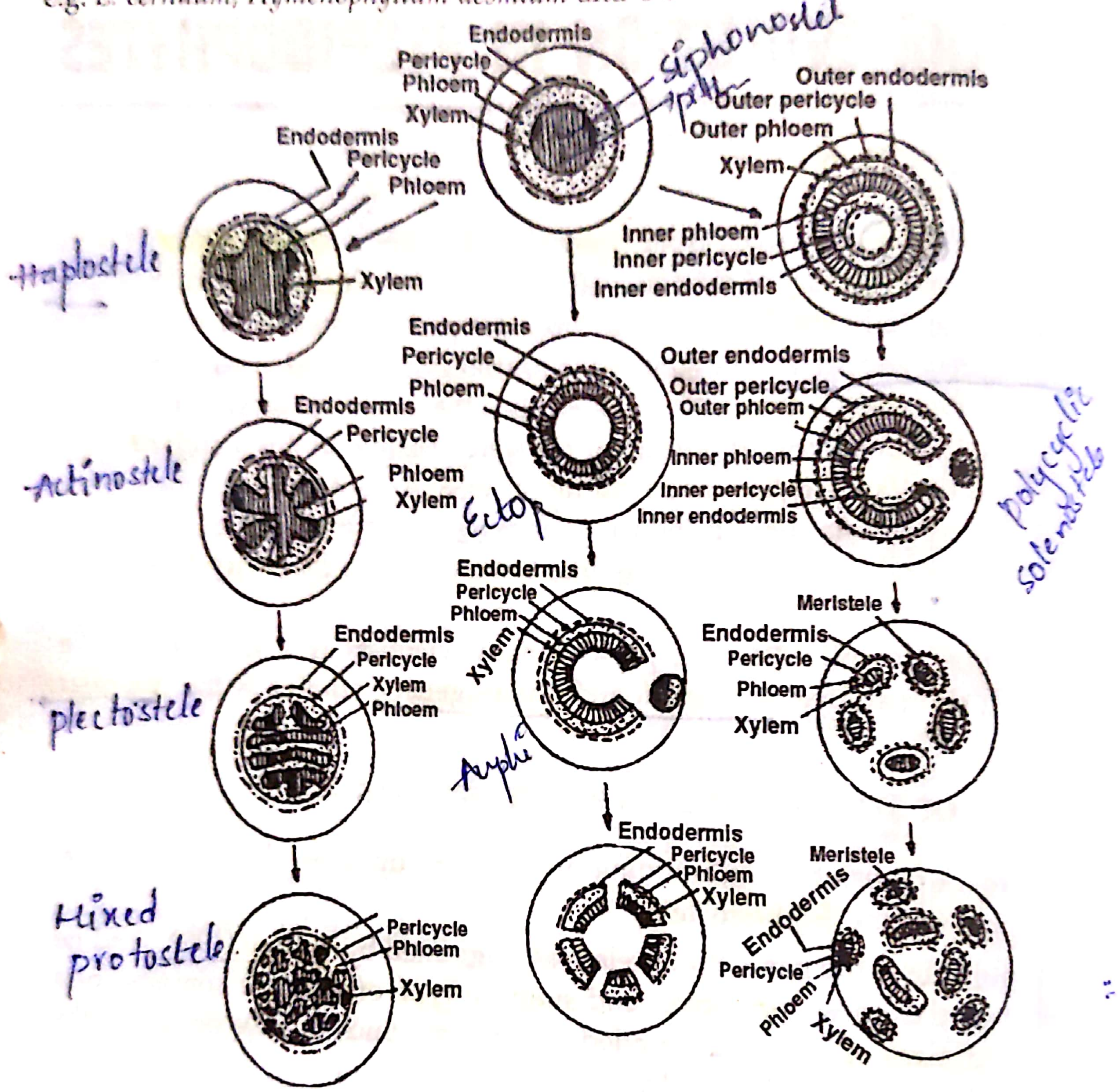


Fig. 5·1 : Stelar Evolution in Pteridophyta

2. Siphonostele : It is a modified form of protostele in which the pith is present in the centre of the stele. This is also termed as **medullated protostele**. Here the central pith is surrounded by a cylinder of xylem and phloem. Such stele is found in most members of Pteropsida (ferns).

(a) Origin of Siphonostele : There is a general acceptance that the siphonostele has evolved from protostele. Two theories have been proposed accounting the phylogenetic origin of pith.

(i) Intra Stelar origin of pith : This theory was supported by Gwynne Vaughan (1908), Bower (1911), Petry (1914) and Thompson (1920). According to this thoery, **the pith has been developed by metamorphosis of the inner vascular elements into parenchyma**. The presence of tracheids and parenchyma in the central region of the protostele in plants like *Botrychium virginianum, B. lunaria* and *Osmunda regalis* support this view.

(ii) Extrastelar origin of pith : This theory was put forwarded by Jeffrey (1897, 1902, 1907). He believed that the pith is extrasteler in origin. The theory holds that the pith originated as a result of invasion of the cortical cells into the stele through leaf gaps and branch gaps in course of phylogenetic evolution.

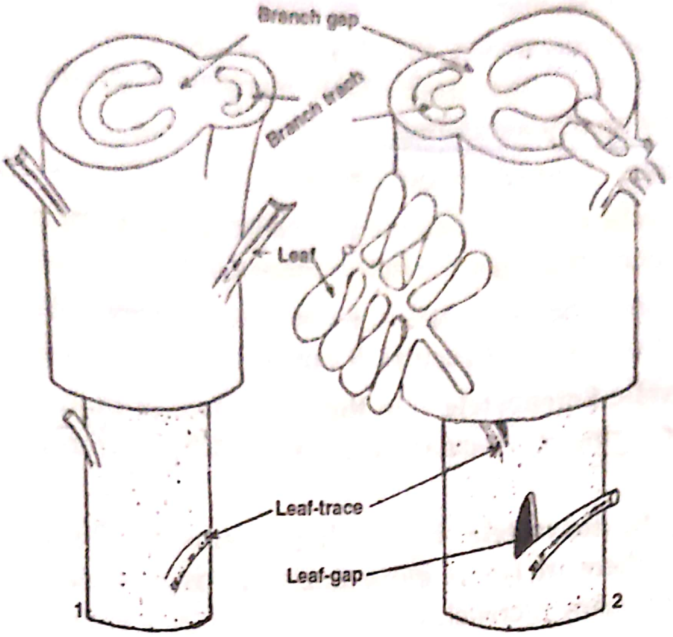


Fig. 5·2 : Stereodiagram of siphonostele showing leaf-trace with (2) and without leaf-gap (1)

(b) Types of Siphosteles : Depending upon the distribution of phloem and xylem, the siphonosteles are of three types :

(i) Ectophloic siphonostele : In this type of stele, the centrally located pith is surrounded by the concentric rings of xylem and phloem. It is found in some ferns like *Osmunda* and *Schizaea*.

(ii) Amphiphloic siphonostele : In this type of stele, the phleom is present both on the inner and outside of the xylem cylinder. This type of stele is found in *Adiantum* and *Marsilea*.

(iii) Eustelic siphonostele : This type of stele is formed by breaking of the vascular cylinder along with the central pith in to a number of collateral vascular bundles. These bundles are arranged in a ring. This stele is also termed as *Polyfascicular siphonostele* and is found in *Equisetum*.

In lower vascular plants e.g. *Lycopodium* and *Selaginella*, the leaf gaps are absent. In these plants, the stele shows a continous ring of tissues. A siphonostele which has no leaf-gap is termed *cladosiphonic siphonostele* . In ferns (filicales), large leaf gaps are found in the siphonosteles. Such a siphonostele is named by Jeffrey as *Phyllosiphonic siphonostele*.

The siphonosteles may assume different forms, depending upon the occurence, number and distribution of leaf gaps. These are as follows :

(i) Solenostele : In simpler siphonosteles of Pteropsida and Lycopsida, the leaf gaps are at a distance and they do not overlap. At a node, the siphonostele is perforated by a single leaf gap only. The solenostele may be **ectophloic** or **amphiphloic.**

(ii) Dictyostele : In more advanced ferns, the siphonostele, has overlapping leafgaps. So the stele becomes broken into longitudinal strands or meristeles. When there are numerous meristeles, the stele looks like a cylindrical mesh. Such a siphonostele is known as dictyostele. Each meristele is protostelic in nature. The leafgaps are made up of parenchyma.

e.g., *Pteridium* , *Polypodium* and *Dryopteris*.

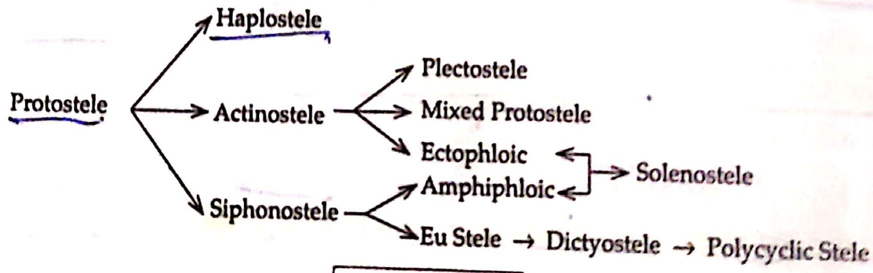
(iii) Polycyclic stele : When the meristeles of different sizes are distributed in two or more concentric rings, the stele is known as *polycyclic stele*.

In some plants, the outer stele may be a solenostele, while in others it is a dictyostele. On the basis of structure, it can be recognised as following types.

(i) Polycyclic Solenostele : In this type, two or more concentic steles are present. The outer ring of vascular cylinder is C-shaped with a single leaf gap. e.g. *Pteris* Sp.

(ii) Polycyclic dictyostele : In some higher ferns, like *Pteridium aqualinum* and *Matonia pectinata* there are two or more concentric rings of stele. The outer ring is a dictyostele having many meristeles, while the inner ring is siphonostele. In *Matonia* there are three rings of meristeles.

Conclusion : It is difficult to establish phylogenetic relationships based on stelar organisation. In many species, young portions of stems are protostelic, while mature stems are siphonostelic. This indicates that there is a transition from protostele to solenostele in individual species. Within the genus *Gleichenia*, certain species are protostelic, while others are solenostelic. All these variations confirm that stelar evolution took place along several indenpedent lines. The flow chart representing the evolution of stelar system is as follows :



Questions

1. Describe the different types of steles in Pteridophyta.
2. Trace out the course of evolution of steles in pteridophyta.
3. Define the term 'stele'. Describe briefly the various types of steles met within pteridophytes studied by you.
4. *Write short notes on :*

(a) Solenostele, (b) Protostele,

(c) Polycyclic condition, (d) Siphonostele.