VIVEKANANDA COLLEGE

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NAAC ACCREDITED 'A' GRADE

Topic:	PTERIDOPHYTES
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Reproduction in Selaginella

Gametophytic Generation:

The development of male and female gametophytes (prothalli) takes place from the haploid microspores and megaspores respectively i.e., microspores and megaspores are the unit of male and female gametophytes, respectively.

Development of male gametophyte:

- The microspore is the initial stage in the development of male gametophyte or **male prothalli**. The development of the microgametophyte starts within the microsporangium.
- Generally a 13-celled microgametophyte is formed before the microsporangium dehisces.
- Each **microspore** is a unicellular, uninucleate, rounded or spherical, haploid structure with outer spiny thick exosporium and inner thin endosporium.
- The first division is in such a way that 2 unequal cells are formed into **smaller prothallial cell** and a **larger antheridial cell** (Fig. 13 A).
- The prothallial cell does not divide further and takes no part in further development of male gametophyte.

- **The antheridial cell divides** to form a group of 12 cells. The antheridial cell divides vertically (2-2) to the prothallial cell to **form the two primary cells of the antheridium** (Fig. 13B).
- At this stage the young gametophyte consists of **3 cells** (2+1 cell, Fig; 13 B).
- The wall which separates the two primary cells is called the first primordial wall.
- Two primary cells thus formed divide transversely .
- This division is at right angle to the first and can be seen only if we cut a vertical section of the spores. This stage of gametophyte consists of **5 cells** (2 + 2+1 cells).
- Out of these four cells formed by the division of primary cells, the basal cells divide no further and become the **cells of the jacket layer of the antheridium**. Upper two cells divide further by curving or arching the wall.
- In this way **6 cells** are formed and microgametophyte has seven cells at this stage (4+ 2+1 cells).
- Out of the four cells formed by the last division, two bigger cells divide again by curved walls and thus a **9 celled** microgametophyte is formed (6 + 2+1 cells, 8 antheridial cells and one prothallial cell).
- These antheridial cells are arranged in such a manner that four cells are present in the middle and two cells are present on either side i.e., above and below.

- The middle four cells divide by periclinal walls (13 D) to form 4 primary androgonial cells and 8 jacket cells.
- The gametophyte now consists of **13 cells** (**1 prothallial cell + 4 androgonial cells + 8 jacket cells).**
- In *S. kraussiana* the gametophyte is shed at this stage. Further development takes place after shedding.
- At this stage the spores are liberated and their exosporium ruptures. Primary **androgonial cells divide** and redivide to **form 128 or 256 androcytes** or **antherozoid mother cells**.
- Each antherozoid mother cell **finally metamorphoses** into a **single antherozoid** (Fig. 13 F, G) which is a spirally coiled, uninucleate and biflagellate structure. The two flagella are unequal in size. The antherozoids are liberated by the rupturing of endosporium and swim in water till they reach the neck of archegonium.

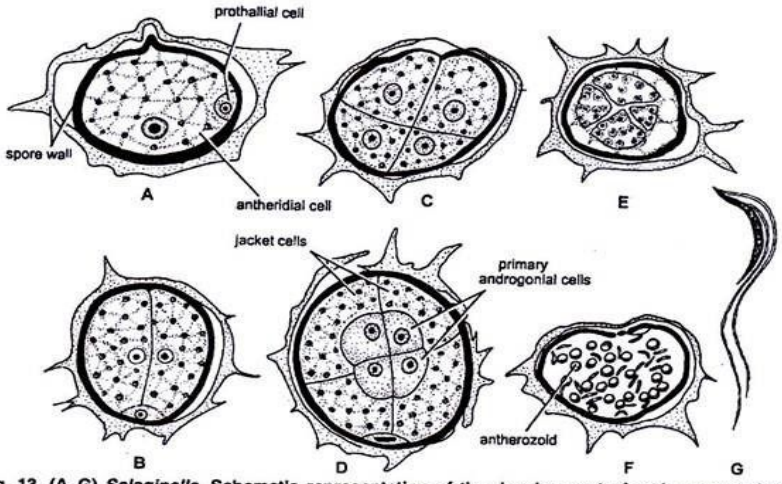

Fig. 13. (A–G) *Selaginella*. Schematic representation of the development of male gametophyte

Development of female gametophyte:

- The megaspore is the initial stage in the development of female gametophyte. The development of female gametophyte starts while the megaspore is still inside megasporangium.
- The megaspores are liberated from the megasporangium either at the time of first archegonium formation or just after fertilization.
- First of all the exospore or outer wall grows faster than the mesospore which results in the formation of space between exospore and mesospore.
- The whole structure increases in size as a result of which a big central vacuole appears (Fig. 14 A).
- Now nucleus divides by free nuclear divisions, forming a large number of nuclei.
- First the nuclei are equally distributed in the cytoplasm but later on more nuclei collect in the apical region.
- At this stage wall formation starts from the apical region downwardly thus forming an upper cellular region known as **female prothallus** and a lower non-cellular region known as storage region. The wall of the lower cells becomes thick forming a diaphragm (Fig. 14 B-E).

- Later on the vacuole also disappears as the cytoplasm increases in amount.

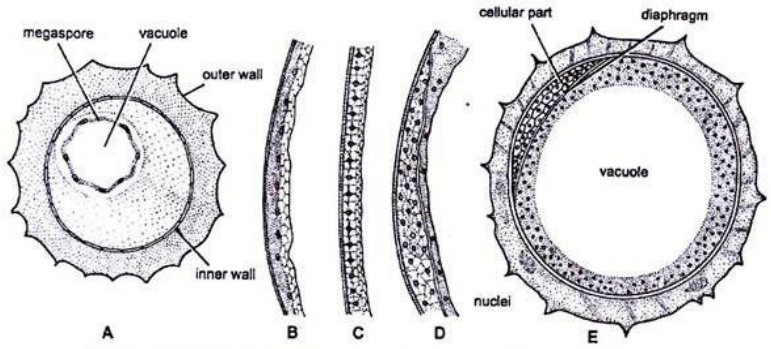

Fig. 14 (A–E). *Selaginella*. Stages in the development of female gametophyte

- This may be absent in a few species e.g., *S. martensii*. At this stage usually the female gametophyte is liberated from the gametangium.
- If it falls on suitable substratum, it germinates. The exine and mesine ruptures.
- The cellular tissue protrudes out and a few rhizoids develop which fixes the gametophyte to the substratum and absorbs water (Fig. 15).

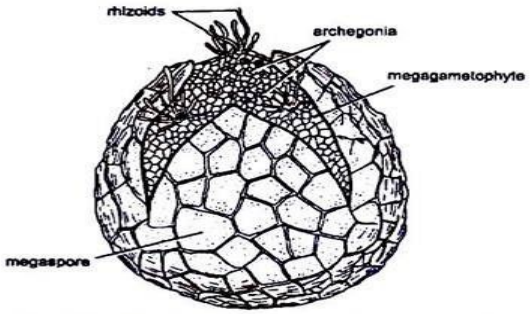

Fig. 15. *Selaginella*. Female gametophyte. A. Dehiscent megaspore and rhizoids in *S. kraussiana*

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Development of archegonium:

- A few cells near the apex of female prothallus behave as **archegonial initials** which by further divisions, give rise to archegonia (Fig. 16H). Each archegonium develops from a single superficial cell of the female prothallus situated near the apical region and is termed as archegonial initial (Fig. 16 A).
- It divides transversely forming an **upper primary cover** cell and a **lower central cell** (Fig. 16 B).
- The **primary cover cell**, by two vertical divisions at right angles to each other, forms 4 cells which **by a transverse division form** a **neck of 2 tiers of 4 cells each** (Fig. 16 C, D).
- The **central cell** again **divides to form an upper primary neck canal cell** and a **lower primary venter cell** (Fig. 16 D). The former forms a **single neck canal cell** while the latter divides to form a **ventral canal cell and egg** (Fig. 16 E).

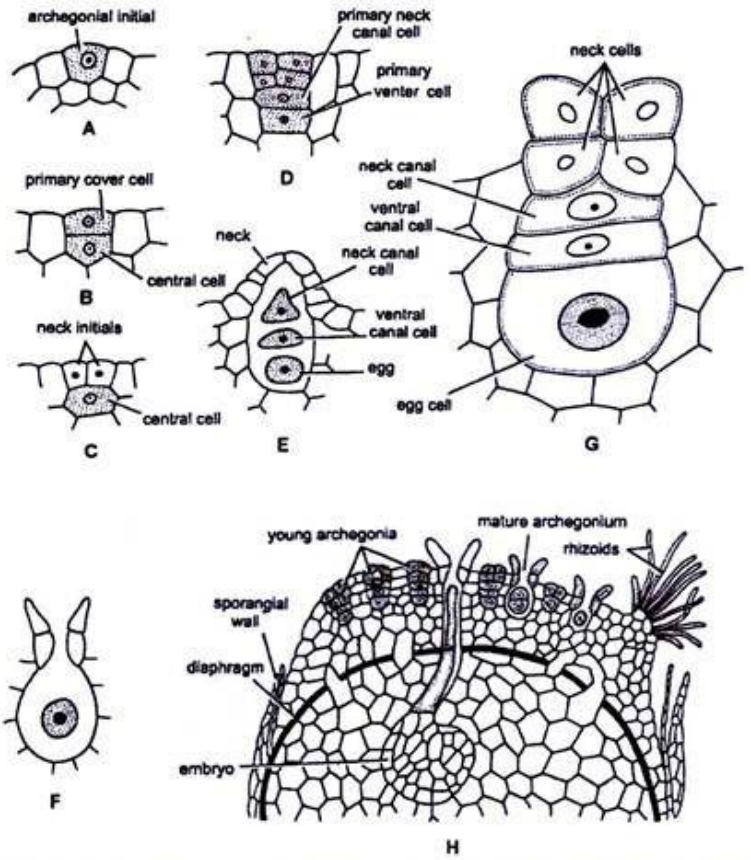

Fig. 16 (A–G). *Selaginella* : Development of archegonium. A–F. Various stages in the development, G. A mature archegonium before fertilization, H. A nearly median section of a mature prothallus showing various stages in the development of archegonium.

Structure of Mature Archegonium:

- The archegonium is a short flask shaped structure embedded in female gametophytic tissue (Fig. 16 H).
- Only the upper tier of neck cells projects out.
- Each archegonium consists of a short neck of 2 tiers of 4 cells each and a broad venter. The four cells of the upper tier of the neck function as cover cells.

- The neck encloses a single neck canal cell and the venter consists of a ventral canal cell and an egg (Fig. 16 G).
- There is no definite wall of venter.
- At maturity the neck canal cell and the ventral canal cell disorganize and absorb water which creates a pressure to separate the cover cells (Fig. 16 F) through which the antherozoids enter the archegonium and reach the egg.

Fertilization:

Water is necessary to carry out the process of fertilization. The swimming antherozoids reach the egg through the neck of archegonium and the nucleus of antherozoid fuses with the egg nucleus thus forming a zygotic nucleus. The fertilized egg secretes a wall around it forming a diploid structure known as zygote or oospore (2x). Thus the gametophytic generation ends and the initial stage of sporophytic generation is formed.

In some species e.g. S. intermedia the egg develops into an embryo without fertilization. This phenomenon is known as parthenogenesis.

Sporophytic generation (*Development of embryo*):

- **Oospore is the initial stage of sporophytic generation**. During development of the embryo, the oospore first divides by a transverse division into an **upper suspensor initial (epibasal)** and a **lower embryo initial (hypobasal)** (Fig. 17 A, B).
- The **suspensor initial** further divides in all directions **forming** a **multicellular suspensor** which thrusts the developing embryo deep into the female gametophytic tissue to absorb food for further development of embryo.
- The **embryo initial** divided by 2 vertical divisions at right angle to each other thus **forming 4 cells** (**quadrant**. Fig. 17 C).
- One of these 4 cells divides by an oblique wall forming a **shoot initial** (Fig 17 D). Now the cells except the shoot initial divide sporophyte transversely forming 2 tiers of 4 cells each. Later on by further divisions it forms a **multicellular structure** which gets **differentiated into foot, rhizophore, stem and cotyledons** (Fig. 17 E-J).

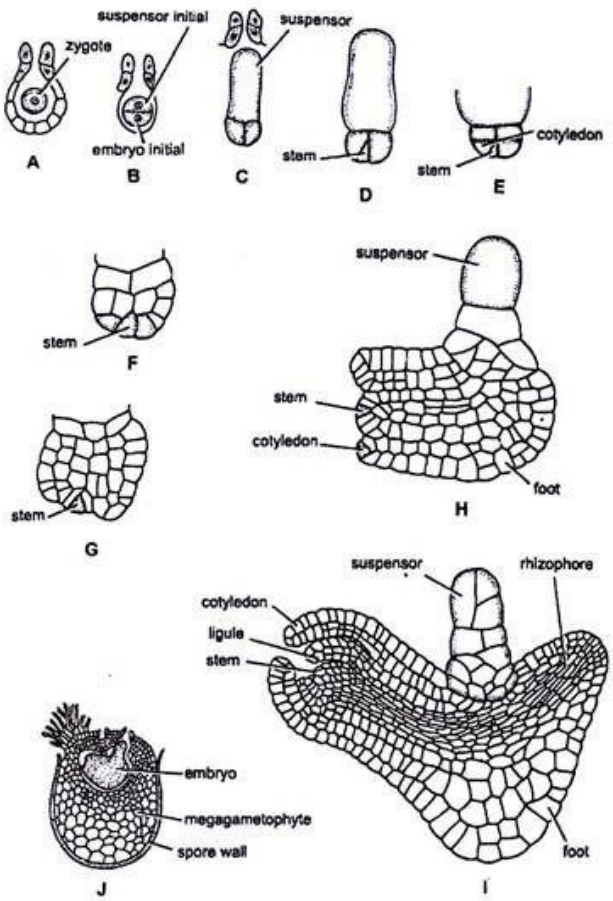

Fig 17 (A–J). *Selaginella* : Development of embryo.
A–I various stages in the development J. Longitudinal section of female gametophyte bearing embryo.

In some species of *Selaginella* (e.g.,*S. rupestris*) the megagametophytes are never shed from the megasporangium and remain on the strobilus. The oospore completes its development within the megasporangium and the young embryo grows into a seedling, develops primary root and then falls on the ground (Fig. 18).

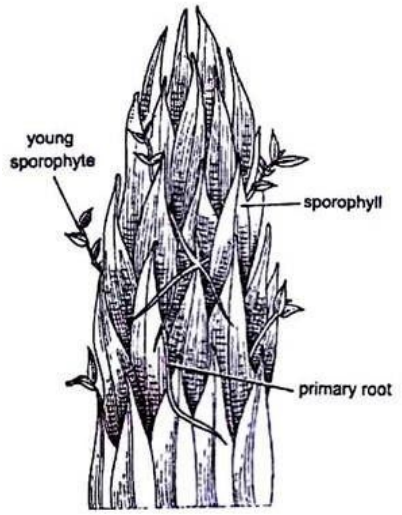

Fig. 18. *Selaginella.* Young sporophytes developing upon the strobilus of parent plant in *Selaginella rupestris.*

Life Cycle Patterns of *Selaginella*:

Selaginella is a sporophytic plant (2n) and produces two different types of spores i.e., microspores and megaspores. In other words we may call it a **heterosporous plant**. These **spores on germination produce male and female gametophytes** (n) respectively which in turn developing upon the strobilus of parent **produce antherozoids and egg in antheridia and archegonia respectively.**

These reproductive structures **after fertilization produce zygote (2n)** which again **on germination gives rise to a sporophytic plant (2n)**. In this way the **sporophytic and gametophytic generations alternate with each other although the**

sporophytic phase is dominant over the gametophytic phase (Figs. 19, 20).

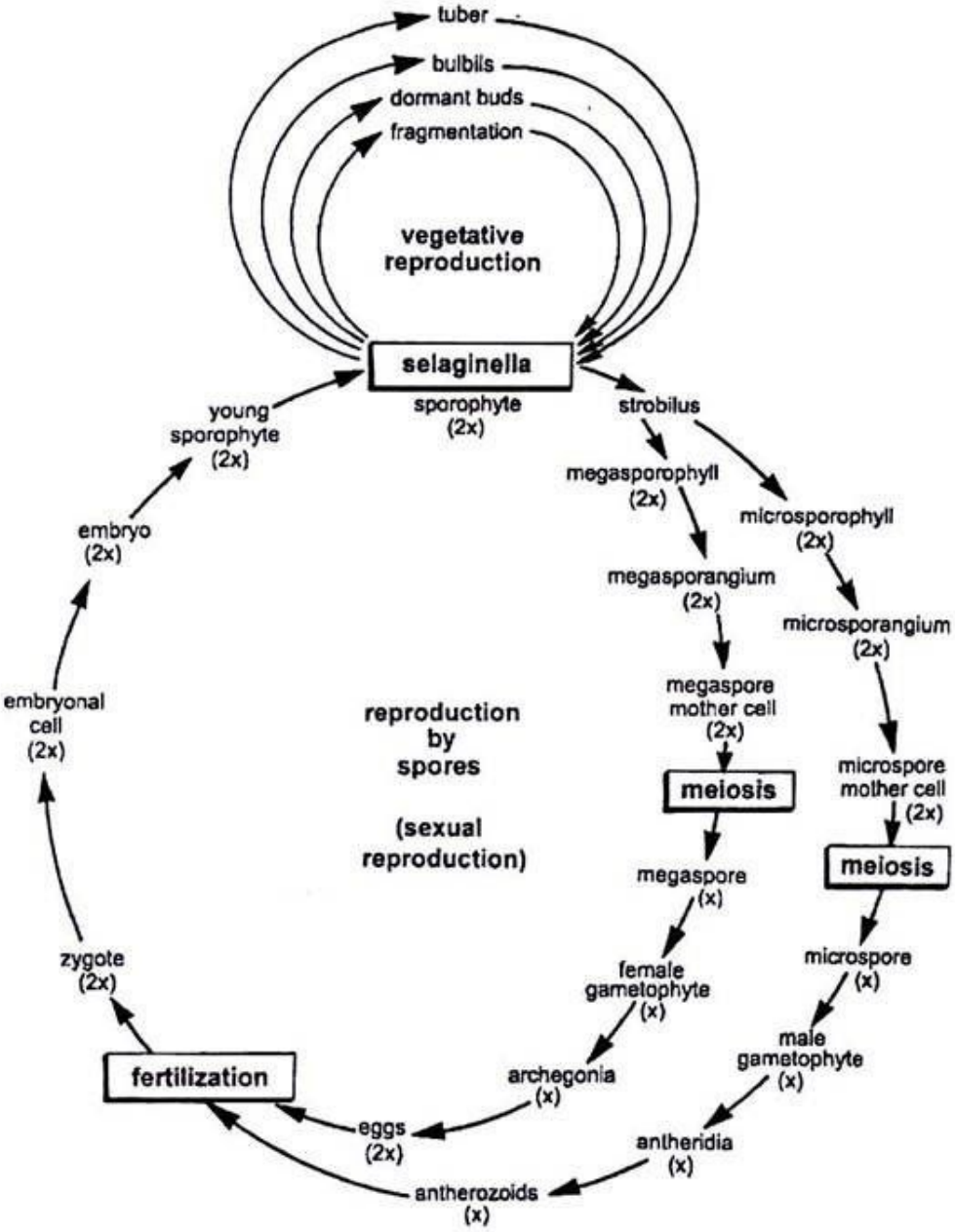

Fig. 20. *Selaginella* : schematic life cycle