# Pteridophyta Classification

# PTERIDOPHYTE CLASSIFICATION

- The classification of pteridophytes has been changing in the recent past, mainly because of discoveries of several new fossil plants in different parts of the world.
- Several scientists proposed different classification systems.
- Among them, the classification given by **SMITH (1957), CRONQUIST (1966), BIERHORST (1971)** and **A R SMITH (2006)** are considered as major ones.
- According to SMITH (1957), the Pteridophytes has been classified into 4 classes, viz.,
  1. Psilophyta
  2. Lepidophyta
  3. Calamophyta
  4. Pterophyta

**1. PSILOPHYTA**

- They are primitive Pteridophytes
- The plant body is sporophytic, and the sporophytes are rootless with Numerous rhizoidal hairs.
- They are homosporous.
- This includes only two genera, viz., *Psilotum* and *Tmesipteris*

**2. LEPIDOPHYTA**

- The sporophytic plant body is differentiated into roots, stem and leaves.
- Leaves are small, univeined, generally spirally arranged on the stem.
- Leaf gaps are absent.
- Sporangia are present on the adaxial surface of sporophylls, and both sporangia and sporophylls are loosely arranged in the form of strobilus.
- Some are homosporous (e.g. Lycopodium) while others are heterosporous
- This group includes five living genera, viz., *Lycopodium*, *Selaginella*, *Phylloglossum*, *Isoetes* and *Stylites*.

## 3. CALAMOPHYTA

- The sporophytic body is divided into  divisible into roots, stem and leaves.
- The stem is branched, articulated, longitudinally furrowed and contains nodes and internodes.
- Leaves are small, scaly and arranged on the nodes in the form of a whorl.
- Sporangia develop on sporangiophores, and all these together constitute a compact strobilus or cone.
- Most species are homosporous. Prothalli (gametophyte) may be monoecious or dioecious.
- It consists of one living genus (18 fossil genera), i.e., Equisetum.
- **4. PTEROPHYTA**
- This group includes all the megaphyllous pteridophytes, like ferns.
- The sporophytic plant body includes roots, stem and large-sized leaves.
- Sporangia occur in groups called **SORI**.
- The sori develop on the margin or on the abaxial (ventral) surface of leaves.
- Some members are homosporous, while others are heterosporous.

# *Selaginella*

## DISTRIBUTION AND HABITAT

- **Systematic Position**
  - Class : Lycopsida
  - Order : Selaginellales
  - Family : Selaginellaceae
  - Genus : *Selaginella*
- The genus Selaginella consists of about **700** species.
- In India, **65** species are reported.
- Majority of the species occurs in **TROPICAL** and **SUB-TROPICAL** regions, and some also occur in **TEMPERATE** regions of the world.
- Most of the species grow on the **GROUND** of tropical rain forests, in **HUMID AND SHADY HABITATS**, as well as on the **DAMP SHADY PLACES**. A few species are **XEROPHYTES** e.g. *S. rupestris* and *S. lepidophylla*.

# SPOROPHYTIC PHASE

# MORPHOLOGY OF SPOROPHYTE

- The dominant phase of the plant is sporophyte and the sporophytes vary greatly in size and other morphological characteristics.
- The length of the plant body varies from 5-6 cm (*S. selaginoides*) to 20 meter (*S. willdenovii*).
- Many species are flat creepers on the ground (S. kraussiana), whereas some species have moss-like upright branches (*S. rupestris*).
- **STEM**: In some species, the stem is erect and shows a dichotomous type of branching, while in some species, the stem is prostrate or suberect with lateral branching.
- **LEAVES**: The leaves are simple, and contain a midrib. In some species the leaves are only one type and in some the leaves are two types (small and large). This character made them to devide into two sub-genus. The leaf gaps are absent.
- **ROOTS**: The plants are supported by dichotomously branched roots which helps in anchoring and absorption of nutrients from the soil.
- **RHIZOPHORES**: They are long, unbranched, leafless structure towards the lower side of the stem.

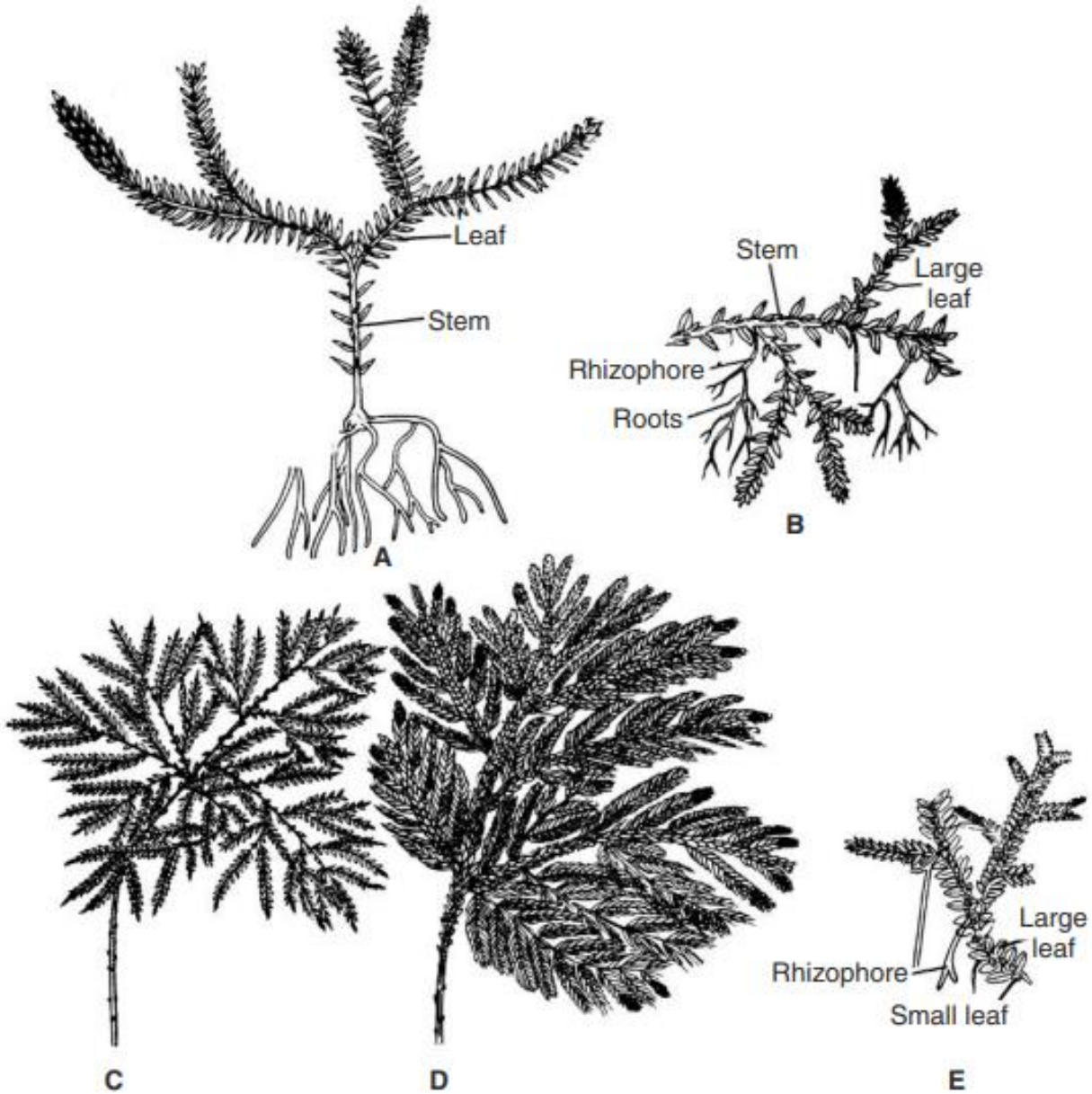


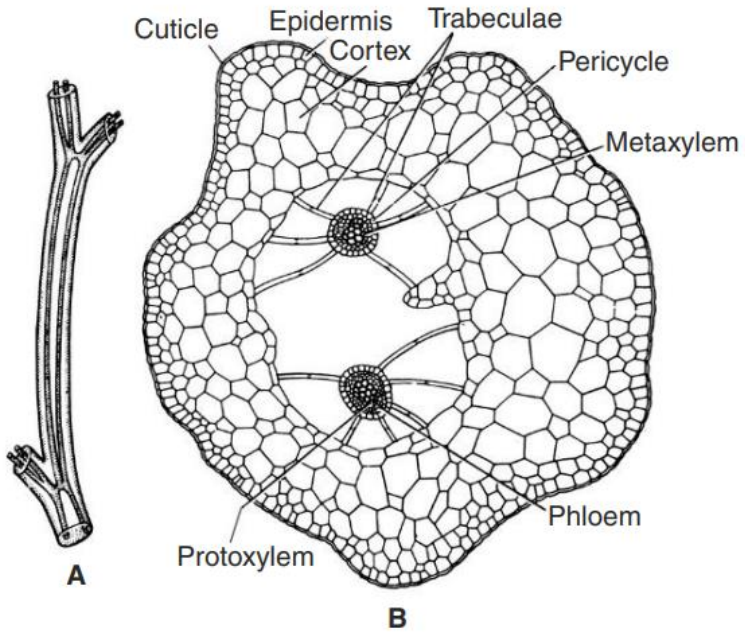

**Fig. 12.1** *Selaginella*, external features: (A) *S. selaginoides*; (B) *S. kraussiana* ; (C) *S. braunii*; (D) *S. umbrosa*; (E) *S. martensii* (A, after Bower; B, after Smith; C–D, after Heironymus; E, after Goebel).

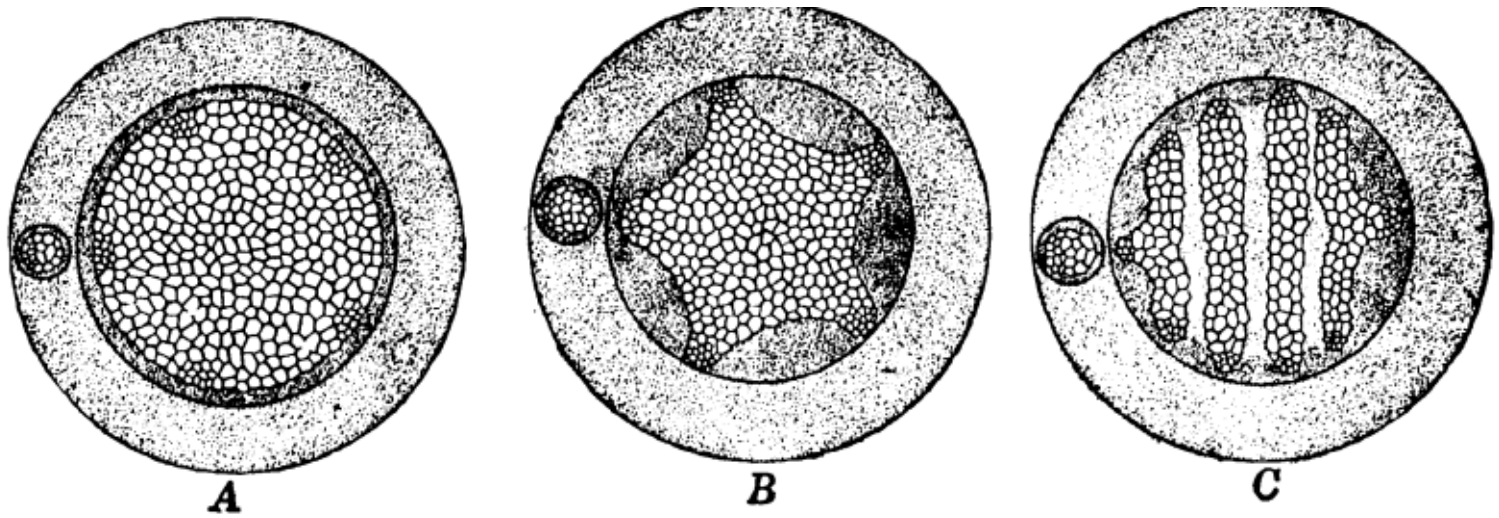
# ANATOMY OF STEM

- Anatomically, the stem is differentiated into an outer layer of **EPIDERMIS**, middle layers of **CORTEX** and centrally located **STELE.**

1. **EPIDERMIS:** The outermost one-celled thick layer consists of cutinized cells with no stomata.
2. **CORTEX**: The cortex consists of an outer thick-walled sclerenchymatous layer and inner thin-walled parenchymatous cells.
3. **STELE**: It is the centrally located part.
   - ✓ It is connected with the cortex with the help of many, long radially elongated cells called **TRABECULAE**.
   - ✓ In between the trabeculae are present large intercellular spaces or **lacunae**.
   - ✓ The number of steles is variable from **1** (*S. spinulosa*) to 16 (*S. laevigata*) in different species.

- ✓ The number of steles is variable from **1** (*S. spinulosa*) to 16 (*S. laevigata*) in different species.
- ✓ The type of stele It also varies from a simple **PROTOSTELE** to a **POLYCYCLIC SIPHONOSTELE**.
- ✓ The xylem is **ENDARCH** in condition.
- ✓ Typically there is no secondary growth in *Selaginella.*

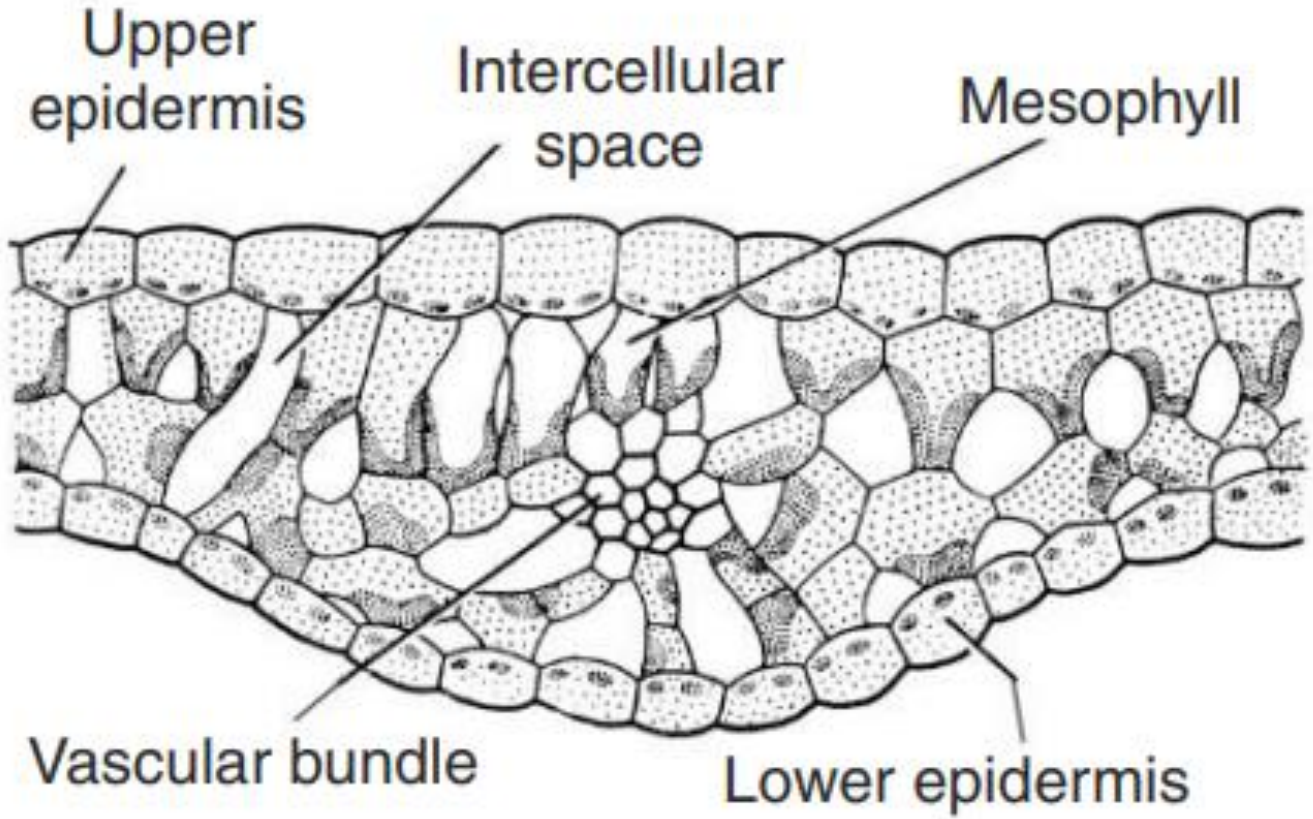


# ANATOMY OF LEAF

- Anatomically, the leaf is differentiated into an outer layer of **EPIDERMIS**, middle layers of **MESOPHYLL** and centrally located **STELE.**

1. **EPIDERMIS:** Externally, a leaf is bounded by an upper and a lower layer of epidermis. The stomata may be present on both the layers.
2. **MESOPHYLL**: Inside the epidermis is present the mesophyll, the cells of which contain chloroplasts. Mesophyll is **not differentiated** into palisade and spongy parenchyma
3. **STELE**: In the centre is present a single vascular bundle, which is median and concentric.
   - ✓ The stele type is **protostele**.
   - ✓ A layer of bundle sheath cells surrounds Stele.


Upper epidermis
Intercellular space
Mesophyll
Vascular bundle
Lower epidermis

# ANATOMY OF ROOT

- Anatomically, the root is similar as that of stem, and is differentiated into an outer layer of **EPIDERMIS**, middle layers of **CORTEX** and centrally located **STELE.**

1. **EPIDERMIS:** This is the outermost layer made up of large cells. Some cells possess root hairs.
2. **CORTEX**: Below the epidermis are present a few layers of parenchymatous cortex. But in older roots, the cortex is a region of thick-walled sclerenchymatous cells. In some species, the outer few layers are converted into sclerenchymatous cells.
3. **STELE**: It is the centrally located part.
   - ✓ The endodermis seperates the cortex from stele.
   - ✓ 3-4 layers of pericycle is present.
   - ✓ Stele type is protostele and they are in **monarch** to **tetrarch** and **exarch** structures.

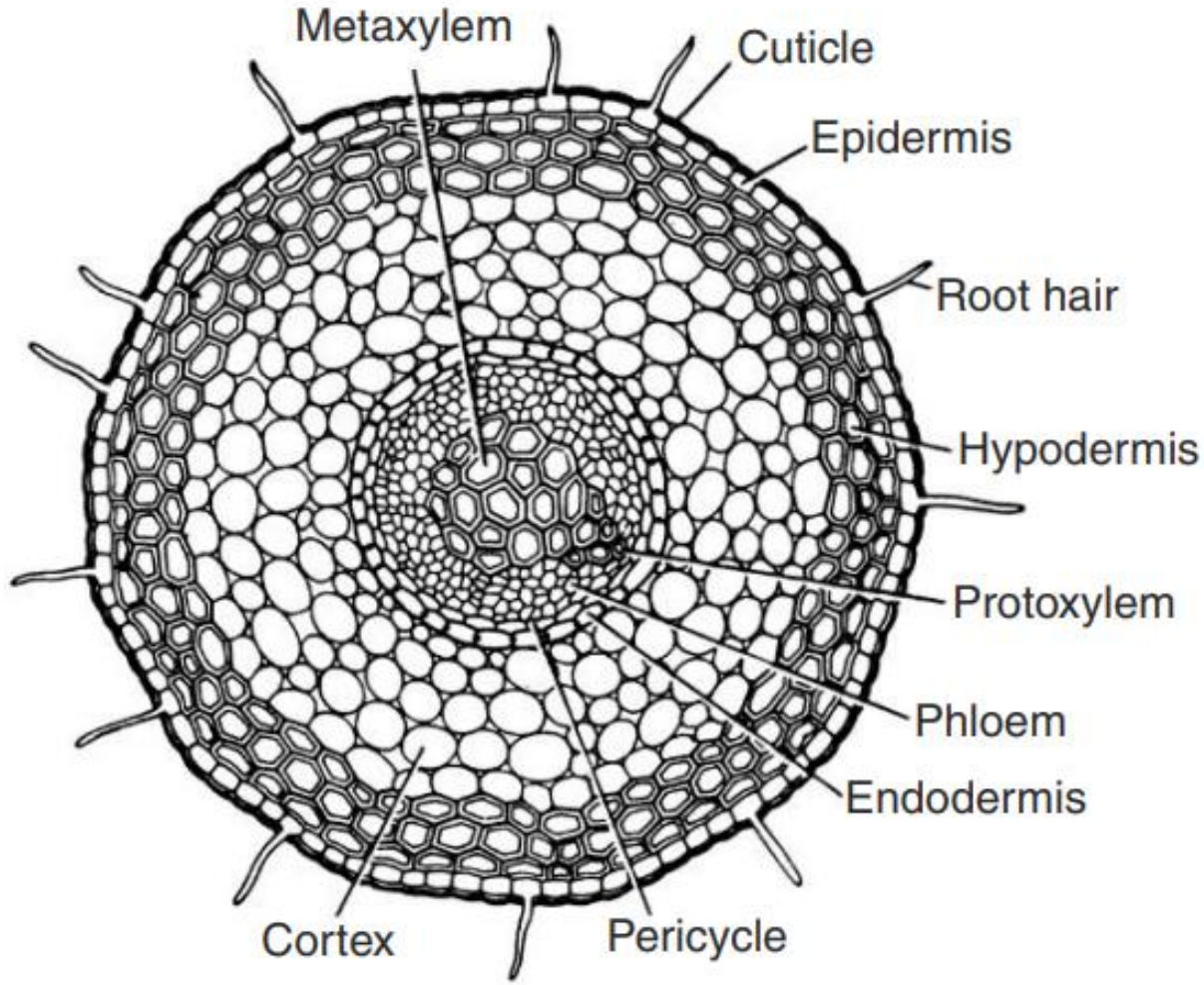



**Fig. 12.8** *Selaginella chrysocaulos*, T.S. root.

# REPRODUCTION

## 1. VEGETATIVE REPRODUCTION

- Vegetative reproduction is common in *Selaginella*.
- **FRAGMENTATION.**
- Prostrate branches become **ROOTED AT CERTAIN PLACES**, are later separated, and behave as a new individual plant.
- **TUBERS** develop at the tips of underground branches arising from the base of the stem.
- **RESTING-BUD**develop at the ends of some aerial branches and grow into new individuals when the conditions are favourable.

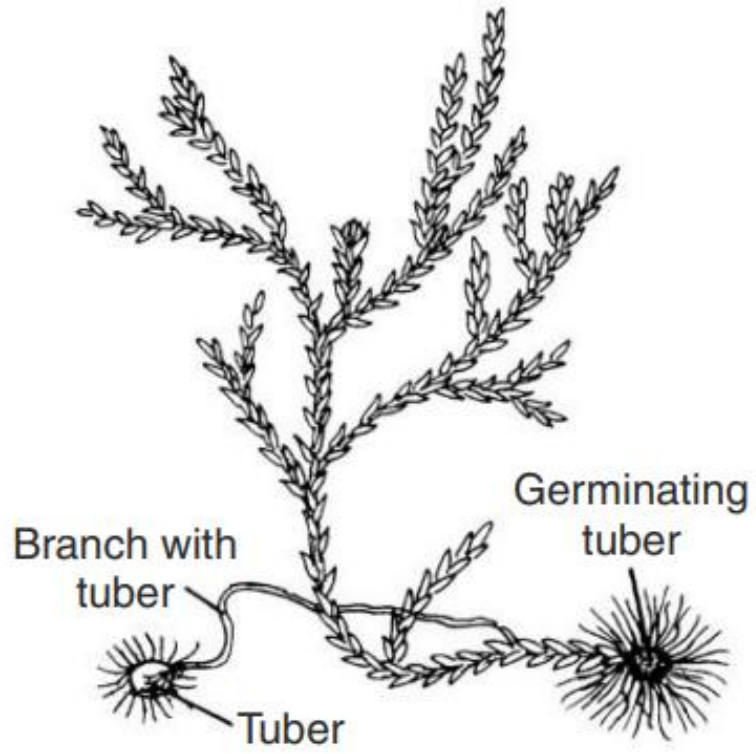



**Fig. 12.12** *Selaginella chrysorrhizos*, showing germination of tuber.

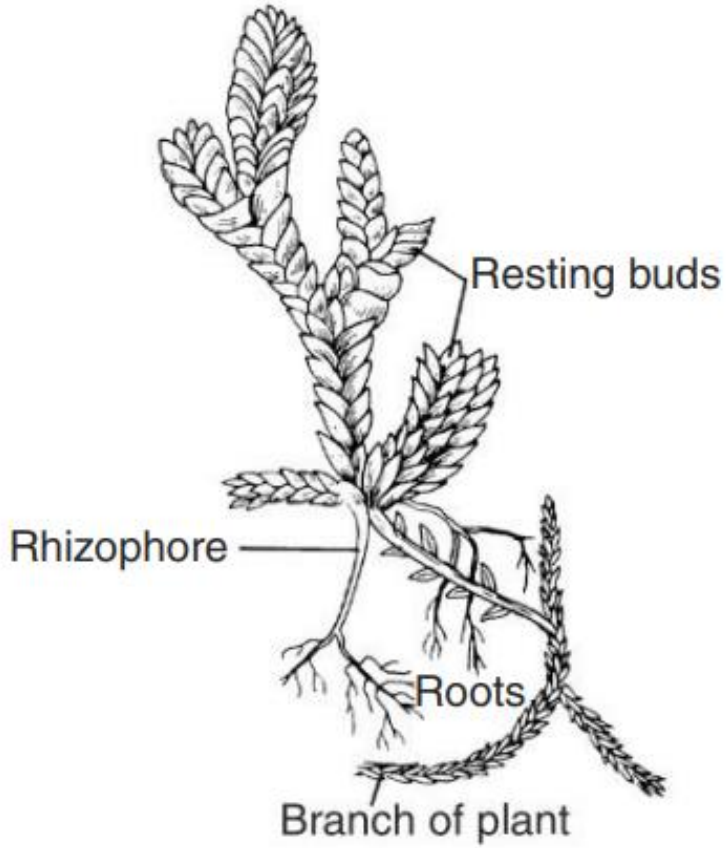



**Fig. 12.13** *Selaginella chrysorrhizos*, a part of plant having resting buds.

## 2. ASEXUAL REPRODUCTION

- Asexual reproduction is by the formation of spores.
- The spores are produced within the spore-producing structures called **SPORANGIA**.
- The sporangia may be born on apical position of main axis or lateral branches.
- The sporangia are present in the axils of leaf-like structures called **SPOROPHYLLS**.
- Sporophylls are loosely or spirally arranged, usually in four rows on the axis and they form a loose cone-like structure called **STROBILUS** or **SPORANGIFEROUS SPIKE**.

**STRUCTURE OF A STROBILUS**:

- ✓ The strobilus is a structure bearing sporophylls and present at the apex of the main stem or lateral branches.
- ✓ Sometimes, it continues its growth as a vegetative branch.
- ✓ Most of the *Selaginella* species are **heterosporic** and some are **homosporic**.
- ✓ In heterosporic species, the strobilus bears two types of sporophylls, i.e., **MICROSPOROPHYLLS** and **MEGASPOROPHYLLS**.

- ✓ Microsporophylls produce microspores and megasporophylls produce megaspores.
- ✓ In homposporic species, only one type of sporophylls are present in the strobilus.

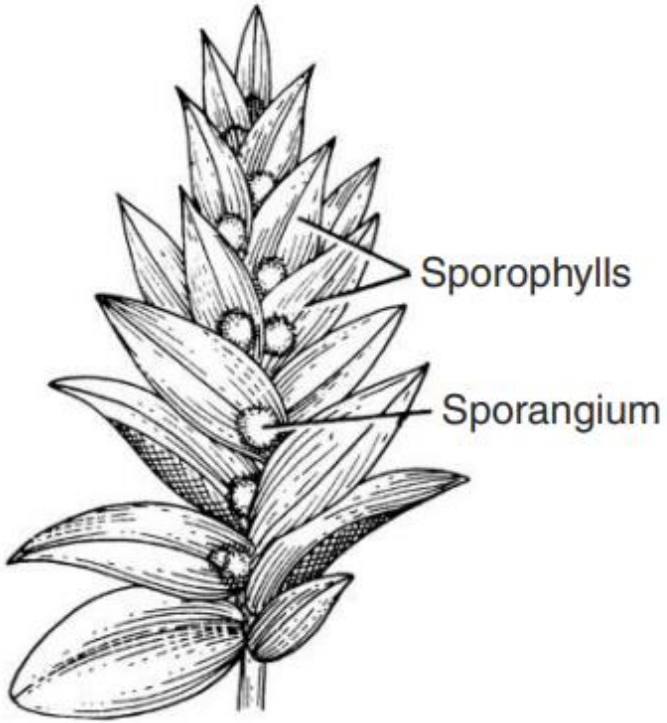



**Fig. 12.14** Strobilar region of *Selaginella apoda* (after Clute).

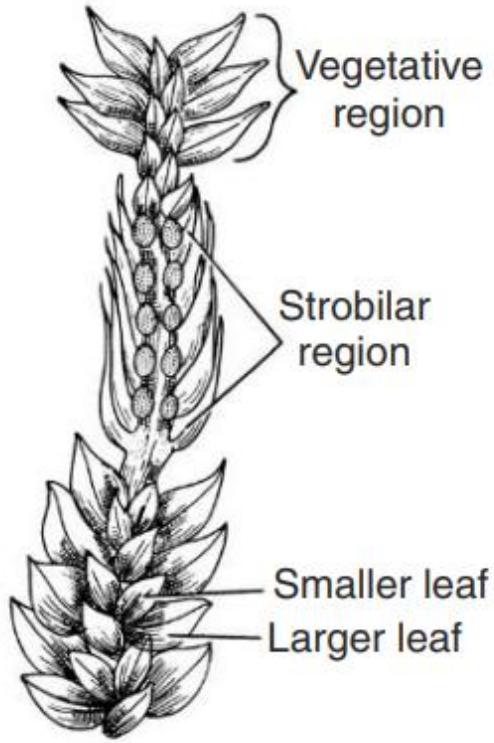
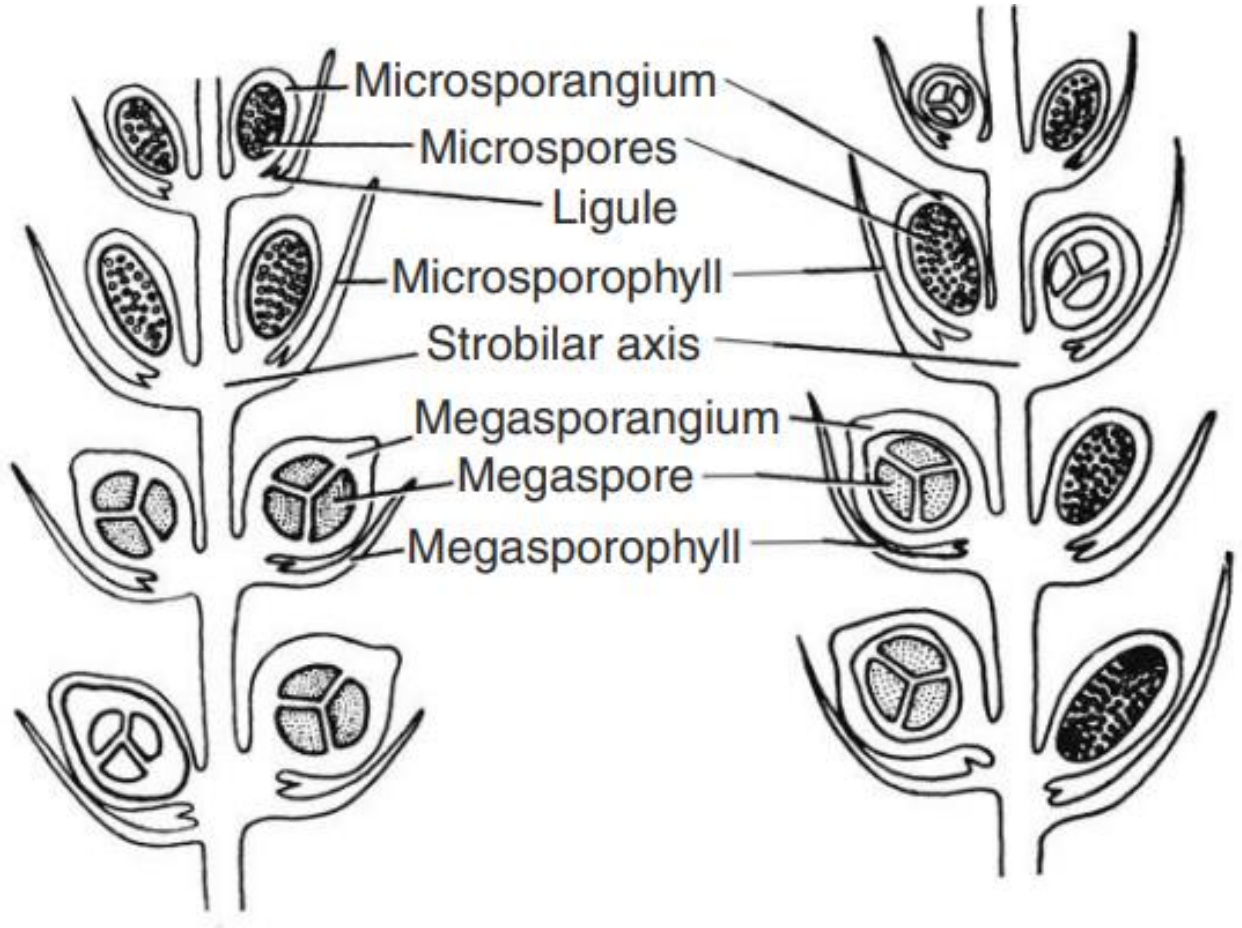



**Fig. 12.15** *Selaginella* sp. showing strobilar region changing into vegetative region (after Mitchell).

**ARRANGEMENT OF STROBILI:**

- ✓ The arrangement of strobili may be different in different species.
- ✓ In most of the species basal sporophylls are megasporophylls bearing megasporangium, while all the remaining are microsporophylls bearing microsporangia.
- ✓ But in some species, the sporophylls of one side of strobilus are microsporophylls, while those of other side are megasporophylls. n S. rupestris and many other species,
- ✓ In a few species, there is no definite arrangement of micro and megasporophylls.



- **MATURE SPORANGIUM:**
- Mature Sporangium (both micro and mega) are shortly stalked structures usually surrounded by a wall of two layers.
- The cells of the outer layer are thick-walled, while that of the inner layer are thin-walled.
- Mature microsporangia may be yellow, brown or red-coloured structures while the megasporangia are greenish-white or pale in colour.
- Megasporangia are generally four-lobed structures, each lobe having one megaspore.
- Megasporangium is much larger than microsporangium.
- After the maturation, the sporangial wall ruptures are spores come out and carried out by wind currents.
- The microspore germinates and form **MICROGAMATOPHYTES** or **MALE GAMATOPHYTES**.
- The megaspore germinates and form **MEGAGAMATOPHYTES** or **FEMALE GAMATOPHYTES**.

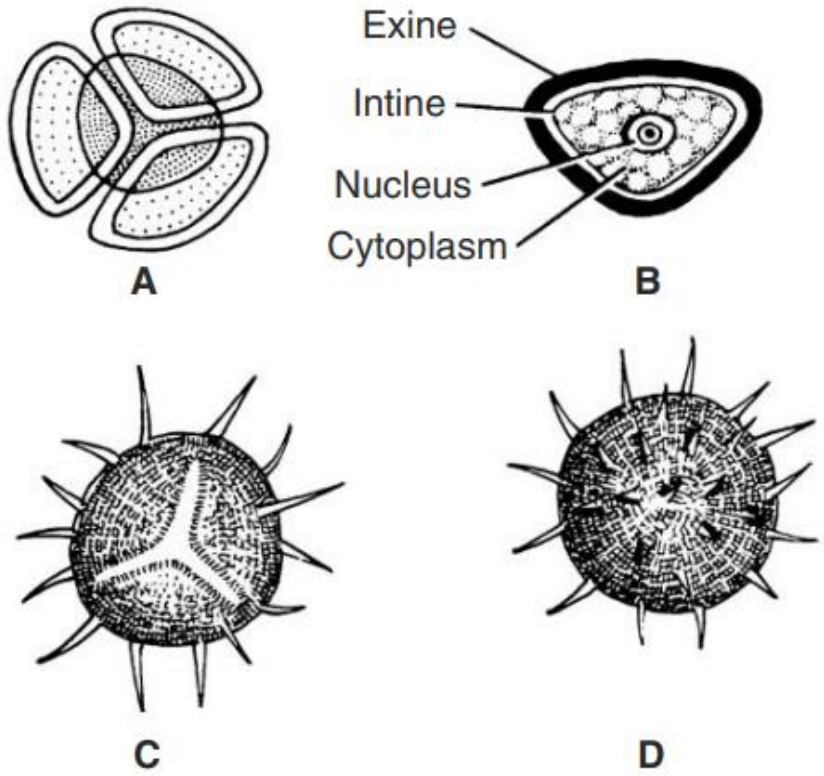



**Fig. 12.19** *Selaginella kraussiana*: (A) microspores in tetrad; (B) a single microspore; (C) apical view of microspore; (D) basal view of microspore (C and D, after Slagg).

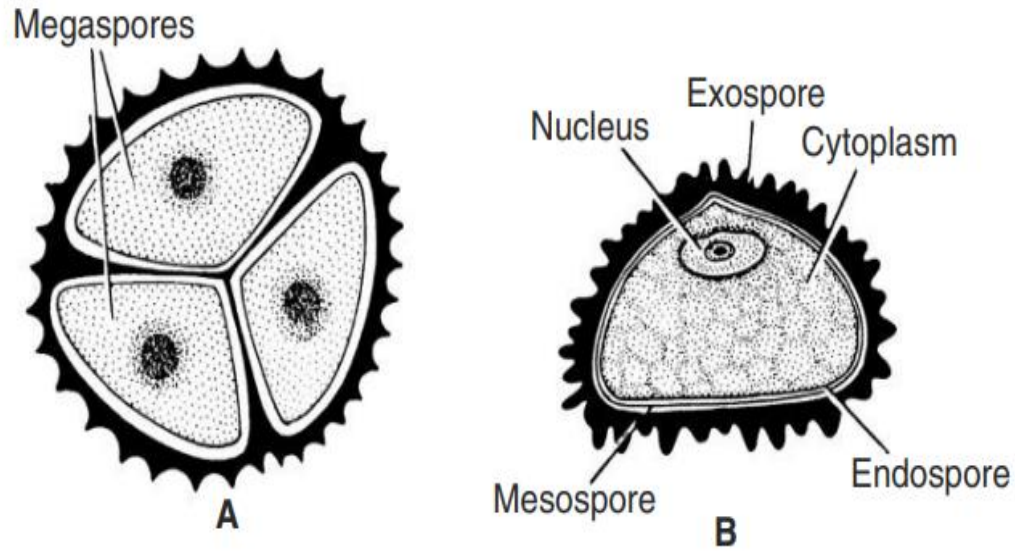


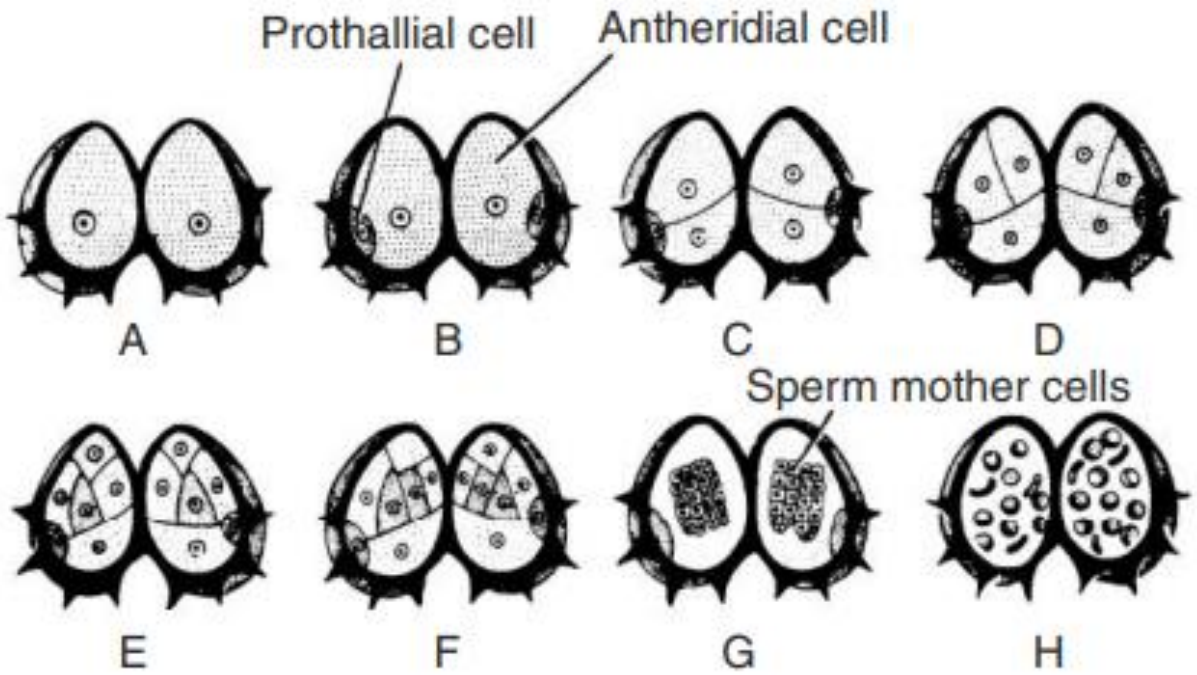

**Fig. 12.20** *Selaginella* sp. (A) megaspores in tetrad; (B) a single megaspore.

# GAMATOPHYTIC PHASE

# GAMATOPHYTES

- The spore is the first cell of the gametophyte.
- Microspore develops into microgametophyte or the male gametophyte, whereas megaspore develops into megagametophyte or female gametophyte.
- The gametophytes are very much reduced structures and they are called as **PROTHALLUS**.
- The structure of **ANTHERIDIUM** and **ARCHEGONIUM** are closely resembles as that of Bryophytes.
- The germination of microspore is ***IN SITU*** or **PRECOCIOUS**, i.e. it starts within the microsporangium.
- The microsporangium in *S. kraussiana* dehisces when the microgametophyte attains a 13-celled stage. It produces **ANTHERIDIUM** inside which male gamates or **ANTHEROZOIDS** are formed.
- The antheridial mother cells divide meiotically to form a haploid antherozoids.
- Antherozoids are biflagellate and uninucleate structures.

- The development of megagametophyte from megaspore also starts **IN SITU**, i.e. while it is lying in the sporangium. But the actual development differs from species to species.
- A mature archegonium thus consists of a neck made up of two tiers of four cells each, a neck canal cell, a venter canal cell and an egg.
- The egg mother cell
- Fertilization takes place after the megagametophyte has fallen on the ground.
- At the time of fertilization, the neck cells are spread apart, and the neck canal celland venter canal cell are disintegrated, thus leaving a free passage for the entry and union of the antherozoid with the egg.
- Dew or rain water helps transfer antherozoids up to the neck of the archegonium.
- The resultant zygote now develops into an embryo and subsequently into a **SPOROPHYTE**.



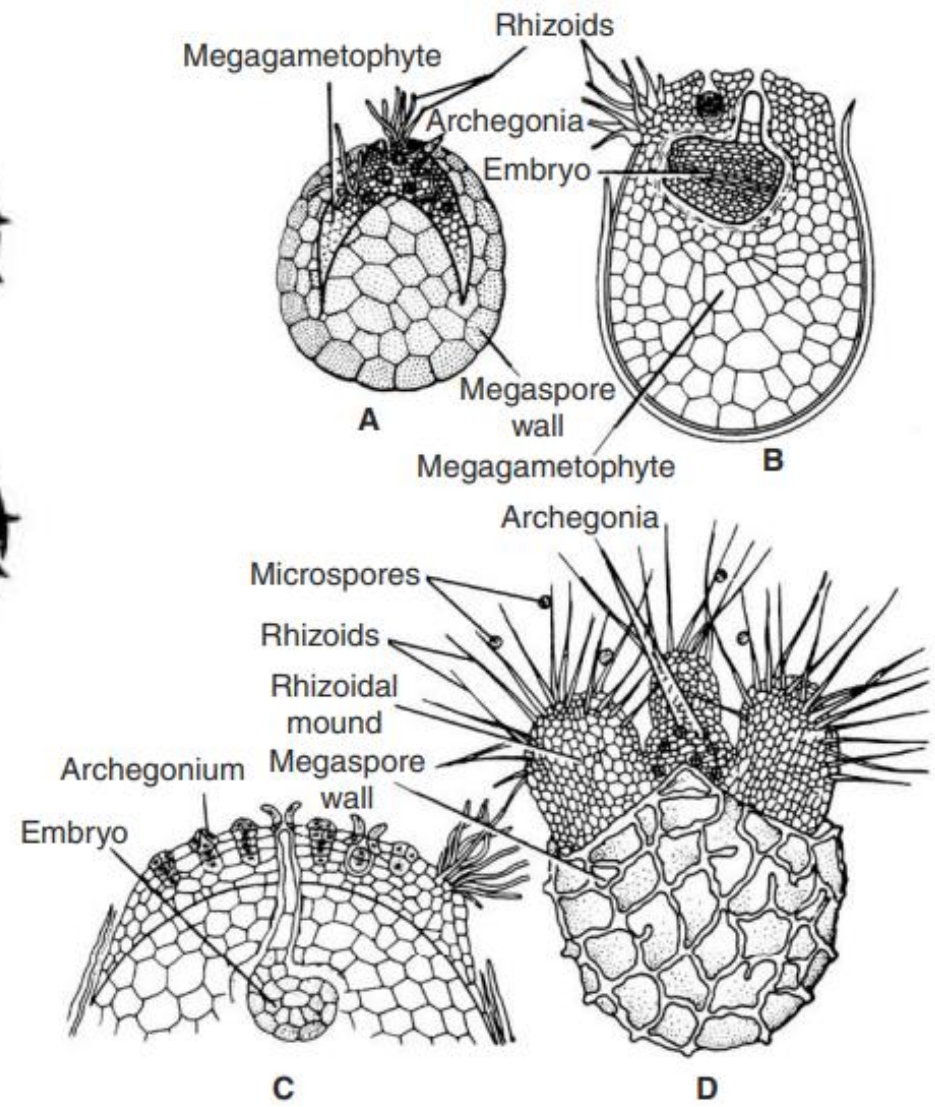




**Fig. 12.26** *Selaginella*, showing mature female gametophytes of some species with apical sex organs. (A) S. *kraussiana*; (B) S. *martensii*; (C) S. *poulteri*; (D) S. *galeottii* (after Bruchmann).

# SPOROPHYTE

- The mature embryo develops into a sporophyte.
- In the early stages, the young sporophyte may remain attached to the megagametophyte, but later on the first root penetrates the ground and starts to function normally by producing the young sporophyte.

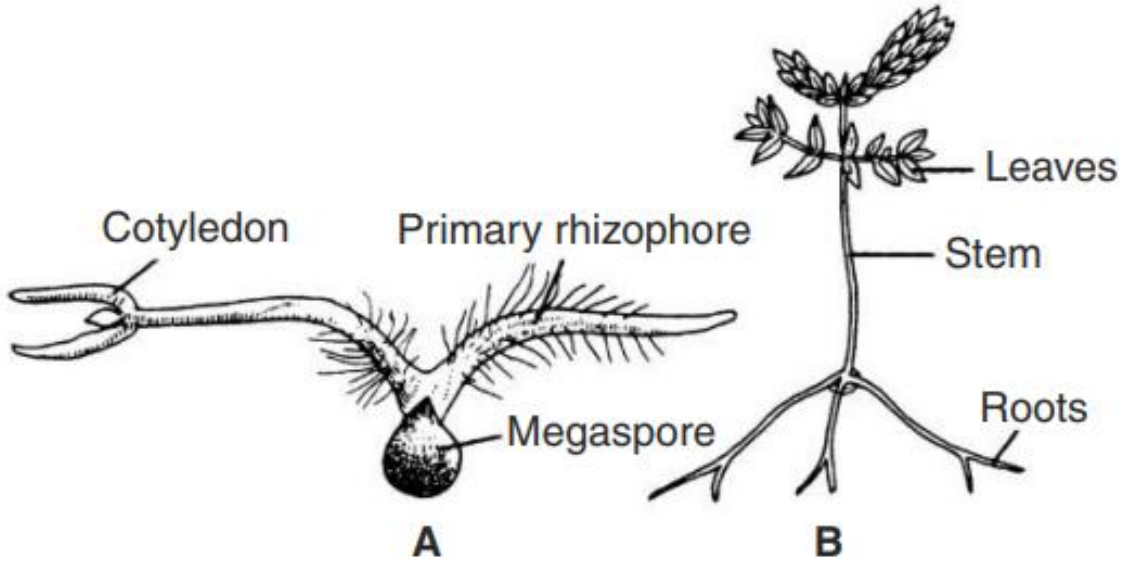



**Fig. 12.29** *Selaginella kraussiana* showing germination of megaspore and formation of sporophyte (after Campbell).

# LIFE CYCLE

- The life cycle of Selaginella shows a distinctive heteromorphic alteration between dominant sporophytic phase and a short lived small gametophytic phase.
- As in the bryophytes, the sporophytes are diploid and gamatophytes are haploid.
- Hence, the life cycle of Selaginella is termed as **DIPLO-HAPLONTIC LIFE CYCLE**.

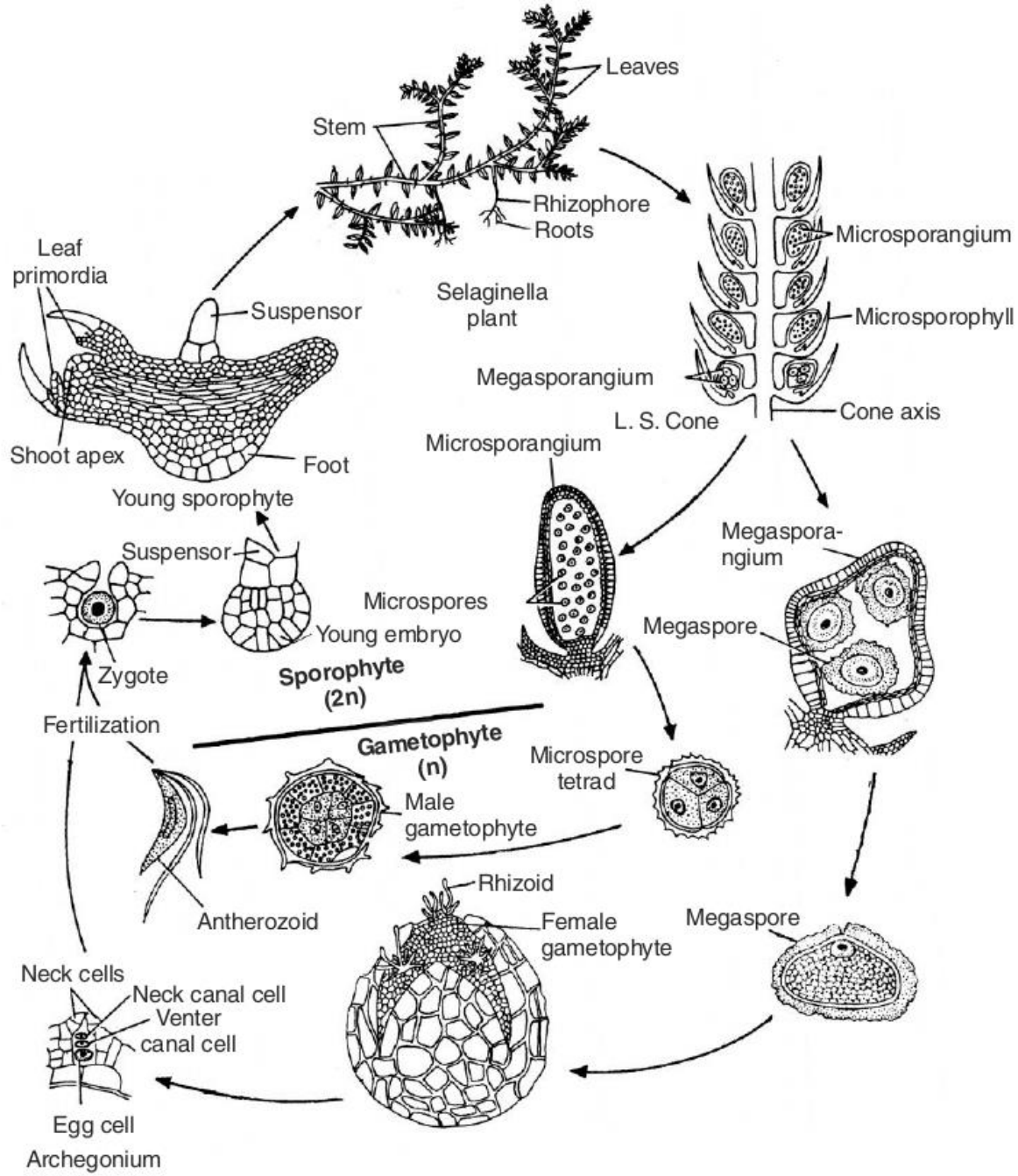



**Fig. 12.31** Pictorial life cycle of *Selaginella*.