21

PTERIS

Division : Filicophyta (or Pterophyta)
Class : Leptosporangiopsida
Order : Filicales
Family : Polypodiaceae
Sub-family : Pteridoideae
Genus : *Pteris*

OCCURRENCE

The genus *Pteris* includes about 280 species distributed in tropical and sub-tropical regions of the world. They are mostly terrestrial. The common Indian species are *Pteris vittata, P. cretica, P. quadriaurita*, etc. *Pteris vittata* commonly grows along mountain walls upto 1,200 metres above sea level *P. cretica* occurs from 1,200 to 2,400 metres above sea level. *P. quadriaurita* commonly grows along the road-sides and valleys throughout the Western Himalayas.

THE PLANT BODY
(Adult sporophyte)

EXTERNAL FEATURES (Fig. 21.1)

The main plant body is sporophyte (diploid). It is differentiated into root, stem and leaves.

Stem (rhizome) : The stem is modified into underground rhizome. It may be long creeping (*e.g., P. vittata*) or short, compact and semi-erect (*e.g., P. cretica, P. longifolia*). They are covered with scales.

Roots : The primary root is short lived. It is replaced by adventitious roots, which arise from the lower surface of rhizome or from all over its surface (*P. biaurita*). They arise in acropetal succession.

Leaves : The leaves are macrophyllous (large). They are pinnately compound to decompound. Flattened scales and simple hairs are usually present at leaf bases. In *P. longifolia*, each leaf is spindle-like in appearance with smaller pinnae near the base, larger in the middle and again smaller at the apex. Each pinna is sessile, traversed by a central mid-rib which gives lateral forked venis, broad at the base which gradually tappers at the apex and coriaceous or rough to touch. The young leaves are circinately coiled. Their growth is very slow.

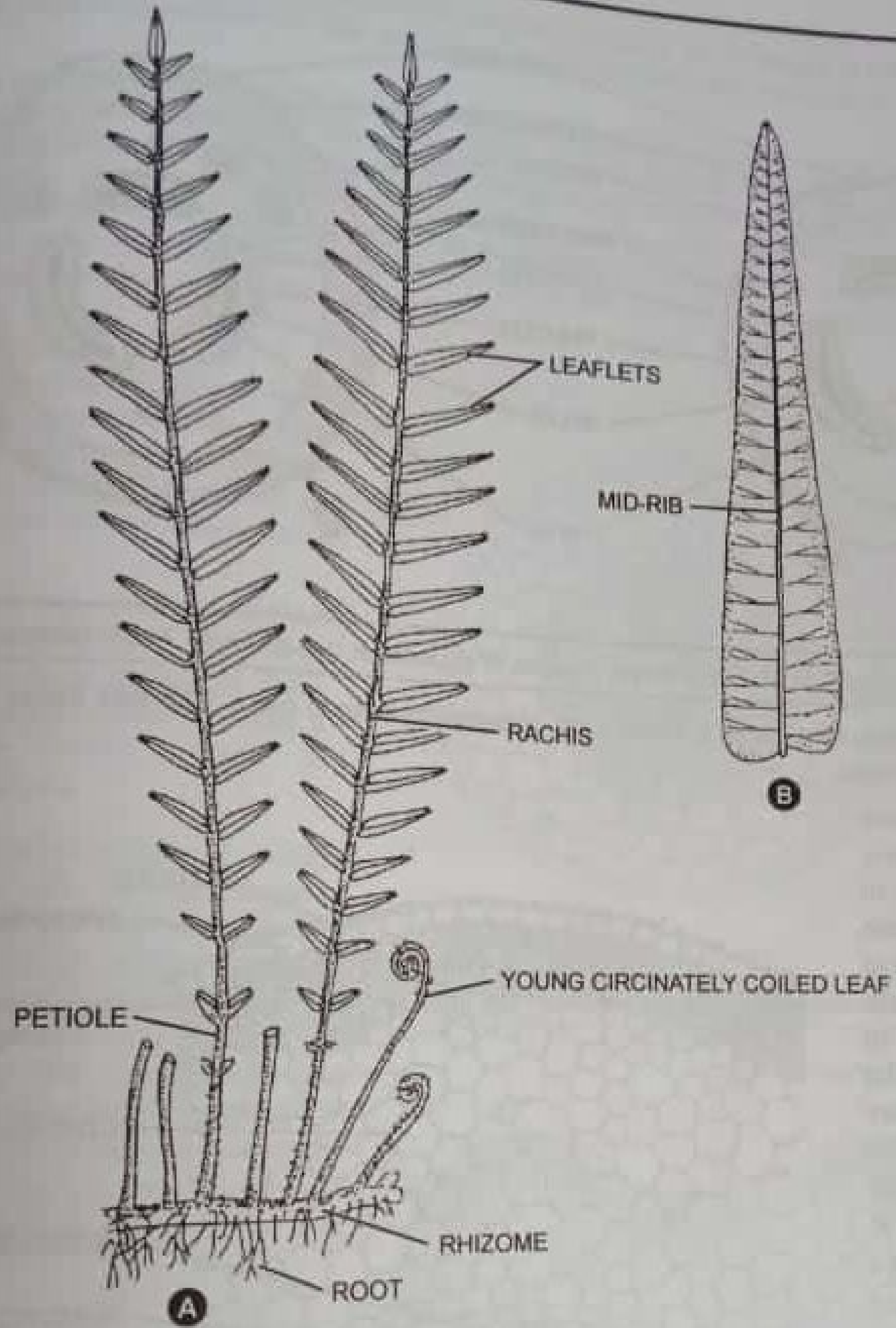

FIGURE 21.1. *Pteris vittata*. A, external feature of plant showing habit ; B, single sterile pinna.

INTERNAL STRUCTURES :

STEM (RHIZOME) (Fig. 21.2, 21.3) :

A transverse section of rhizome shows more or less an oval outline. It is differentiated into epidermis, hypodermis, cortex and stele.

Epidermis : The outermost single layered epidermis consists of narrow quadrangular cells. The outer surface of epidermis is thickly coated with cuticle.

Hypodermis : The epidermis is followed by multilayered, sclerenchymatous hypodermis. It is usually uniform. In some cases, the hypodermis is interrupted on either side by parenchymatous cells.

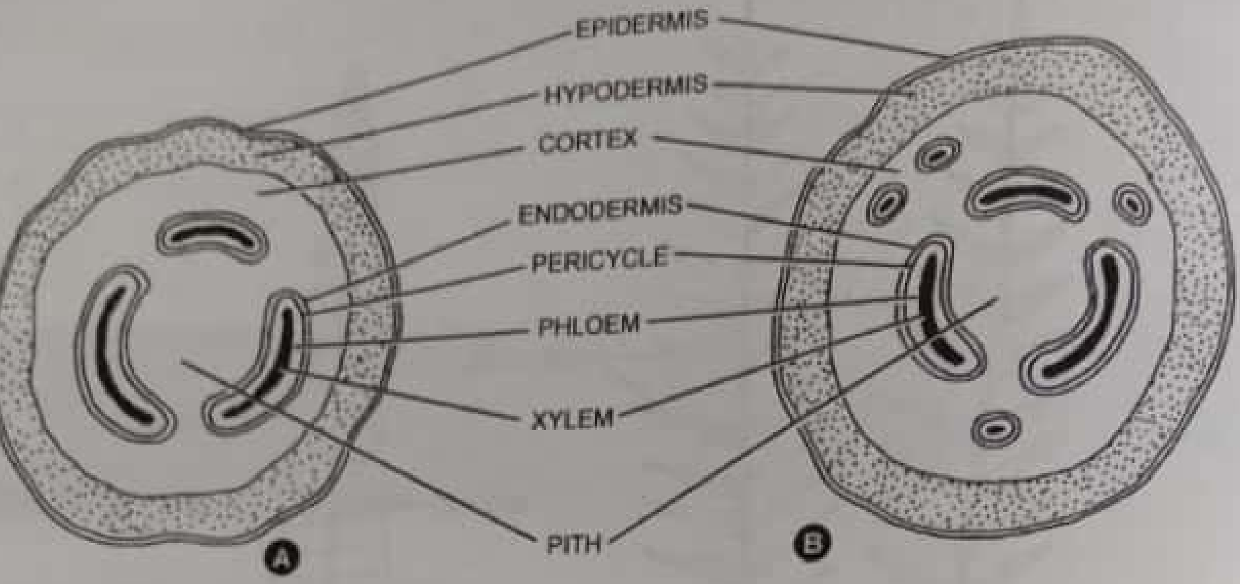

FIGURE 21.2. *Pteris vittata.* A-B, transverse sections of rhizome at two different levels (diagrammatic).

Cortex : The cortex consists of a broad zone of parenchymatous cells. The leaf traces or root traces may be present in the cortex.

Stele : The structure and organization of stele varies from species to species, or even in the same species at different levels of rhizome. It ranges from typical solenostele to polycyclic (usually dicyclic) dictyostele. The medullary strands are absent. The typical solenostelic condition is found in *P. grandifolia*. It consists of a ring of xylem surrounded on both outer and inner sides by phloem, pericycle and endodermis. The ring is broaken at one or few places by separation of leaf or root traces. The centre is occupied by parenchymatous pith.

A simple dictyostele is found in *P. cretica*, where the solenostele is further broaken at many places by

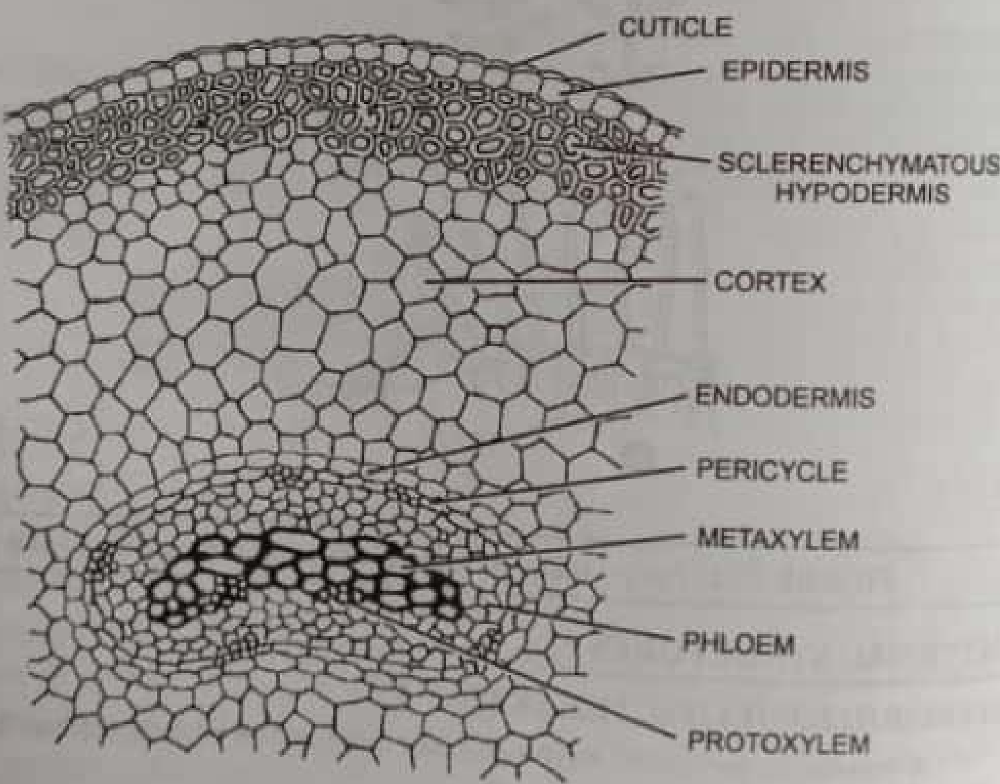

FIGURE 21.3. *Pteris vittata.* A portion of transverse section of rhizome.

the formation of leaf and root gaps. The arc or C-shaped meristeles are arranged in one ring and embedded in the parenchymatous ground tissue. The leaf or root traces, resemble the meristeles in structurs, but smaller is size.

Each **meristele** is surrounded by single layered endodermis followed by one or two layered pericycle. Next to pericycle is a single layer of protophloem composed of small sieve tubes and large parenchymatous cells. The protophloem encloses a broad zone of metaphloem composed of large sieve tubes. The companion cells are absent. The phloem surrounds the central xylem. The protoxylem is surrounded on all the sides by metaxylem and thus, the xylem is mesarch. The protoxylem consists of spiral or reticulate tracheids whereas metaxylem consists of scalariform tracheids. The xylem and phloem are separated by parenchymatous cells. The meristeles are thus, **concentric** in nature.

ROOT (Fig. 21.4)

A transverse section of root shows nearly circular outline. The outermost single layered piliferous layer consists of thin-walled cells. A few cells grow out and form root hairs.

The cortex is multilayered differentiated into outer and inner cortex. The outer cortex is thin-walled parenchymatous whereas a few-layered inner cortex is sclerenchymatous.

The endodermis is single layered with cells having casparian thickenings on their radial walls. It is followed by single layered pericycle composed of thin-walled cells. The vascular tissue consists of centrally located plate-like xylem with two protoxylem points facing opposite to each other. The metaxylem is in the centre. The xylem is thus, diarch and exarch. The phloem lies on either side of xylem.

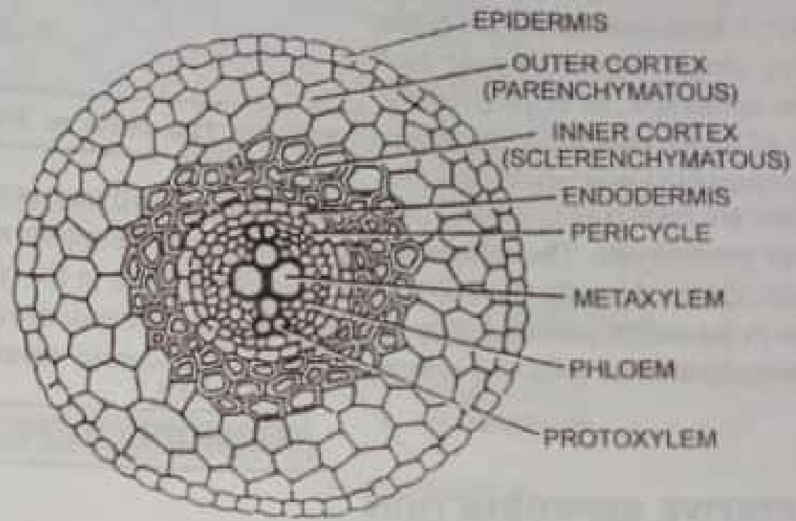

FIGURE 21.4. *Pteris* sp. Transverse section of root.

LEAF

(a) Petiole (Fig. 21.5) : The outline of transverse section of petiole is roughly semi-circular. The outermost single layered epidermis consists of narrow quadrangular cells. They are coated with thick cuticle. A few cells elongate to form multicellular unbranched hairs. The epidermis is followed by multilayered sclerenchymatous hypodermis and parenchymatous ground tissue.

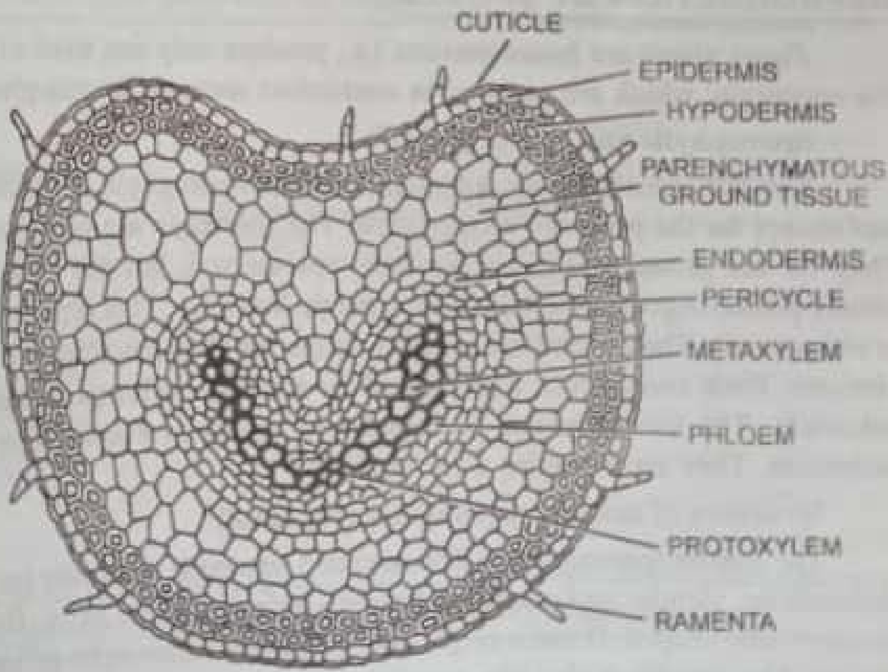

FIGURE 21.5. *Pteris* sp. Transverse section of rachis.

A C-shaped or U-shaped vascular bundle is embedded in the parenchymatous ground tissue. In structure, it resembles a meristele. It has its own single layered endodermis followed by one to two layered pericycle. The xylem is C-shaped having metaxylem in the centre and protoxylem at the terminal ends of arc. It is diarch and exarch. The xylem is surrounded by phloem.

(b) Leaflet (or pinna) (Fig. 21.6) : A transverse section of pinna shows single layered upper and lower epidermis. In *P. cretica*, the cells of upper epidermis are larger as compared to lower epidermis. The stomata are restricted to lower epidermis. The mesophyll may or may not be differentiated into palisade and spongy parenchyma. The cells of mesophyll contain chloroplasts and separated with each other by large inter cellular spaces. Usually there is a single vascular bundle in the mid-rib region. It is concentric type having xylem in the centre surrounded by phloem, pericycle and endodermis. The green mesophyll cells are replaced by parenchymatous cells and sclerenchymatous hypodermis around the mid-rib.

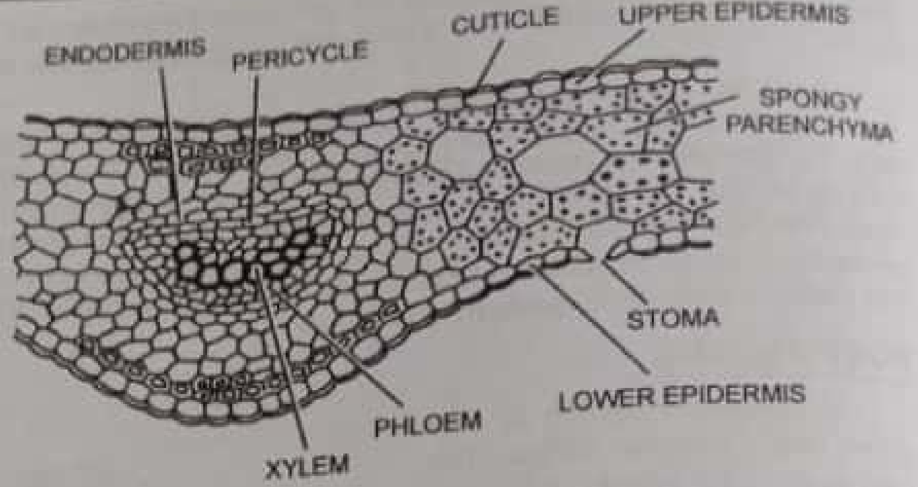

FIGURE 21.6. *Pteris* sp. Transverse section of a portion of sterile pinna.

REPRODUCTION

VEGETATIVE REPRODUCTION

Vegetative reproduction in *Pteris* occurs by death and decay of older portion of rhizome. When the decay reaches upto the branching region, the two branches separate and grow as individual plants.

REPRODUCTION BY SPORES

Pteris plants are **homosporous** *i.e.*, produce only one kind of spores. The spores are produced inside the sporangia, which are grouped in continuous sorus at the margins of fertile pinnules (sporophylls).

Sporophylls and sori (Fig. 21.7) :

The fertile leaf bearing sporangia is called sporophyll. It is similar in form and structure to vegetative leaf except for the presence of sporangia. The sporangia are borne on the lower margins of fertile pinnules. They are not grouped together in small separate sori, but the sorus is continuous in which many sori are closely placed together and lose their separate indentity. This type of sorus is called **continuous linear sorus** or **coenosorus.** The coenosorus is borne on marginal connecting vein of pinnule. It is lacking at the apices of pinnules. Each coenosorus is protected by scarious reflexed margin of fertile pinnule. It is called **false indusium.** The true indusium is completely absent in *Pteris*. The sporangia are not borne in a regular succession. They are mixed in a coenosorus.

Structure of mature sporangium (Fig. 21.8) :

The mature sporangium is differentiated into stalk and body (or capsule). The stalk is long, cylindrical, multicellular, slender and consists of three vertical rows of cells. Body of sporangium (capsule) is oval or biconvex-lens shaped. It has a single layered jacket. A few cells of jacket are modified to form stomium and annulus. The annulus is ring like, consists of vertically elongated cells. It begins from stalk on one side, runs to the top and extends upto about half way to the other side, where it joins with the epistomium. The outer and side walls of annulus are thin whereas inner tangential and radial walls are thick. It helps in the dehiscence of capsule. The stomium consists of four transversely elongated thin-walled cells. The upper two cells which join the annulus are called epistomium and the lower two which join the stalk are called hypostomium. The capsule wall encloses about 48 dark coloured homosporous spores.

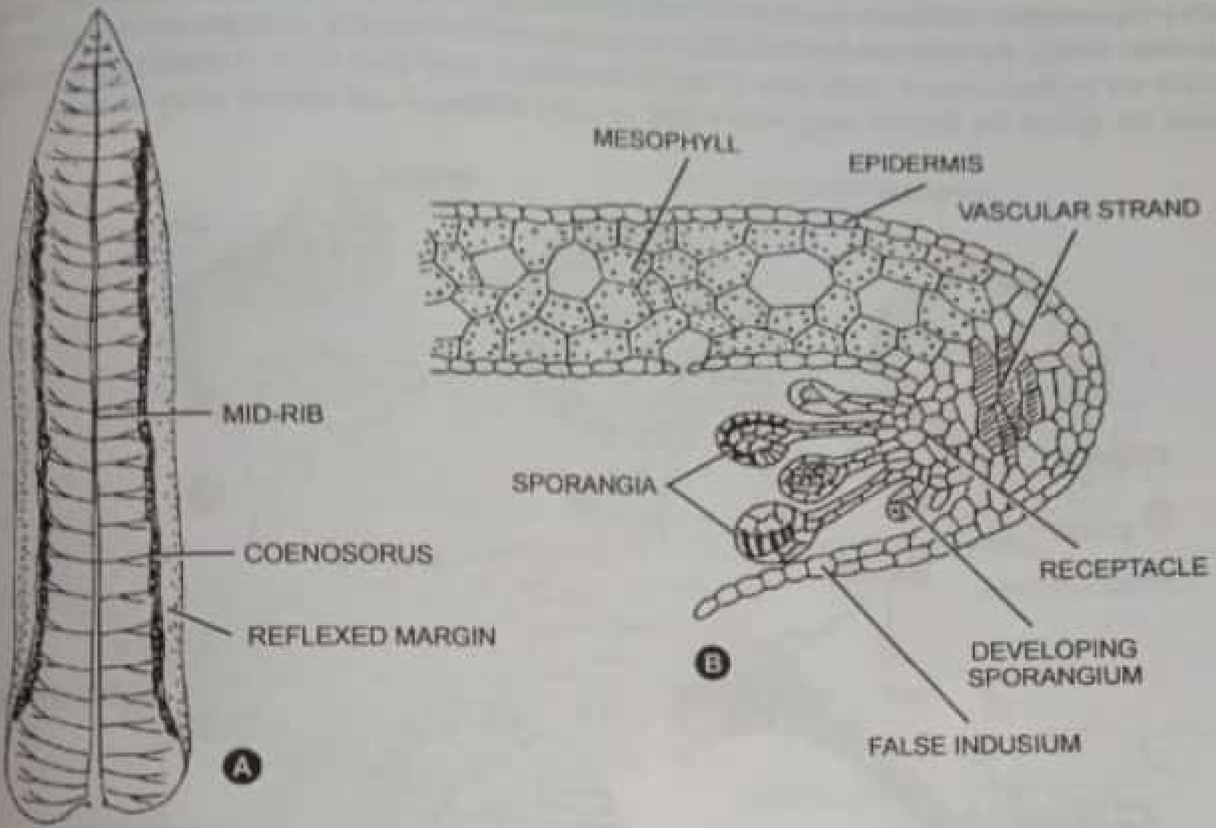

FIGURE 21.7. *Pteris* sp. A, single fertile pinna showing coenosorus ; B, transverse section of fertile pinna showing sorus.

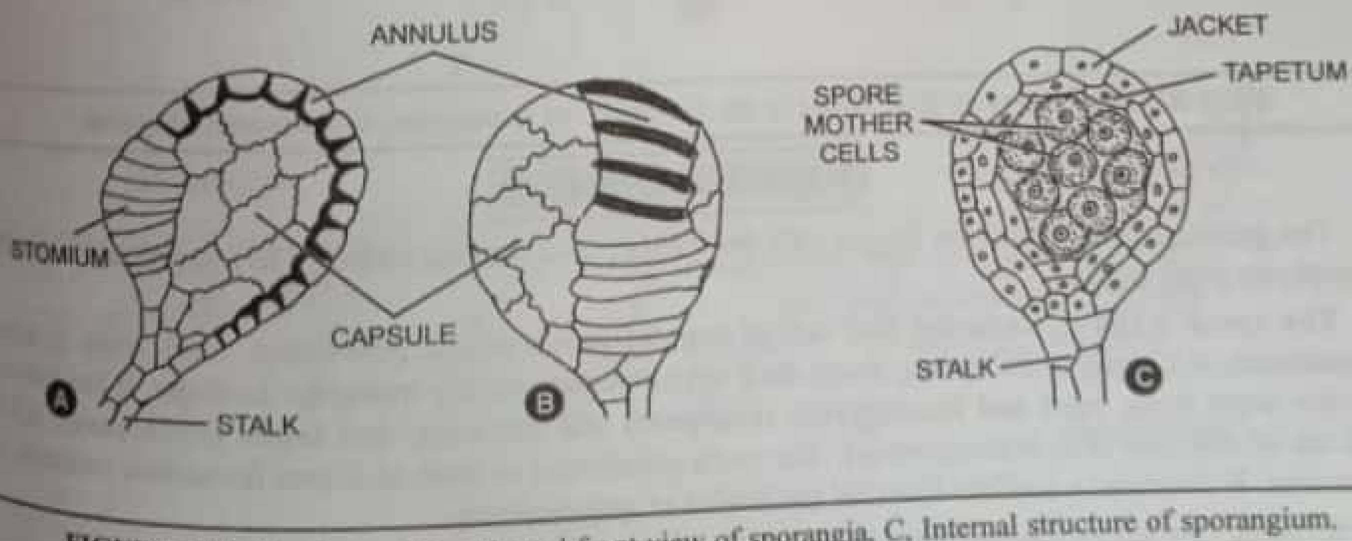

FIGURE 21.8. *Pteris sp.* A-B, side and front view of sporangia, C, Internal structure of sporangium.

Dehiscence of the sporangium (Fig. 21.9) :

The dehiscence of sporangium normally occurs in dry weather. As the coenosorus attains maturity the indusium dries and shrivels, exposing the mature sporangia to dry air. Drying causes outer cells of sporangium, including those of annulus, to lose water. The water is lost from the cells of annulus and their internal volume decreases. The outer thin walls of annulus cells are sucked-in so that the outer surface area decreases. This creates a tension in the entire annulus strip. It results breaking of stomium between the two lips (i.e., epistomium and hypostomium), where the walls are extremely delicate. The annulus bends backwards rupturing the body of sporangium and carrying its upper half containing spores. The spores are dispersed in air. As the cells continue to dry, the cohesive force of water within the cells of annulus decreaes considerably. Their thin outer walls are pushed towards outer side. It results annulus to snap back to its original position. During this movement the spores are thrown away with a jerk to some distances and carried away by wind.

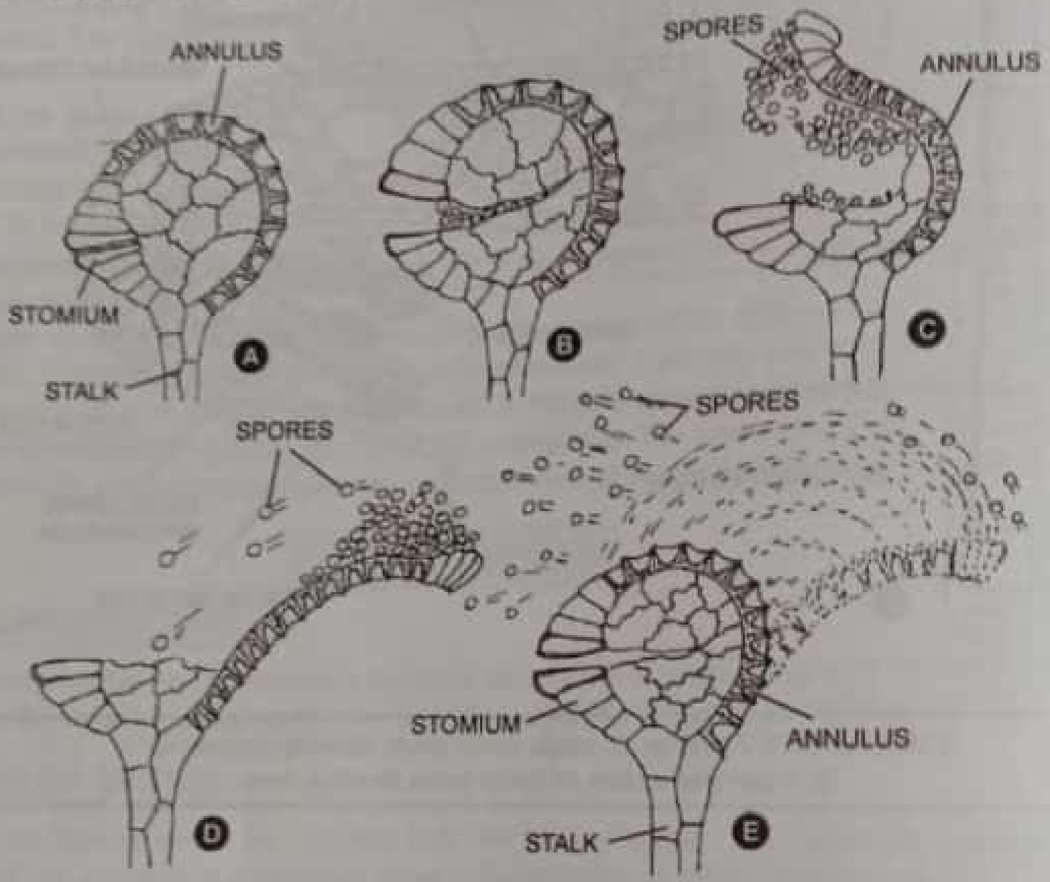

FIGURE 21.9. *Pteris sp.* A-E, stages in the dehiscence of sporangium and dispersal of spores.

THE GAMETOPHYTE

The gametophytic generation begins with the formation of haploid spores. They germinate to produce gametophytic plant body.

The spore : The spore is the first cell of haploid gametophytic generation. Each spore is minute (approximately 0.03 mm in diameter), dusty, dark coloured and roughly triangular in shape. It has two-wall layers-the outer thick, hard and brown **exine (exospore)** and the inner, thin **intine (endospore)**. All the spores are of one type (*i.e.*, homosporous). The spore germinates as soon as it gets favourable moisture and temperature. It develops a cordate bisexual prothallus or gametophyte.

Structure of mature prothallus (gametophyte) (Fig. 21.10) :

The prothallus (or gametophyte) is small (approximately 5 to 10 mm in diameter), green, heart-shaped (or cordate) and thalloid. It is flat, dorsiventral and shows an apical notch in which the growing apex is situated. The central portion of prothallus is several cells thick, called cushion whereas the lateral wings are one cell in thickness. All the cells are thin-walled, polygonal, uninucleate and bear many small discoid chloroplasts. The prothalli are autotrophic in their mode of nutrition. Many unicellular and unbranched rhizoids arise from the ventral surface near the posterior end. They penetrate into the soil and serve the function of anchorage and absorption. The rhizoids are hyaline but later on become brown. Under favourable conditions the prothalli develop both the sex-organs (bisexual) on the ventral side. The antheridia are produced towards the base, among the unicellular rhizoids whereas the archegonia develop on the central cushion behind the apical notch.

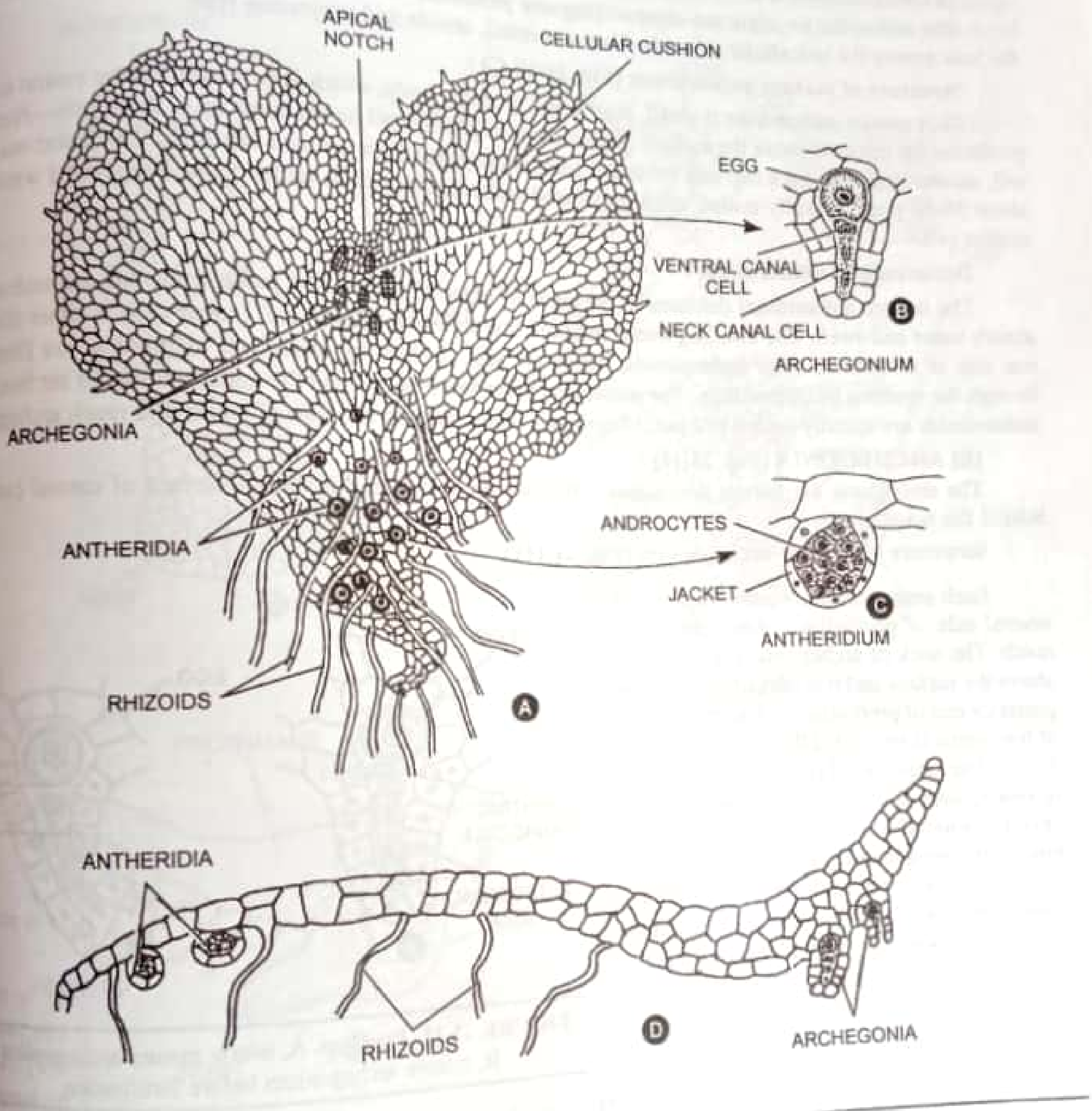

FIGURE 21.10. *Pteris sp.* A, mature prothallus as seen from below ; B, archegonium ; C, antheridium ; D, v.s. of mature prothallus.

SEX-ORGANS

The gametophytes of *Pteris* are **monoecious** and bear both the sex-organs-antheridia and archegonia. Under unfavourable conditions, they develop only antheridia. However, they develop archegonia at a later stage. The monoecious prothalli are protendrous. The sex-organs are formed on the ventral surface of prothallus. The antheridia are borne towards the posterior side whereas the archegonia are borne upon the massive cushion, just behind the apical notch.

[A] ANTHERIDIA :

The antheridia are male sex-organs. They are produced on the ventral surface of prothallus towards the base among the unicellular rhizoids. They are small, sessile and projecting type.

Structure of mature antheridium (Fig. 21.10 C) :

Each mature antheridium is small, sessile and globular body, which is embedded in the ventral side of prothallus but projects above the surface. It consists of single layered jacket made up of three cells—first ring cell, second ring cell and a cap cell (or cover cell). Sometimes there are two cap cells. The jacket encloses about 30-50 large, spirally coiled, multiflagellated antherozoids. Each antherozoid is enclosed within its mother cell.

Dehiscence of antheridium :

The mature antheridium dehisces in presence of external water. The jacket cells and the androcytes absorb water and swell. The swelling exerts pressure due to which the cap cell (cover cell) is either tilted to one side or thrown off. The antherozoids, which are still covered by androcyte membrane, are liberated through the opening of antheridium. The membrane dissolves in water and the antherozoids are set free. The antherozoids are spirally coiled and multiflagellated. They swim in the film of water and reach archegonia.

[B] ARCHEGONIA (Fig. 21.11) :

The archegonia are female sex-organs. They are produced on the ventral surface of central cushion behind the apical notch.

Structure of mature archegonium (Fig. 21.11) :

Each archegonium is embedded in the ventral side of prothallus behind the apical notch. The neck of archegonium is projected above the surface and it is curved towards the posterior end of prothallus. The **neck** consists of four vertical rows of cells. Each row has 3-7 cells. The axial row of archegonium consists of single, large and deeply seated **egg ;** single small, **ventral canal cell** and a long, binucleate **neck canal cell.** At maturity the ventral canal cell and neck canal cell disintegrate and become mucilaginous. The mucilage imbibes water and swells. It exerts pressure so that neck cells diverge and create a wide opening.

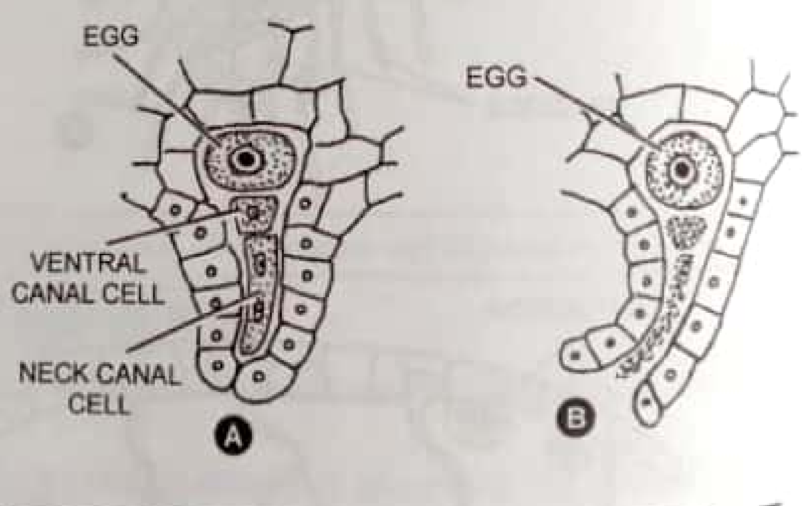

FIGURE 21.11. *Pteris sp.* A, nearly mature archegonium ; B, mature archegonium before fertilization.

FERTILIZATION

Fertilization occurs in presence of water. The water fills the space between the lower surface of prothallus and soil. It is needed for the dehiscence of antheridia, liberation and movement of antherozoids and opening of archegonial neck. The antherozoids liberated from dehisced antheridia, swim in all directions in the film of water between prothallus and soil. The mature archegonium secretes mucilage that contains some chemical substances *viz.*, malic acid. The antherozoids are chemotactically attracted towards the open mouth of archegonia. They reach the archegonial mouth and enter into the neck canal. Many antherozoids can enter but only one fuses with the egg. The haploid nucleus of antherozoid fuses with the hapolid nucleus of egg and forms diploid **Zygote.** Usually only one archegonium is fertilized, the others remain unfertilized.

THE EMBRYO
(Young sporophyte)

Zygote is the first cell of sporophytic generation. It remains embedded in the archegonium and develops into an embryo, which ultimately gives rise to mature sporophytic plant body (Fig. 21.12). The polarity of

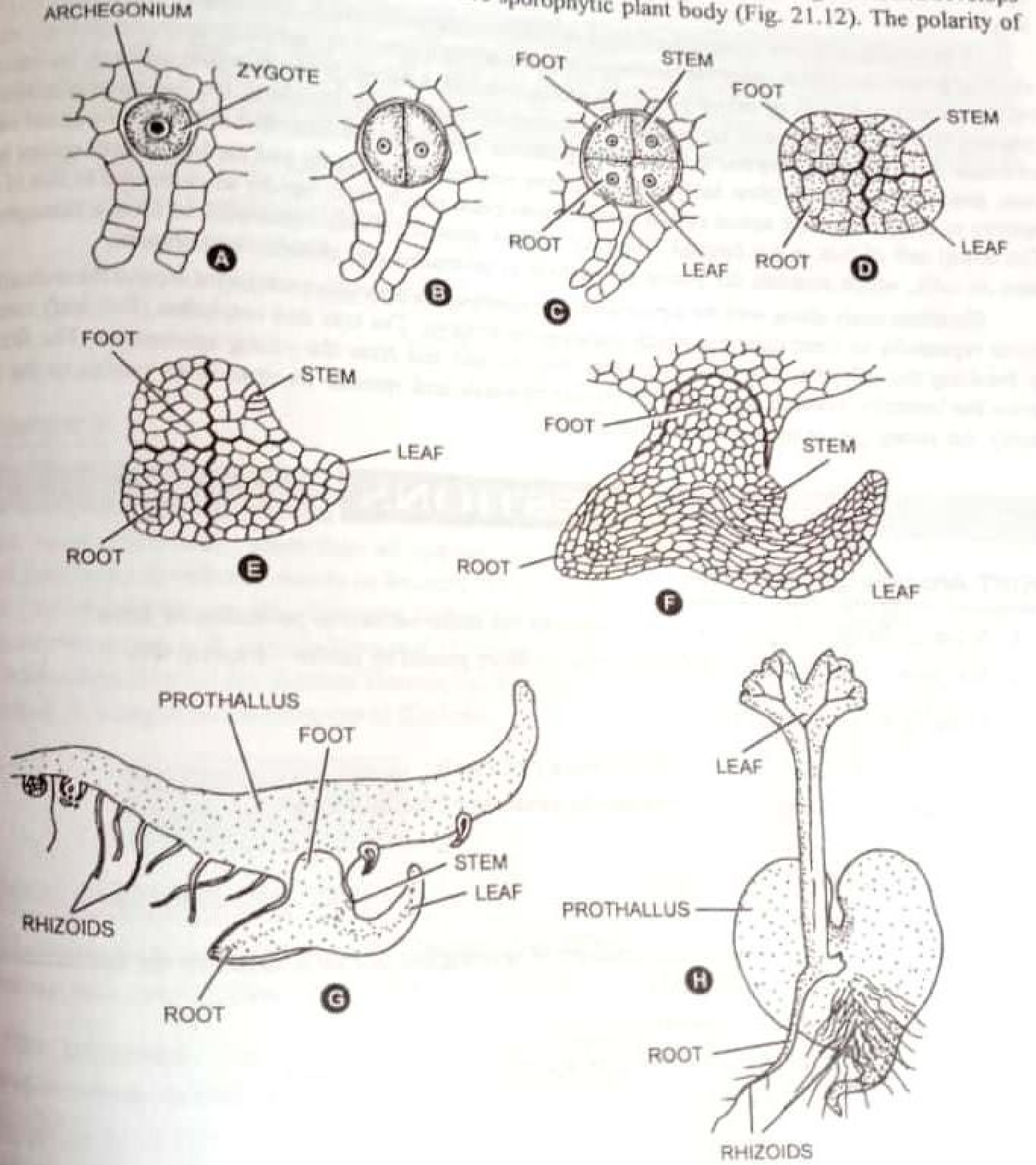

FIGURE 21.12. *Pteris sp.* A-G, stages in the development of embryo ; H, young sporophyte attached to prothallus.

embryo development is **lateral** because its axis is at right angles to that of archegonium (It is neither exoscopic nor endoscopic).

The zygote divides by vertical wall, formed parallel to the long axis of the archegonium, forming two unequal cells. The smaller cell towards the anterior side of prothallus is **epibasal cell** and that towards posterior side is **hypobasal cell.** The next division occurs by the formation of a median wall at right angles to the first division wall resulting into a four celled **quadrant** stage. The third division is transverse occurs by the formation of wall perpendicular to the long axis of archegonium. It results into eight celled **octant** stage.

The organs of future sporophyte begin to differentiate at this stage. The anterior (epibasal) half forms shoot apex and cotyledon, whereas posterior (hypobasal) half gives rise to first root and haustorial foot. The two outer anterior cells of octant (near the archegonial neck) form the **cotyledon** whereas the other two anterior cells (towards base of archegonium) produce the **shoot apex.** Similarly, the two outer posterior cells of octant form the **root** whereas the other two posterior cells form the **foot**. Subsequently the apical cells of root, stem and cotyledon (first leaf) appear in their respective quadrants and further growth occurs by the activity of these cells. The apical cell of root and cotyledon grows more rapidly as compared to that of stem. The apical cell of foot is not formed. The cells of foot quadrant divide repeatedly to form a hemispherical mass of cells, which attaches the young sporophyte to prothallus and absorbs nourishment.

Simultaneously along with the development of embryo, the cells of gametophyte around the archegonium divide repeatedly to form calyptra, which encloses the embryo. The root and cotyledon (first leaf) come out by breaking the calyptra. The root penetrates into the soil and fixes the young sporophyte. The first leaf grows horizontally towards apical notch, bends upwards and spreads its spathulate lamina to the light. Finally the young sporophyte becomes independent.

QUESTIONS

SHORT ANSWER QUESTIONS

1. What is the advantage to have sex-organs on the under surface of prothallus of ferns ?
2. The young foliage leaves of *Pteridium* are seldom grazed by cattles—Explain why ?

LONG ANSWER QUESTIONS

3. Give an illustrated account of the life-history of *Pteris*.
4. With labelled diagrams only illustrate the structure of the following—
   (*a*) T.S. of rhizome of *Pteris*.
   (*b*) T.S. of fertile pinna of *Pteris*.
   (*c*) T.S. of *Pteris* petiole.
5. Give an illustrated account of the structure of sporangium of *Pteris*. Describe the mechanism of its dehiscence and dispersal of spores.
6. Write short notes on the following :—
   (*a*) Mechanism of sporangial dehiscence and spore disperal in *Pteris*.
   (*b*) Morphology of *Pteris* rhizome.
   (*c*) Prothallus of a homosporus fern.
7. With the help of labelled diagrams describe the structure of gametophyte of *Pteris*. How do the sperms reach the archegonia.