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# Selaginella

## ❖ *Habit and Habitat of Selaginella:*

*Selaginella* is the only living genus of the order Selaginellales and is commonly known as 'spike moss' or 'small club moss'. It is a large genus comprising about 700 species distributed all over the world. Abundantly it is found growing in tropical rainforests.

Mostly the species **prefer moist and shady places to grow** but a **few** species are also found **growing in xerophytic** conditions i.e., on dry sandy soil or rocks e.g., *S. lepidophylla*, *S. rupestris* etc. A very **few** species are **epiphytes** e.g., *S. oregana*. It is found growing on tree trunks.

A few xerophytic species of *Selaginella* e.g *S.lepidophylla* and *S. pilifera* show cespitose habit and are sold as curiosities under the name of **resurrection plants**. They curl and become ball like when dry and again become green and fresh when moisture is available. About 70 species have been reported from India.

They are mainly found growing in eastern as well as Western Himalayas and the hills of South India.

Some of the common Indian species are *S. repanda*, *S. biformis*, *S. denticulata*, *S. monospora*, *S. semicordata*, etc. *S. kraussiana* is cultivated in a greenhouse.

### ❖ *External Morphology of Selaginella:*

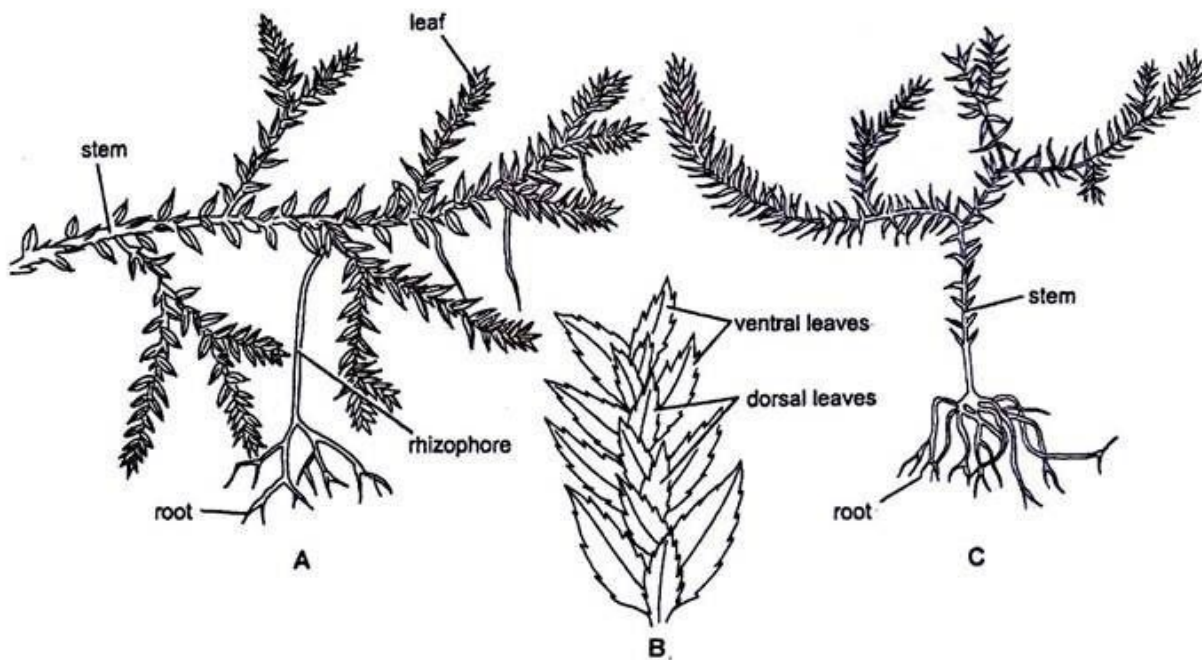
The sporophyte is an evergreen, delicate herb. Its size varies greatly from species to species i.e., from a few cm. to 20 meters. Plants may erect or prostrate depending upon the sub-genus. In the sub-genus **homoeophyllum the plants are erect** e.g., *S. rupestris*, *S. spinulosa* etc. and in the sub-genus **heterophyllum the plants are prostrate** e.g., *S. kraussiana*, *S. lepidophylla* etc.

**The plant body is distinctly differentiated into following structures (Fig. 1 A, C):**

- Stem.
- Leaves.
- Ligules.
- Rhizophore.
- Roots.

### **(i) Stem:**

- It is usually **profusely branched, delicate and evergreen**.  
The branching is of monopodial type.
- The growing apex of the stem consists of either meristematic tissue or a single apical cell.
- In the sub-genus homoeophyllum the stem is erect and somewhat cylindrical
- The sub-genus heterophyllum is prostrate with stout erect branches and is somewhat dorsiventral.



**Fig. 1 (A–C). *Selaginella*. External features : A. *S. kraussiana*, B. Leaf arrangement in a branch of *S. kraussiana*, C. *S. spinulosa***

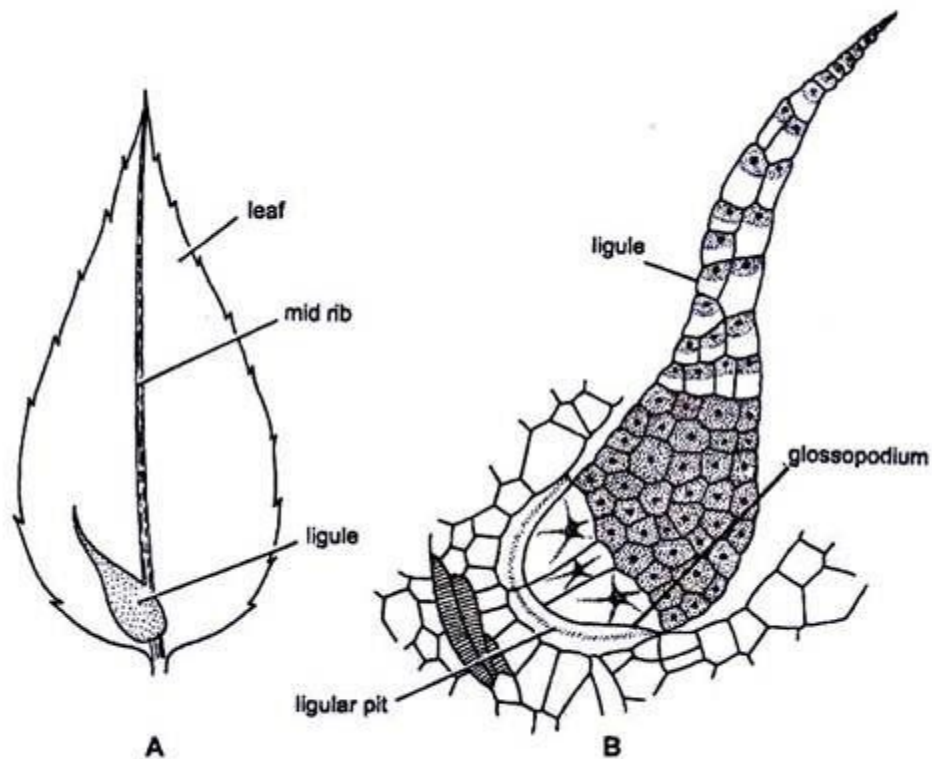
## **(ii) Leaves:**

- They are usually **small, simple and lanceolate with a pointed apex**. Each leaf is provided with a **single unbranched midrib**.
- In the sub-genus **homoeophyllum** all the **leaves are of same size** and are spirally arranged forming a dense covering.
- In the sub-genus **heterophyllum** the **leaves are dimorphic** i.e., of two sizes (small and big) and are arranged in pairs. Small leaves are present on the dorsal side of the stem and bigger ones on the ventral side of the stem (Fig. 1 B). The bigger leaves alternate with bigger ones and smaller leaves alternate with smaller ones.
- Usually the **leaves near the apical portion** of the branch **bear sporangia (micro-or mega) and are called sporophylls (micro-or mega) respectively**. The sporophylls are usually aggregated into a condensed structure which is known as **strobilus**.

### **(iii) Ligules:**

On the **adaxial side of the leaf, near the base** is present a small **membranous out-growth** known as **ligule**. It is embedded at the base of a leaf in a pit-like structure known as ligule pit.

It may be tongue shaped (e.g., *S. vogelii*), fan shaped (e.g., *S. martensii*), fringed (e.g., *S. cuspidata*), or lobed (e.g., *S. caulescens*). It is more than one cell in thickness except at the apex. The structure of the ligule can be differentiated into two parts, **glossopodium** and **the body of the ligule** (Fig. 2 A, B).



**Fig. 2 (A, B). *Selaginella*. Structure of ligule : A. Leaf with ligule, B. Longitudinal section of ligule**

- **Glossopodium:**

It is the basal hemispherical part made up of large thin walled cells. It is surrounded by a glossopodial sheath.

- **Body of the ligule:**

Above the glossopodium is the body of ligule. It is made up of many large and small cells. The **function** of the ligule is not well known. It may be a **water secreting** or **water absorbing** or **protective organ**. According to Earner (1936) the ligule is perhaps a vestigial organ.

**(iv) Rhizophore:**

- This structure arises from the prostrate axis at the point of dichotomy and elongates downward.
- It is a **colourless, leafless, unbranched and cylindrical structure**.
- As soon as the free end of rhizophore touches the soil it develops a tuft of adventitious roots at its free end.
- In few species the rhizophore is present e.g., *S. kraussiana* while in others it is absent e.g., *S. cuspidata*.
- It differs from root in having no root cap and from stem in having no leaves.

**The following views regarding the morphological nature of the rhizophore have been proposed:**

**1. Capless root hypothesis:**

**According to Harvey Gibson (1902), Uphof (1920), Wochok and Sussex (1974), the rhizophore is a capless root because:**

- It is positively geotropic.
- It is a leafless structure.
- It is almost similar in anatomy of the root.
- It has a monostelic stele.

**2. Leafless shoot hypothesis:**

**According to Worsdell (1910), Williams (1937), Cusic (1954) etc. The rhizophore is a leafless shoot because:**

- Root cap is absent.
- Root hairs are absent.
- It is exogenous in origin.
- It arises from the angle meristem present at branching.
- It can develop into leafy shoots under experimental conditions.

### **3. Sui-generis hypothesis:**

According to Goebel (1905), Bower (1908), the rhizophore is an organ “Sui Generis” i.e., having absolutely no parallel structure anywhere in the plant kingdom. Thus, it is altogether a new structure.

Schoult (1938) regarded rhizophore as a specialized stem modified in the direction of root because of the root bearing nature.

### **(v) Roots:**

- They originate either from the tips of rhizophores or directly from the stem or from the swollen base of hypocotyl (Fig. 1 A, B).
- Their origin is endogenous.
- They are usually dichotomously branched structures.
- The roots are provided with root caps and root hairs.

### **❖ Internal Structure of *Selaginella*:**

#### **1. Stem:**

**A Transverse section (T.S.) of the stem of *Selaginella* is somewhat circular in outline and shows the following structures:**

### **(i) Epidermis:**

- It is the outermost covering layer consisting of a single cell in thickness.
- The cells of the epidermis are without hairs and stomata.
- The epidermis is surrounded on all sides by a thick coating of cuticle.

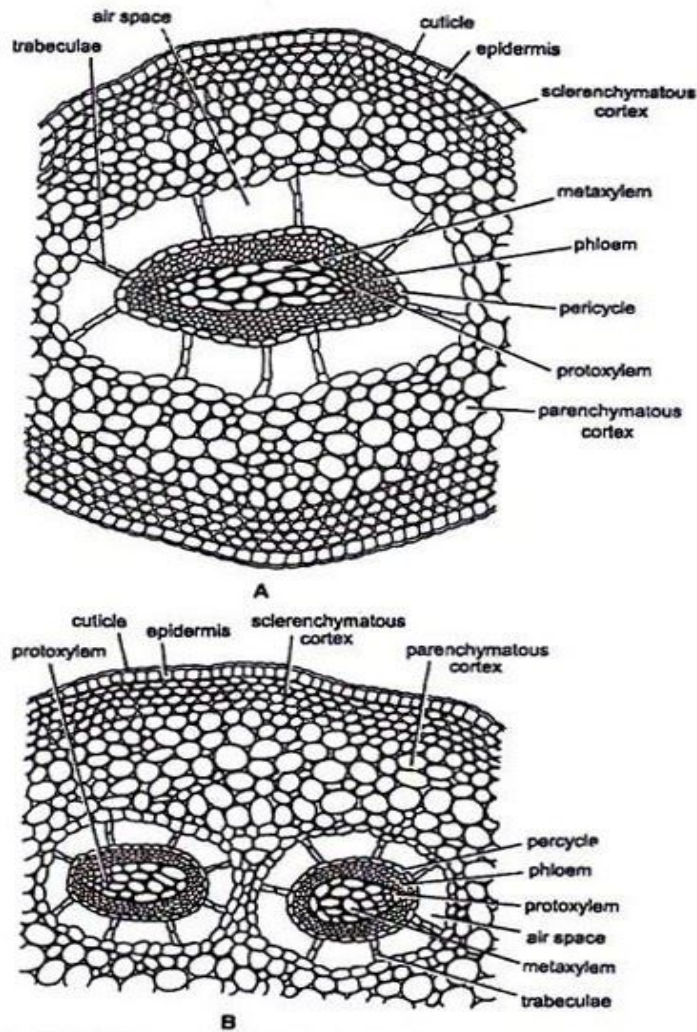


Fig. 3 (A–B). *Selaginella*. T. S. Stem. (A) T. S. monostelic stem, (B) T. S. distelic stem (a part cellular),

## **(ii) Cortex:**

- Inner to the epidermis is a well-defined zone of cortex.
- The cortex may or may not be differentiated into inner and outer cortex.
- In case of *S. selaginoides*, the whole of the cortex is made up of parenchymatous cells while in *S. kraussiana*, it is differentiated into sclerenchymatous outer cortex and parenchymatous inner cortex.
- The parenchymatous cortex is usually made up of angular cells i.e., without intercellular spaces but in some cases the cells are rounded and provided with a few intercellular spaces.

## **(iii) Stele:**

- The central portion of the stem is occupied by a well-developed stele. The stele is of **protostelic** type i.e., xylem is present in the centre and surrounded by phloem on all sides.
- Phloem, in turn, is surrounded by a single layered pericycle. Pith is absent.
- The stele remains suspended in the centre by radially elongated tubular, unicellular structures known as **trabeculae**. These are formed by the radial elongation of the endodermal cells.

- Trabeculae are provided with conspicuous **casparian strips**. In between the trabeculae are present large spaces known as **air spaces**.
- The number of steles is variable in different species of *Selaginella*. It is 1 (**monostelic** e.g., *S. spinulosa*), 2 (**distelic** e.g., *S. kraussiana*) or 12-16 (**polystelic** e.g., *S. laevigata*). The organization of the stele is also variable in different species. It may be **protostele** (e.g., *S. spinulosa*) to **siphonostele** (e.g., *S. laevigata*, *var. lyalli*).
- The stele is surrounded by a **single layered pericycle** made of parenchymatous cells. The **xylem** is usually **monarch** (e.g., *S. kraussiana*), or **diarch** (e.g., *S. oregana*) or **multiarch** (e.g., *S. spinulosa*).
- It is usually exarch but sometimes it may be mesarch (e.g., *S. selaginoides*). Xylem is usually made of tracheids. Vessels are completely absent. Xylem is surrounded on all sides by phloem which consists of sieve cells and phloem parenchyma. Companion cells are absent in phloem.

## **2. Root:**

**A T.S. of the root is somewhat circular in outline (Fig. 4) and shows the following internal structures:**

### **(i) Epidermis:**

- It is the outermost covering layer and is only one cell in thickness.
- The cells are large and the unicellular root hairs arise from them.

### **(ii) Cortex:**

- Just below the epidermis is a wide zone of cortex.
- The cortex may be either wholly made up of thin walled parenchymatous cells
- Or there may be sclerenchymatous outer cortex (hypodermis), 3 to 5 celled in thickness and parenchymatous inner cortex.
- In mature roots of *S. densa* the entire cortex may consist of thick walled sclerotic cells.
- Air spaces have also been reported in the inner cortex (e.g., *S. willdenovii*). It is traversed by trabeculae.

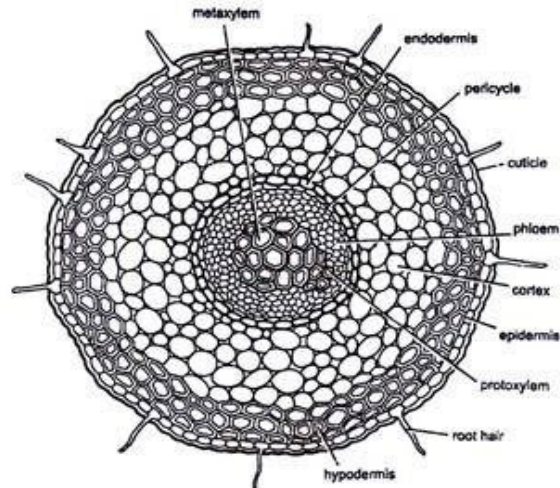


Fig. 4. *Selaginella*. T. S. of root

### **(iii) Endodermis:**

- It is usually not well defined but in some species as for example, *S. densa*, it is a distinct structure and only one cell in thickness.

### **(iv) Pericycle:**

- Endodermis is followed by one to three layered pericycle. It is made up of parenchymatous cells.

### **(v) Stele:**

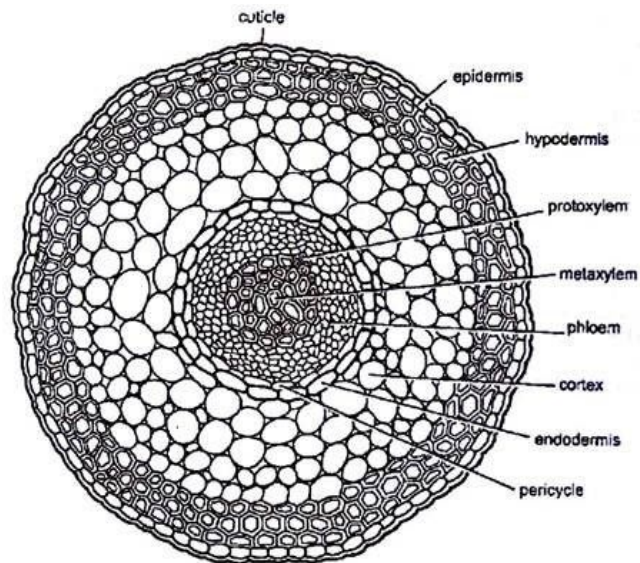
- It is a typical protostele.
- The xylem is exarch and monarch i.e., there is only one protoxylem group situated at the periphery.

- Xylem is surrounded by phloem on all sides. The structure of xylem and phloem elements is similar to that of stem.

### **3. Rhizophore:**

- The internal structure of rhizophore is almost similar to that of root. It is also circular in outline.

**It shows the following structures (Fig. 5):**



**Fig. 5. *Selaginella* . T. S. rhizophore**

#### **(i) Epidermis:**

- It is single layered and the outer wall of epidermal cells is covered with a thick cuticle. Root hairs and stomata are absent.

## **(ii) Cortex:**

- Inner to the epidermis is present a wide zone of cortex differentiated into outer sclerenchymatous and inner parenchymatous zones.

## **(iii) Endodermis:**

- It is the innermost layer of the cortex. It is ill defined single layered structure.

## **(iv) Pericycle:**

- Inside the endodermis is present a single layered parenchymatous pericycle.

## **(v) Stele:**

- It is typically a protostele.
- The xylem is surrounded by phloem.
- Xylem shows distinct protoxylem and metaxylem elements. The position of protoxylem is different in different species.
- In *S. martensii* xylem is exarch and monarch. In *S. atroviridis* the metaxylem is crescentic with a number of

protoxylem strands situated on the concave adaxial side. In *S. Kraussiana*, etc. protoxylem is mesarch (centroxylic).

#### **4. Leaf:**

**A T.S. of the leaf shows epidermis, mesophyll and a single median vascular bundle which has been discussed below in detail:**

##### **(i) Epidermis:**

- It is the outermost surrounding layer and is only one cell in thickness.
- In most of the species the stomata are present only on the lower epidermis near the midrib.
- The stomata may be present on both the outer and inner epidermis.
- The cells of the epidermis are provided with chloroplasts.

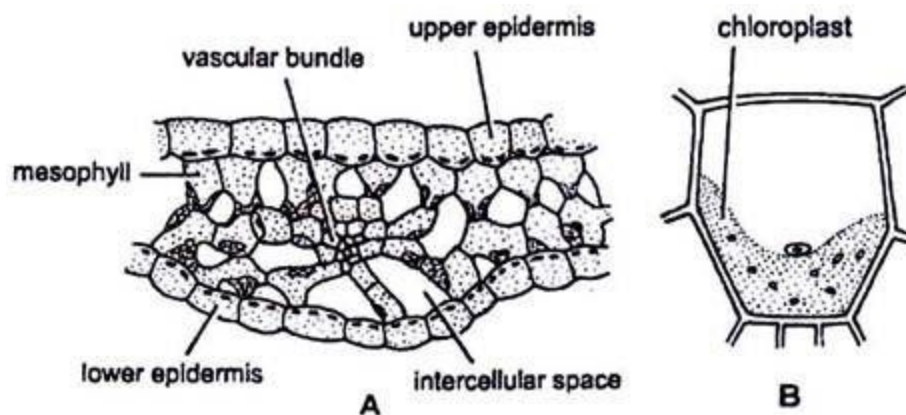
##### **(ii) Mesophyll:**

- It occupies a wide zone between upper and lower epidermis.
- The mesophyll is usually made up of parenchymatous cells which have conspicuous intercellular spaces.
- Each mesophyll cell has one (e.g., *S. martensii*), two (e.g., *S. kraussiana*), or eight (e.g., *S. willdenovii*) chloroplasts.

- Each chloroplast has several pyrenoid like bodies similar to order Anthocerotales (Bryophyta).
- In some species (e.g., *S. concinna*) the mesophyll is distinguished into upper palisade and lower spongy parenchyma.

**(iii) Vascular bundle:**

- Only one vascular bundle is present in the centre.
- It is concentric and amphicribal (ectophloic).
- It is made up of a few xylem tracheids (annular or spiral) surrounded by phloem elements (a few sieve elements).
- A single layered bundle sheath encircles the phloem on all sides.



**Fig. 6. (A–B). *Selaginella* : Internal Structure of leaf. A. T. S. of a part leaf of *S. kraussiana*, B. A mesophyll cell**

