10

General Topics

APOGAMY, APOSPORY AND PARTHENOGENESIS

The normal life-cycle of bryophytes, pteridophytes and spermatophytes shows distinct alternation of generations. However, there are certain other modifications or abnormalities where the essential stages in the life-cycle are eliminated. These modifications may be called—**apogamy, apsopory** and **parthenogenesis.**

Apogamy. According to Winkler (1908) the definition is as follows— *"It is the formation of a sporophyte directly, from the vegetative cells of the gametophyte without the act of syngamy or gametic union."* Thus the apogamy is the development of an embryo from a cell of the gametophyte other than an egg-cell, evidently without the intervention of gametes. The embryo so formed grows into the sporophyte. Apogamy is a constant phenomenon in a number of ferns. However, it may be induced by cultural conditions, such as strong light, modified nutrient culture solutions and insufficient water supply for fertilization.

Apospory. This phenomenon was first discovered by Druery (1884) in a fern where the prothalli were formed from the head or stalk of the spore sac. Thus this phenomenon may be defined as—*The development of the gametophyte from a cell of the sporophyte without the intervention of a spore.* In apospory, a filamentous, or heart-shaped gametophyte may be formed from one or more cells of any vegetative portion of a young or a mature sporophyte. The structures taking part in apospory may be a single cell of gametophytic nature, an antherozoid, an antheridium, a rhizoid, or a gametophyte bearing sex organs. In certain ferns it is sometimes seen that the prothallus develops on the undersurface of the leaf in the place of spores. The prothallus so formed bears antheridia and archegonia. Apospory is not of constant nature in ferns, and occurs occasionally in nature, and may be induced in cultural conditions.

Parthenogenesis. This may be defined as —*The development of the zygote from the egg-cell without the act of fertilization.* It is most commonly found in many algae, fungi and ferns. According to Farmer and Digby (1907), in homosporous leptosporangiate ferns, apospory was followed by neither apogamy nor fertilization but by parthenogenesis. Parthenogenesis has been observed in *Marsilea drummondii* where two types of megaspore mother cells were produced by this species (Strasburger, 1907). The phenomenon of parthenogenesis has been also observed in *Selaginella intermedia* and *S. langere* (Hieronymus, 1911). Bruchman (1912, 1919) and Goebel (1915) observed this phenomenon in other species of *Selaginelia.* In all these species the archegonia did not open, and the embryos developed parthenogenetically.

STELAR SYSTEM IN FERNS

According to the older botanists, the vascular bundle is the fundamental unit in the vascular system of pteridophytes and higher plants. Van Tieghem and Douliot (1886) interpreted the plant body of a vascular plant in the different way. According to them the fundamental parts of a shoot are the cortex and a central cylinder is known as stele. The name stele has been derived from a Greek word meaning pillar. This way, the stele is defined as a central vascular cylinder, with or without pith and delimited the cortex by the endodermis. Van Tieghem and Douliot

(1886) recognized only three types of steles. They also thought that the monostelic shoots were rare in comparison of polystelic shoots. It is an established fact that all shoots are monostelic and polystelic condition rarely occurs.

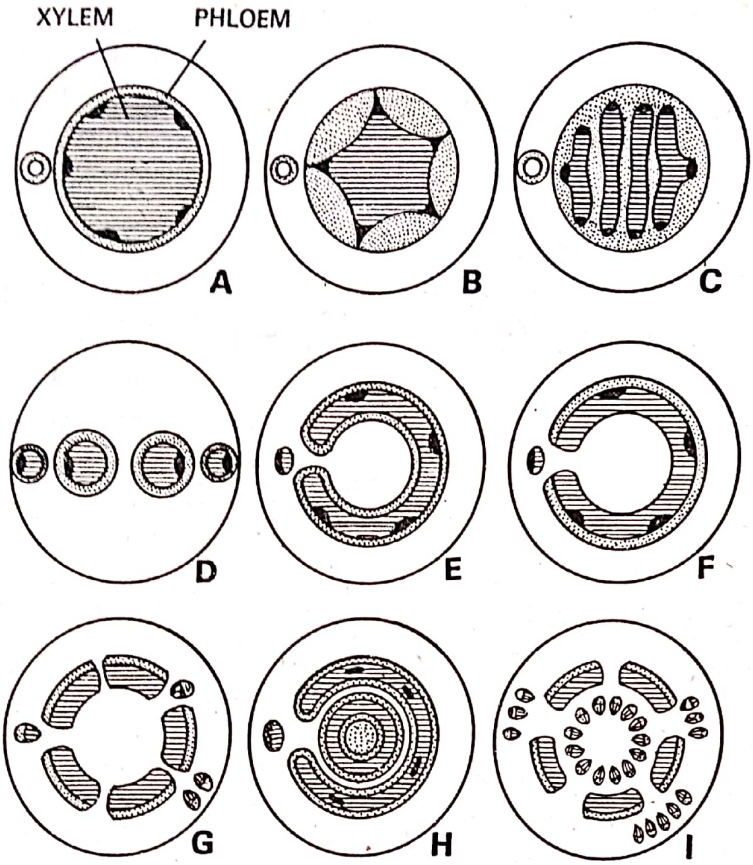

Fig 10.1. Different types of the steles found in various ferns. A, most primitive type-haplostele; B, actinostele; C, plectostele; D polystele; E, amphiphloic solenostele; F, ectophloic solenostele; G, dictyostele; H, polycyclic solenostele; I, polycyclic dictyostele.

The stele of the stem remains connected with that of leaf by a vascular connection known as the **leaf supply.**

The steles may be of the following types :-

A. Protostele. Jeffrey (1898), for the first time pointed out the stelar theory from the point of view of the phylogeny. According to him the primitive type of stele is **protostele.** In protostele, the vascular tissue is a solid mass and the central core of the xylem is completely surrounded by a layer of phloem. This is the most primitive and simplest of stele.

There are several forms of the protostele which are as follows :

1. Haplostele. This is

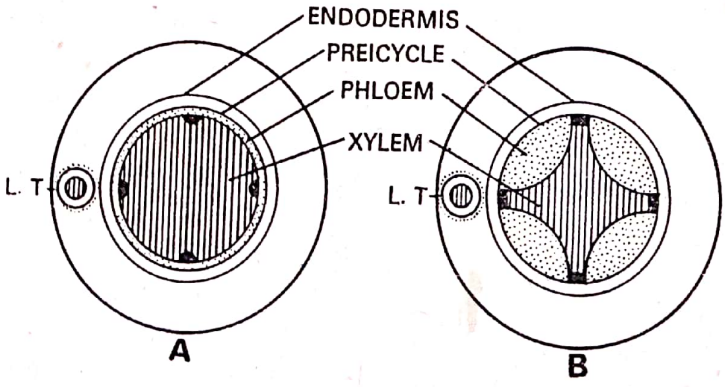

Fig. 10.2. Stelar system in ferns. A, haplostele; B, actinostele.

the most primitive type of protostele. Here the central solid smooth core of xylem is surrounded by a layer of phloem, *e.g.*, *Salaginella* sp.

2. **Actinostele.** This is the modification of the haplostele and somewhat more advanced in having the central xylem core with radiating ribs, *e.g.*, *Psilotum* sp.

3. **Plectostele.** This is the most advanced type of protostele. Here the central core of xylem is divided into a number of separate plates arranged parallel to each other. The phloem alternates the xylem, *e.g.*, *Lycopodium* sp.

4. **Mixed-pith stele.** Here the xylem elements (*i.e.*, tracheids) are mixed with the parenchymatous cells of the pith. This type is found in primitive fossils and living ferns. They are treated to be the transitional types between true protosteles and siphonosteles, *e.g.*, *Gleichenia* sp., *Osmunda* sp.

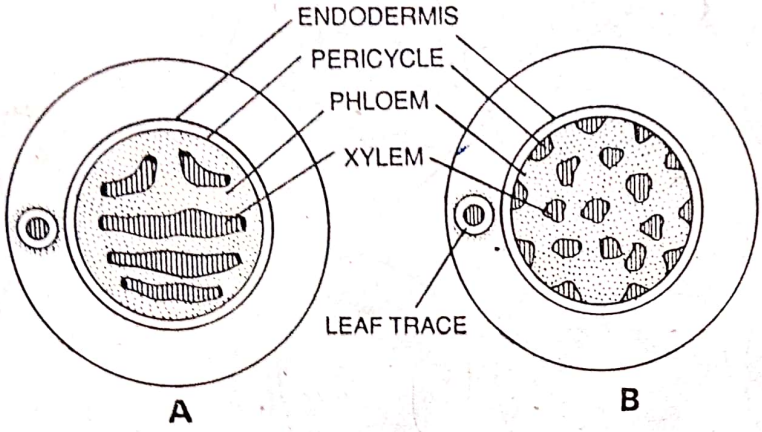

Fig 10.3. Stelar system in ferns. A, plectostele; B, mixed protostele.

B. Siphonostele. This is the modification of protostele. A stele in which the protostele is medullated is known as **siphonostele.** Such stele contains a tubular vascular region and a parenchymatous central region. Jeffrey (1898) interpreted that the vascular portion of siphonostele possessing a parenchymatous region is known as a **gap** immediately above the branch trace only or immediately above leaf and branch trace. On the basis of these branch and leaf gaps, Jeffrey (1910), distinguished two types of siphonosteles. In one type however, the leaf gaps are not found and they are known as **cladosiphonic** siphonosteles. In the other type both leaf and branch gaps are present and they are known as **phyllosiphonic** siphonosteles.

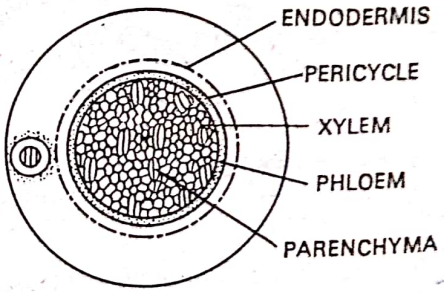

Fig 10.4. Stelar system in ferns. Protostele with mixed pith.

Jeffrey (1902, 1910, 1917) interpreted the evolution of the siphonostele from the protostele as follows : He supported that the parenchyma found internal to the phloem and xylem has been originated from the cortex. The supporters of this theory believe that the inner endodermis found at the inner face of the vascular tissue and the parenchyma encircled by this endodemis have been originated from the cortex. According to Jeffrey and other supporters of this theory the siphonosteles with internal endodermis are more primitive than those without an internal endodermis.

The siphonosteles which donot possess the inner endodermis are believed to have originated by disintegration of inner endodermis during evolution.

According to the theory proposed by Boodle (1901), and Gwynne-vaughan (1903), the siphonostele has been evolved from the protostele by a transformation of the inner vascular tissue into parenchyma.

A siphonostele may be of the following types:

1. **Ectophloic.** In this type of siphonostele, the pith is surrounded by concentric xylem cylinder and next to xylem the concentric phloem cylinder.

2. **Amphiphloic.** In this type of siphonostele the pith is surrounded by the vascular tissue. The concentric inner phloem cylinder surrounds the central pith. Next to the inner phloem is the outer phloem cylinder, *e.g., Marsilea.*

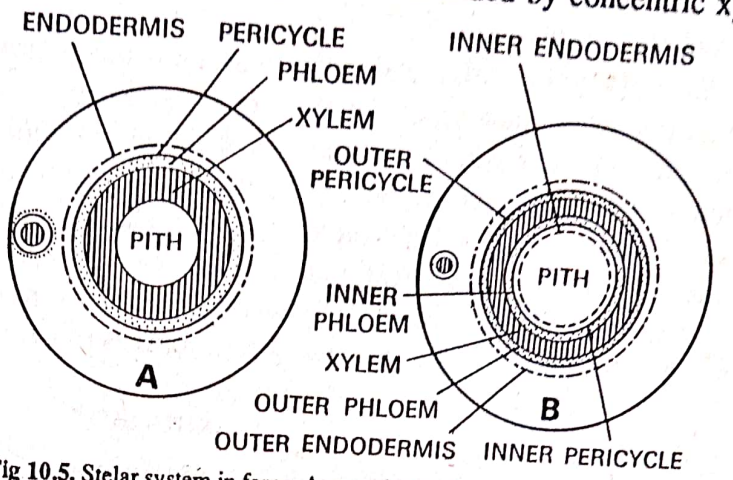

Fig 10.5. Stelar system in ferns. A, ectophloic siphonostele; B, amphiphloic siphonostele.

C. Solenostele. The vascular plants have been divided into two groups on the basis of the presence or absence of the leaf gaps. These groups are 1. Pteropsida and 2. Lycopsida. The ferns, gymnosperms and angiosperms are included in Pteropsida, whereas the lycopods, horse tails etc., are included in

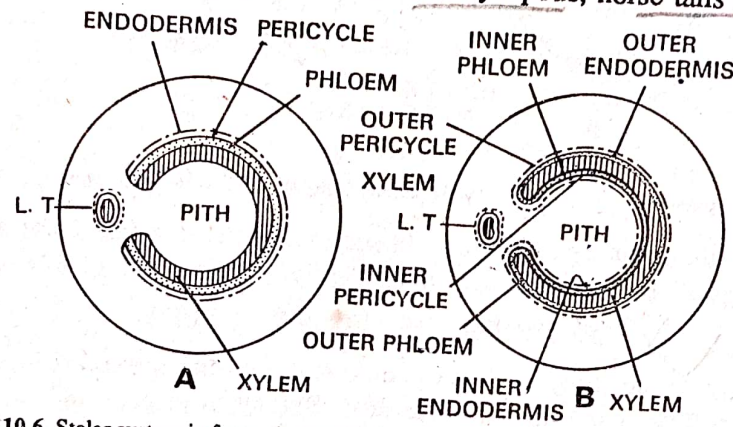

Fig 10.6. Stelar system in ferns. A, ectophloic solenostele; B, amphiphloic solenostele.

Lycopsida. The simplest form of siphonostele has no leaf gaps, such as, some species of *Selaginella.* However, among the simplest siphonostelic Pterospsida and siphonostelic Lycopsida, the successive leaf gaps in the stele donot overlap each other and are considerably apart from each other.

According to Brebner (1902), Gwynne - Vaughan (1901) such siphonosteles which lack overlapping of gaps are known as **solenosteles.** They may be ectophloic or amphiphloic in nature. Some authors (Bower, 1947; Wardlaw, 1952; Esau, 1953), however, interpreted the solenostele as an amphiphloic siphonostele.

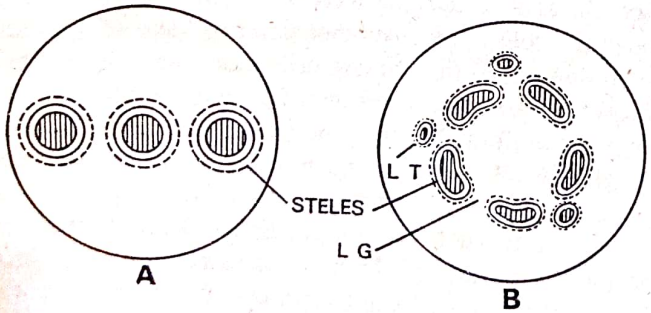

Fig 10.7. Stelar system in ferns. A, polystelic stem; B, dictyostele.

D. Dictyostele. In the more advanced siphonosteles of Pteropsida, the successive gaps may overlap each other. Brebner (1902) called the siphonosteles with overlapping gaps as **distyosteles.** In such cases the intervening portion of the

vascular tissue meristele is of protostelic type. The dictyostele with may meristeles look like a cylindrical meshwork.

E. Polycyclic stele. This type of stelar organisation is the most complex one amongst all pteridophytes. Such type of steles are siphonostelic in structure. Each such stele possesses an internal vascular system connected with an outer siphonostele. Such connections are always found at the node. A typical polycyclic stele possesses two or more concentric rings of vascular tissue. This may be a solenostele or a dictyostele. Two concentric rings of vascular tissue are found in *Pteridium aquilinum* and three in *Matonia pectinata.*

F. Eustele. According to Brebner (1902) there is one more modification of the siphonostele, known as eustele. Here the vascular system consists of a ring of collateral or bicollateral vascular

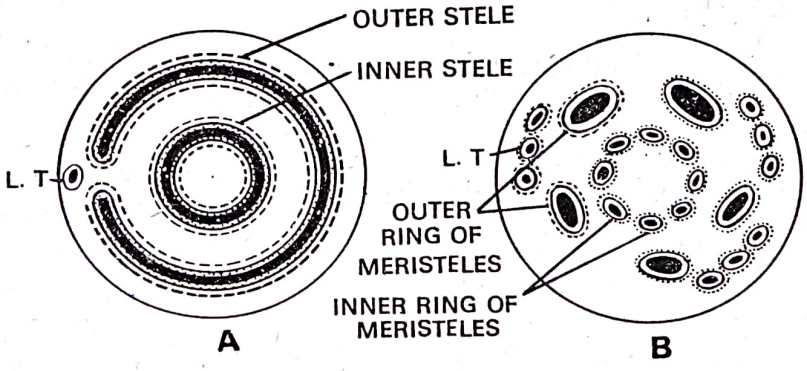

Fig 10.8. Stelar system in ferns. A, polycyclic solenostele; B, polycyclic stele showing the meristeles.

bundles situated on the priphery of the pith. In such steles the interfascicular areas and the leaf gaps are not distinguished from each other very clearly. The example of this type is *Equisetum.*

METHODS OF FOSSIL STUDY

botany or the study of fossil plants, *e.g.*, the plants existed in the past and now