Pteridophytes:

Pteridophytes are vascular cryptogams. They are the earliest know vascular plants which originated in the Silurian period of Palaeozoic era. They are the successful colonizers on land habit.

Characteristic features:

1. Non flowering vascular plant.
2. Sporophyte is the pre-dominant plant body differentiated into root, stem and leaves.
3. Heteromorphic alternation of generation where both the sporophytic and gametophytic generations are nutritionally independent.
4. The stem is generally branched either dichotomous or monopodial.
5. They are polysporangiate, either homosporous or heterosporous.
6. Presence of multicellular sex organs antheridia and archegonia
7. The zygote undergo repeated mitotic division to form embryo.

Adaptive features:

- Spores: The spores are bounded by two concentric wall layers, the outer thick wall (exine) and inner thin wall (intine).

- Cuticle and stomata: The function of cuticle is to prevent water loss, gas exchange from the body. It is also resistant to microbial attack and mechanical injury.
  Stomata controls the passage of gas and water depending on the requirement of plant.

- Tubes and tracheids: Conducting system become essential when plant adopts an upright habit and grows away from the aquatic environment. Tracheids are elongated cells in the xylem of vascular plants that serve in the transport of water and mineral salts. A variety of tubular cells found in early land plants that have fulfilled the role of tracheids.

Distribution:

Mostly terrestrial, some member are aquatic (*Azolla, Salvinia* etc), xerophytic (*Selaginella, Equisetum* etc) and many are epiphyte (*Ophioglossum*, *Polypodium* etc)

Life forms: Small herbaceous annual to large perennials.

Plant Body

- The major plant body is nutritionally independent sporophyte which is differentiated into root, stem and leaves.
- The sporophyte develop from diploid zygote
- The stem is generally branched either dichotomous or monopodial.
- The leaves may be simple, small and sessile; scale like (microphylls or microphllous leaves) or compound, large or petiolate as in ferns (megaphylls ar megphyllous leaf).
- Well developed vascular system with xylem and phloem. Cambium rarely present in some groups.

Reproduction:

The sporophytic plant reproduces by means of spores produced in sporangia.

Sporangium:

- The position of sporangia may vary in different groups. The may borne on stem (fig A, *Psilotum*), or on the ventral surface of leaves i.e. foliar (fig B, *Dryopteris*) or in the axil of the leaves (fig C, *Ophioglossum*).

- The sporangia containing leaves are called sporophylls.

A

B

C

- The sporophylls may be scattered (in *Lycopodium selago*), uniformly distributed (in ferns) or grouped in definite areas to form **strobili** (*Selaginella, Equisetum, Lycopodium clavatum* etc).

- In certain aquatic pteridophytes the sporangia are present within a specialized structure called **sporocarp** (e.g. *Azolla, Salvinia*).

- On the basis of mode of development, the sporangia are of two types, the **eusporangiate** (the sporangia developed from several sporangial initial cells) and the **leptosporangiate** (sporangia developed from a single initial cell).

- In some pteridophytes the sporangia are aggregated in clusters termed **sori** (singular **sorus**).

Spores:

- Meiotic division of spore mother cells produce numerous haploid spores inside the sporangium. If all the spores produced are of equal sizes and shapes, then the plant is called **homosporous** (*Lycopodium, Equisetum, Dryopteris*) and if they are of two different sizes and shapes the plant is called **heterosporous** (*Selaginella, Isoetes, Marsilea*)

***Lycopodium clavatum* strobili**

***Dryopteris* sorus**

➢ In heterosporous type the two different types of spores are produced in separate sporangia. The smaller spores are called **microspores** or male spores and produced large number in **microsporangia**. The larger spores are called **megaspores** or female spores and developed smaller number in **megasporangia**.

➢ Microspore after germination produce male gametophyte and megaspore after germination produce female gametophyte.

➢ Sporophylls of microsporangia are called microsporophylls, while sporophylls of megasporangia are called megasporophylls

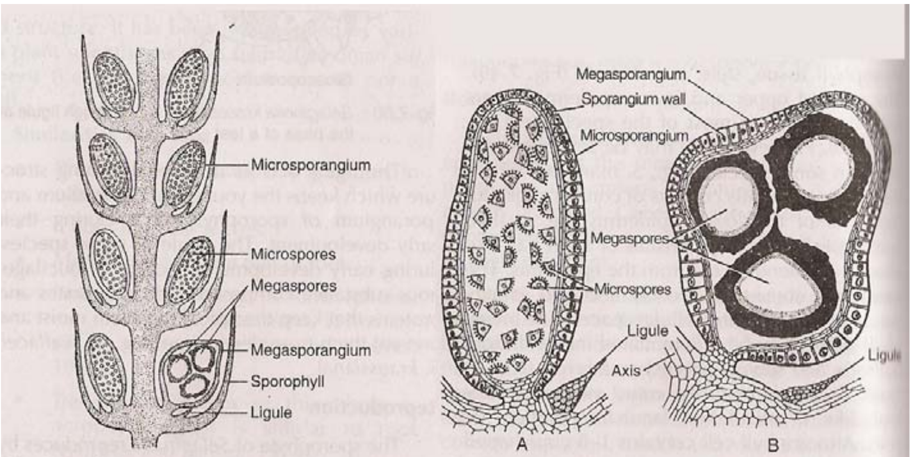


Fig. 7.51 : *Selaginella kraussiana* : L.S. of strobilus

Fig. 7.52 : *Selaginella* : A. A mature microsporangium, B. A mature megasporangium

Heretosporous *Selaginella*

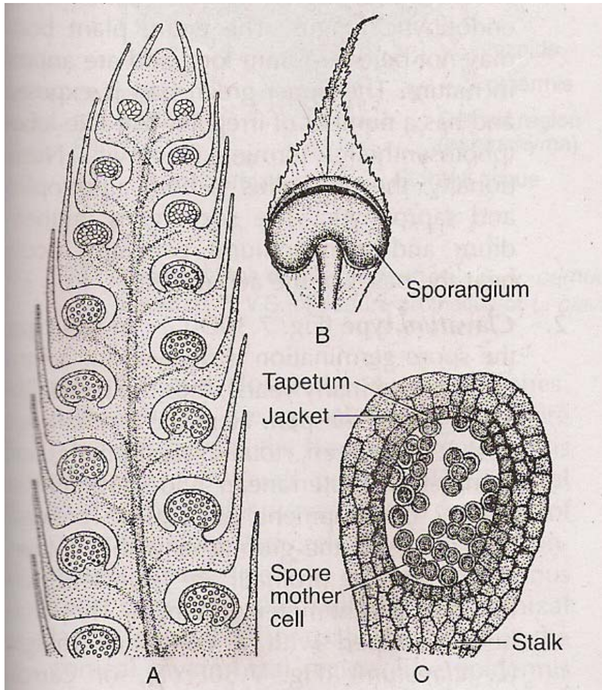


Fig. 7.27 : *Lycopodium clavatum* : A. L.S. of strobilus, B. A sporophyll (adaxial view), C. L.S. of a mature sporangium

Homosporous *Lycopodium*

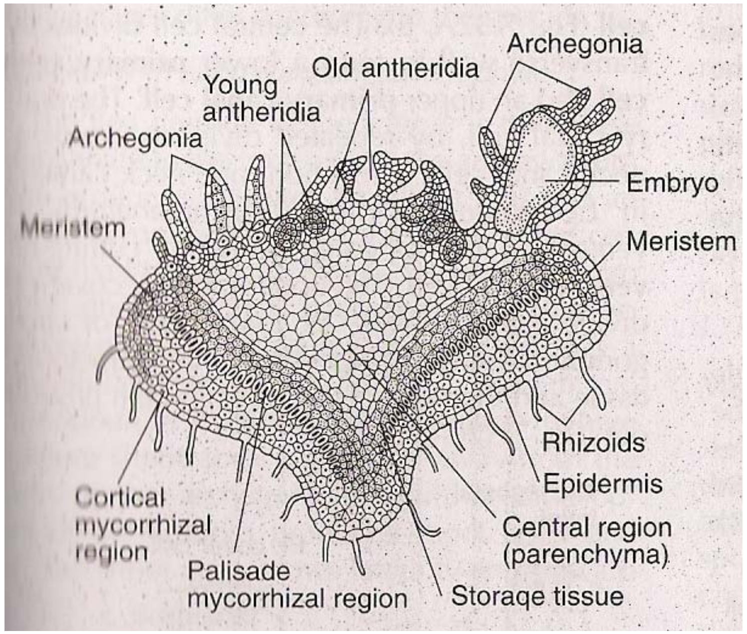
Gametophyte:

❑ The spores germinate to form haploid gametophyte or prothalli. The gametophytes are small and inconspicuous as compared to sporophytes.

❑ The gametophytes are of two types:

In hompsporous forms, the development of gametophyte is **exsosporic** in which the prothallus develops outside the spore wall (e.g. *Psilotum, Lycopodium*).

❑ Gametophyte that develop from heterospores are **endosporic** in which the development of prothallus is confined within the spore wall (e.g. *Selaginella, equisetum*).



Sex Organs: The gametophytes or prothalli bear sex organs viz. male **antheridia** and female **archegonia**. These sex organs are embedded in the gametophyte.

Antheridia: The antheridium is a sessile or shortly stalked globular structure surrounded by a well defined jacket inside containing **androcytes** or **antherozoid mother cells**. Each androcyte gives rise to single motile antherozoid.

Archegonia: The archegonium is a flask shaped structure consisting of a basal, swollen **venter** (bear an **egg** and **venter canal cell**) and a short **neck (**bear **neck canal cells**).

Fertilization: The disintegration of neck canal cell produces a mucilagenous substance (contains malic and fumaric acid). The antherozoid and egg fuse to form diploid zygote

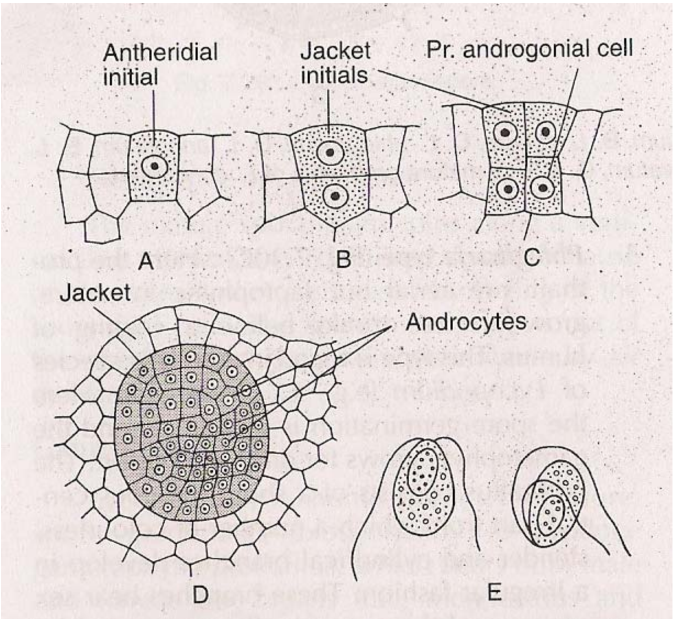


Fig. 7.31 : *Lycopodium* : A–D. Stages in the development of antheridium, E. Antherozoids

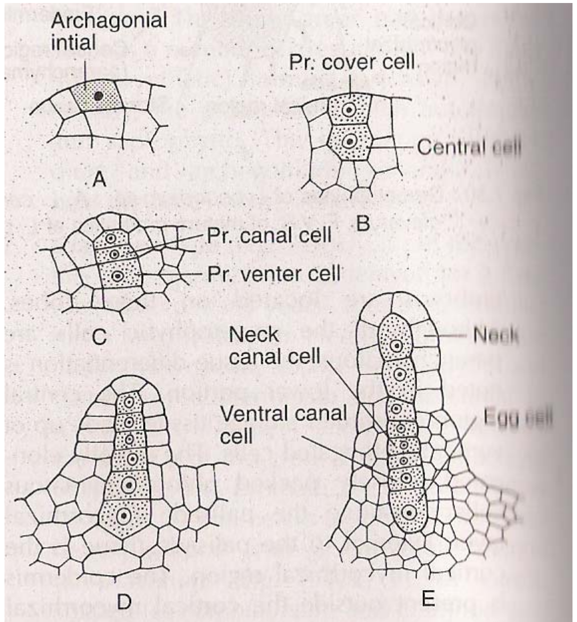


Fig. 7.32 : *Lycopodium* : A–D. Stages in the development of archegonium, E. A mature archegonium

Embryo:

The zygote undergo repeated divisions to form embryo. Further development of embryo results into a well developed sporophyte differentiated into roots, stem and leaves.

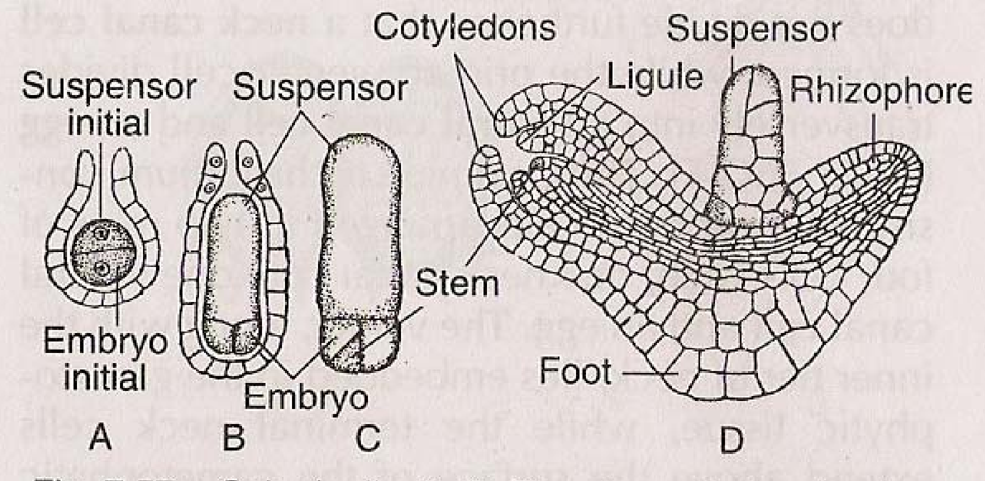


Fig. 7.57 : *Selaginella.* A–D. The stages in the development of embryo.

The life cycle patterns: Heteromorphic alternation of generation with independent sporophytic and gametophytic phases.

Three types:

Homosporous monoecious gametophyte: e.g. *Psilotum*

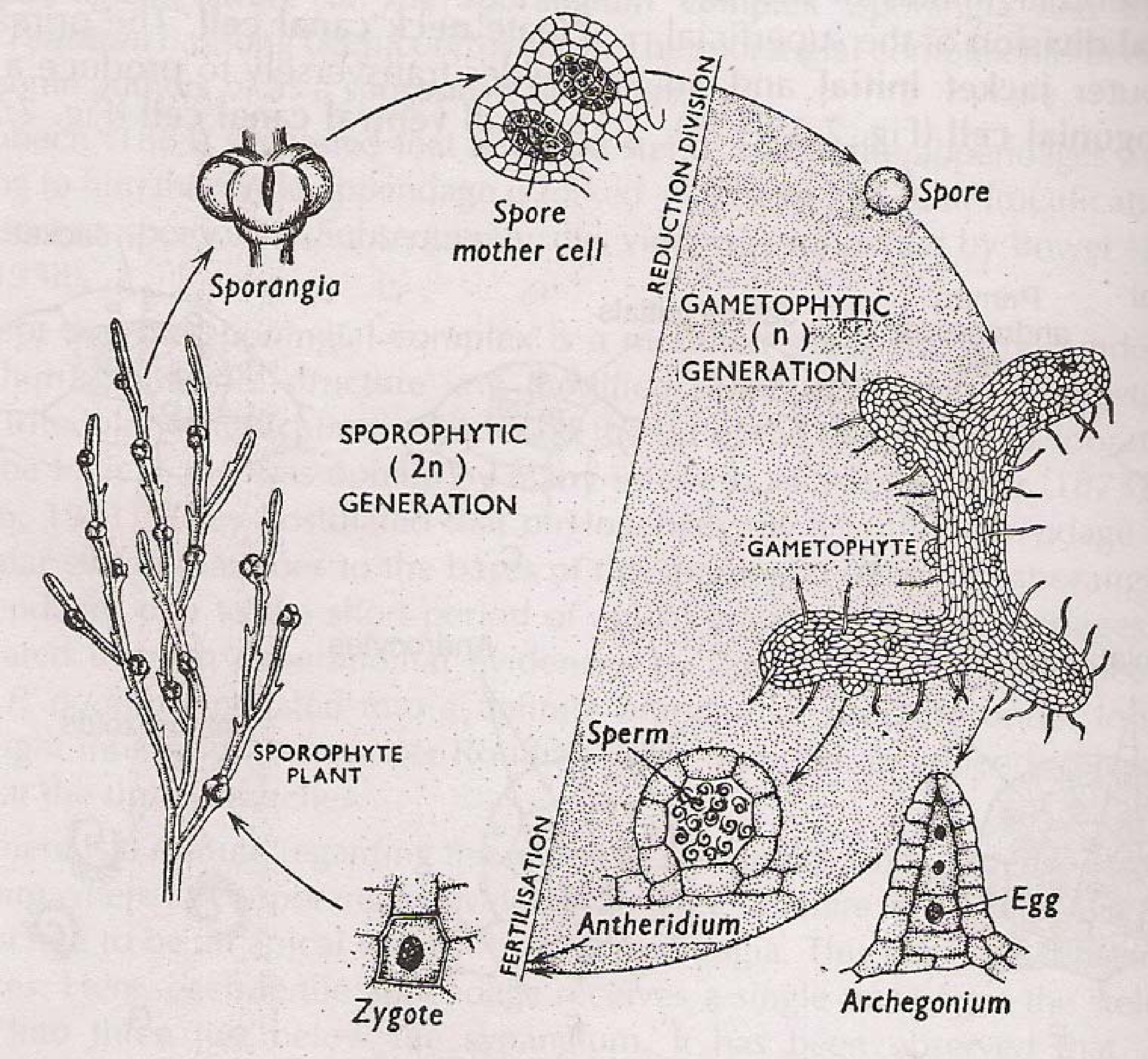
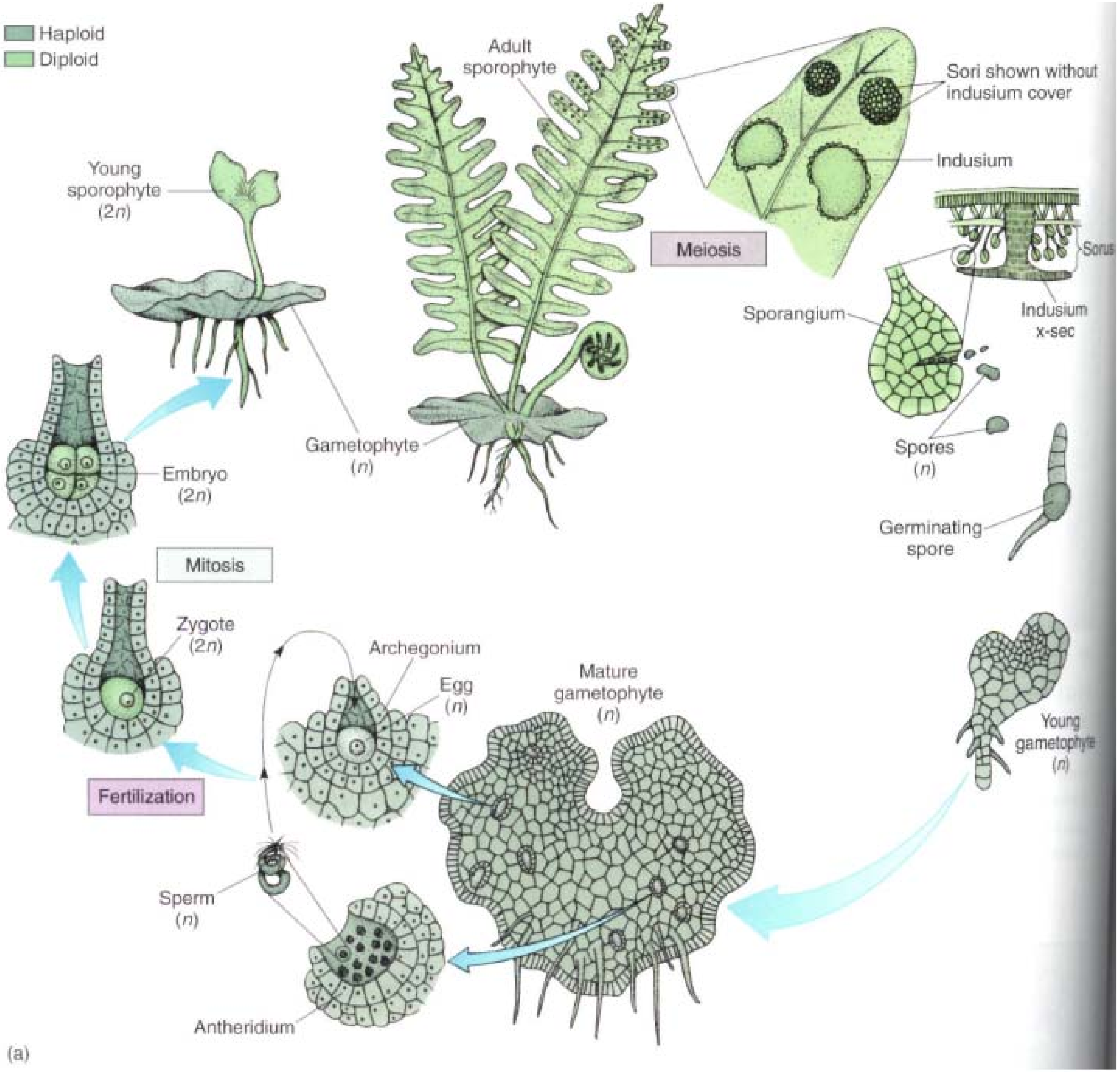


Fig. 7.22 : Life cycle of *Psilotum*

Life cycle pattern of a fern



Homosporous dioecious gametophyte: e.g. *Equisetum*

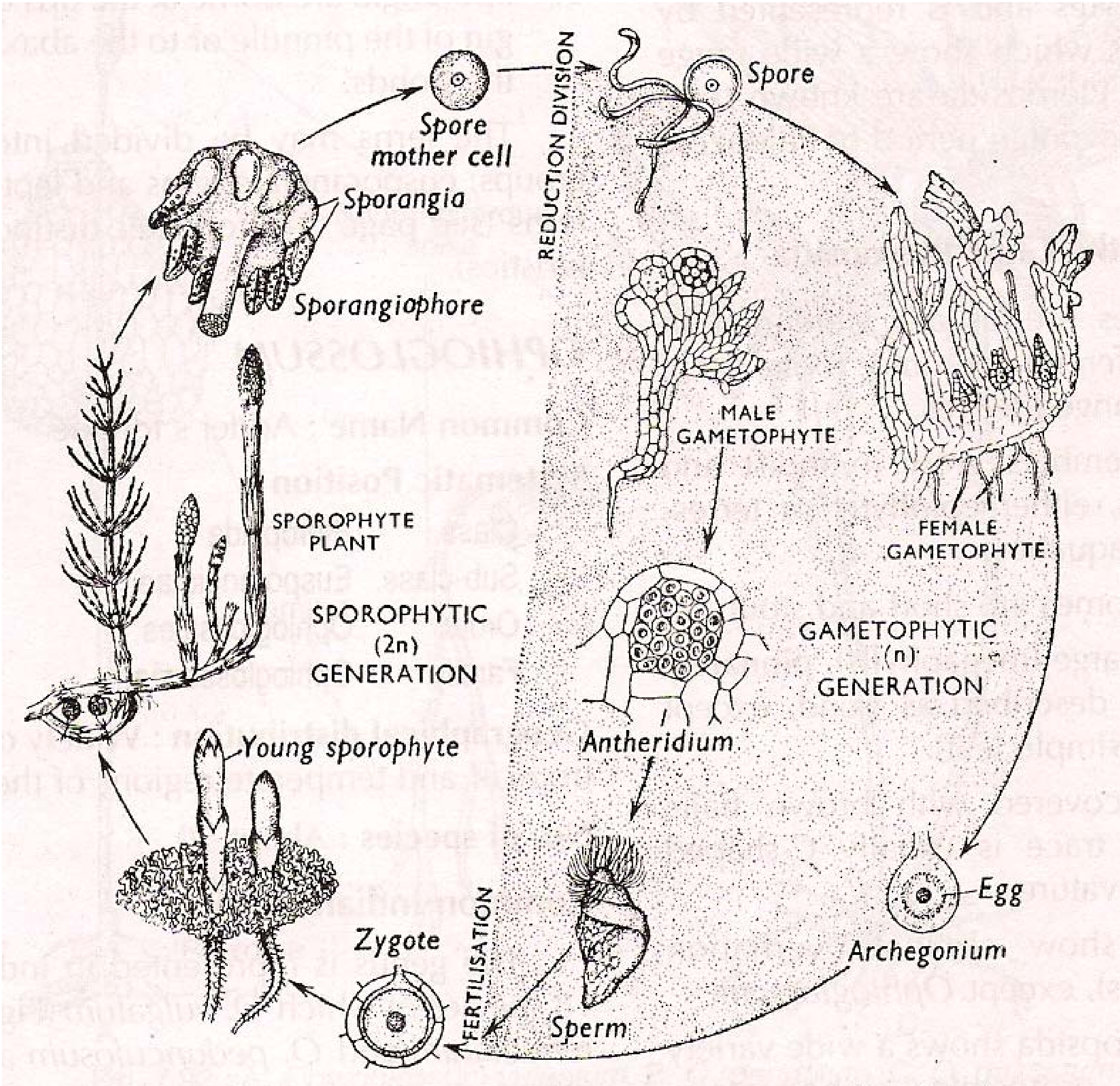


Fig. 7.91 : Life cycle of *Equisetum arvense* (dioecious)

Heterosporous dioecious gametophyte: e.g. *Selaginella*

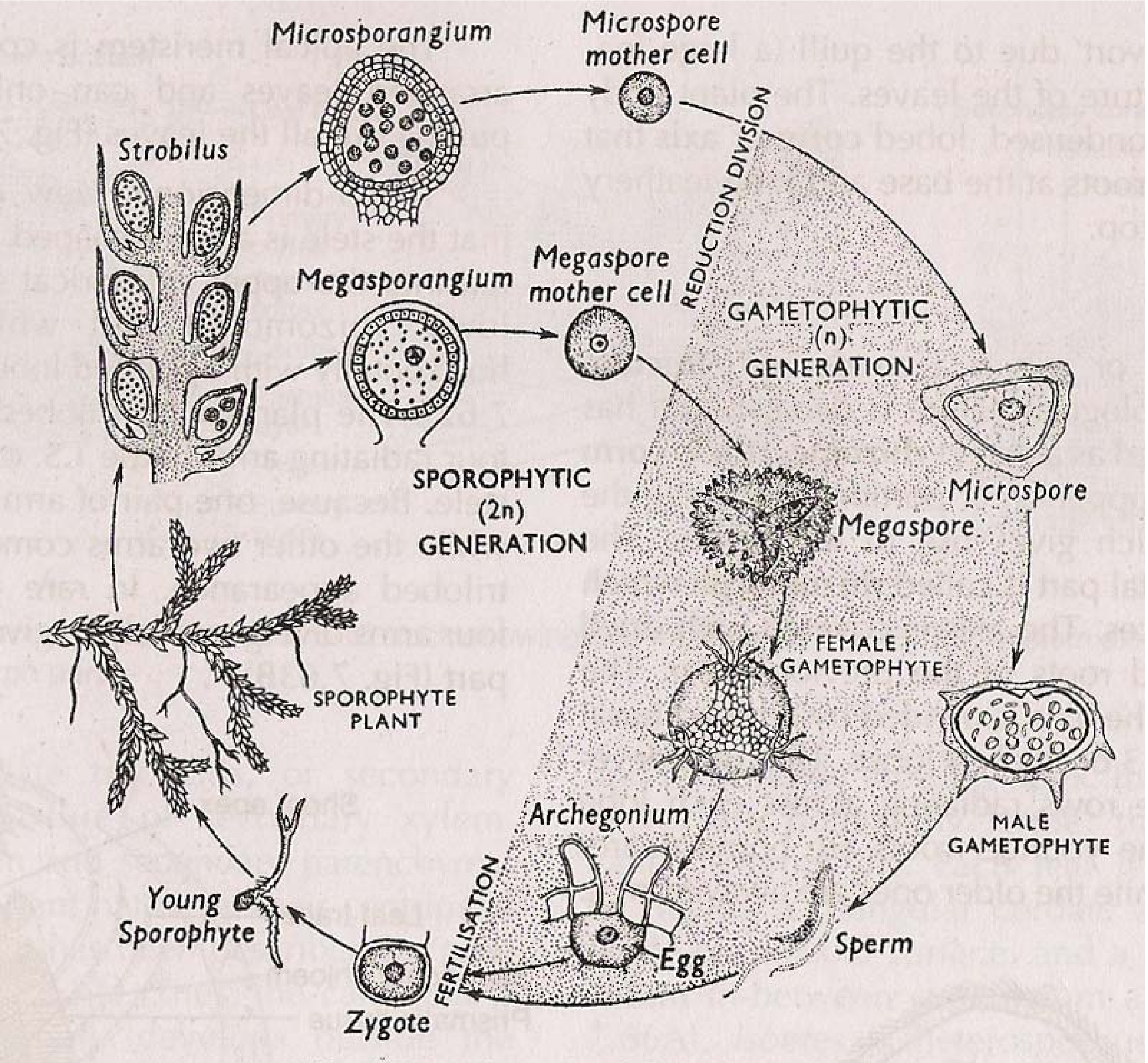
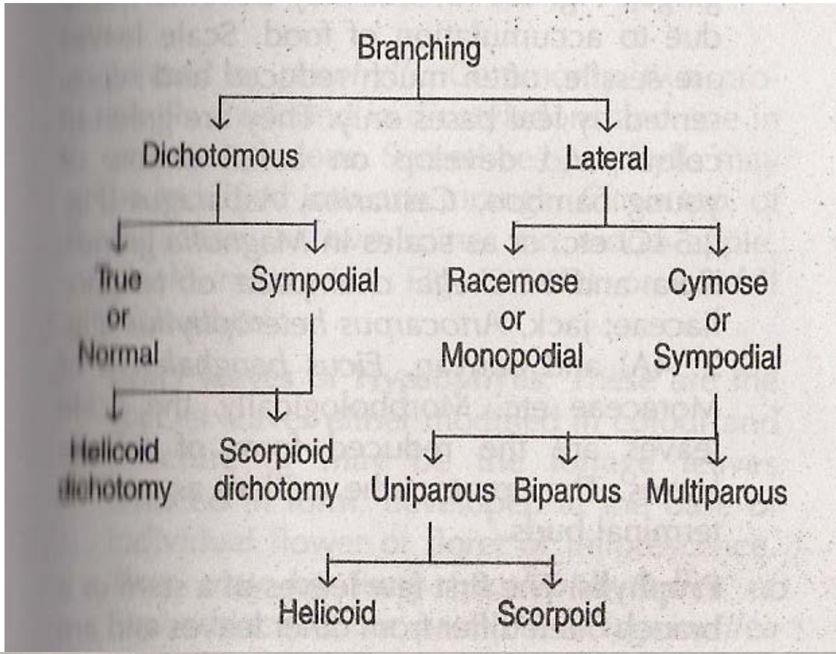


Fig. 7.58 : Life cycle of *Selaginella*

Classification: This classification is proposed by K.R. Sporne (1975). He divided the Division Pteridophyta into 6 clasess.

1. Psilopsida (extinct)
2. Psilotopsida
3. Lycopsida
4. Sphenopsida
5. Pteropsida
6. Progymnospermopsida

Branching pattern



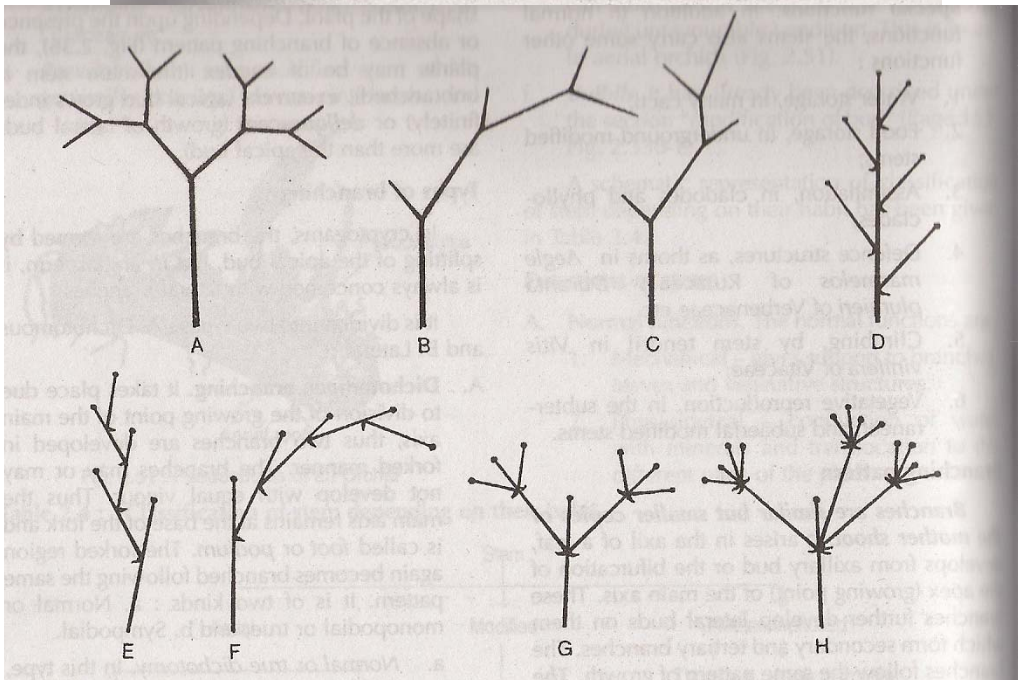


Fig. 2.53 : Branching pattern (diagrammatic) : A. Normal dichotomy, B. Helicoid dichotomy, C. Scorpioid dichotomy, D. Racemose, E. Scorpioid cyme, F. Helicoid cyme, G. Biparous cyme, H. Multiparous cyme

Origin and evolution of life cycles of early vascular plants.

Transformation hypothesis:

➢In the same rocks with *Rhynia* there are other fossils of similar plants. Two of these, *Lyonophyton* and *Sciadophyton,* were gametophytes, not sporophytes. The ends of the stems bore flattened cup-shaped areas that contained gametangia, both antheridia and archegonia, but not sporangia.

➢These plants had upright, dichotomously branched stems, vascular tissue with tracheids, stomata, and a cuticle. The nature of these early gametophytes is important in understanding the early evolution of vascular plants.

➢The discovery of an alternation of heteromorphic generations in algae was possible because the individuals could be grown in culture and their life cycle could be observed.

➢This is impossible with fossils, but it is possible to suspect that because *Rhynia*-type sporophytes occur together with *Sciadophyton*-type gametophytes, they might have been alternate phases of the same species. If this is true, these plants had an alternation of isomorphic generations, and later evolution into the seed plants involved reduction of the gametophyte to just a few cells and elaboration of the sporophyte into a more complex plant. This hypothesis is the **transformation hypothesis** (Fig. 23.7).

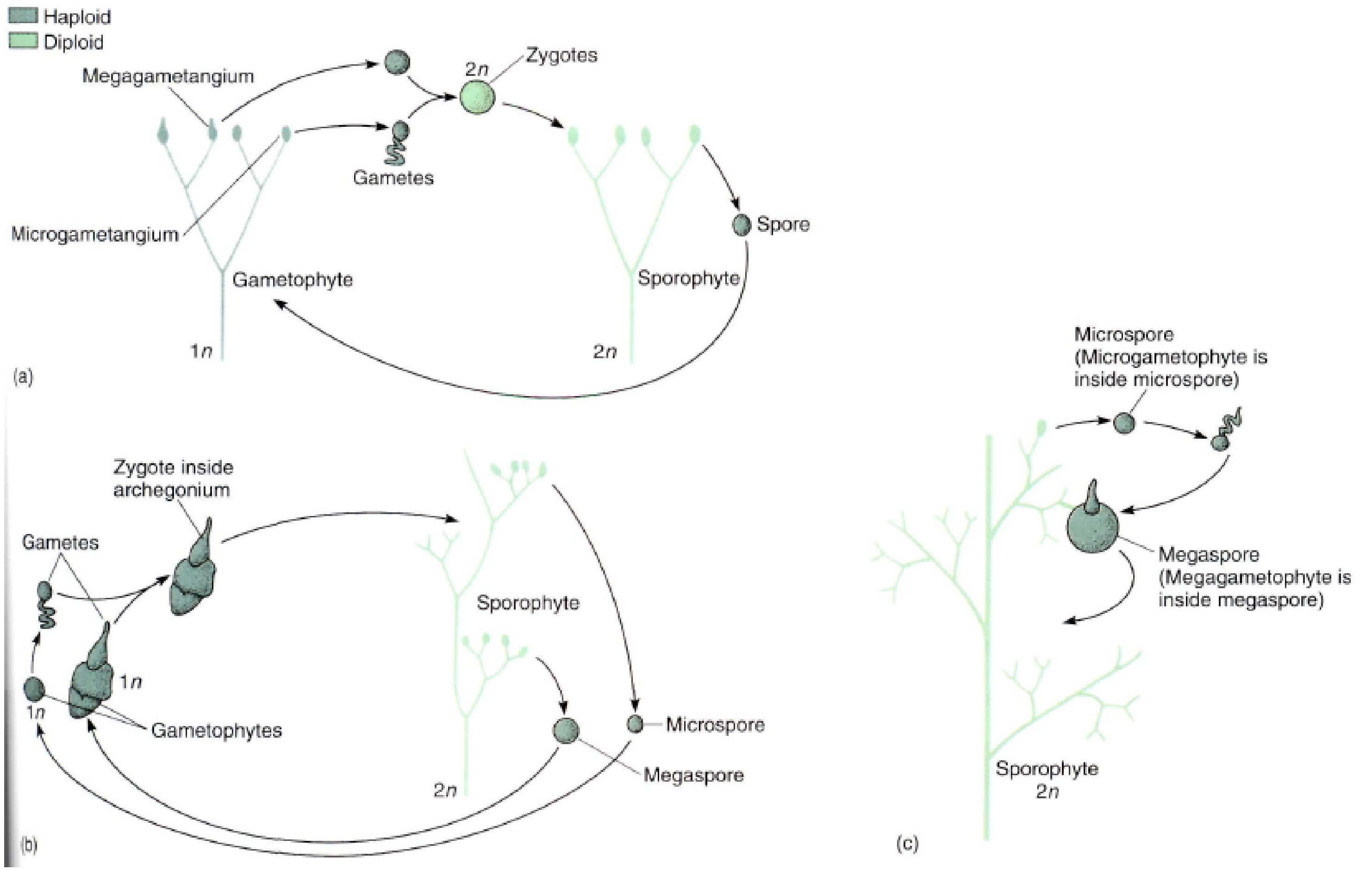


FIGURE 23.7
The transformation theory of the origin of the vascular plant life cycle postulates that in early land plants (a), gametophytes were upright and dichotomously branched, with epidermis, cuticle, and vascular tissue, just like sporophytes. (b) With time, sporophytes became larger and more complex and gametophytes became simpler. Even though these are two plants of the same species, different phenotypes are adaptive for each, because each contributes to the survival of the plant in different ways. In the species illustrated here, the gametophytes have become so small that the microgametophyte develops within the spore wall and the megagametophyte protrudes from the spore only slightly. (c) With continued reduction, it is possible—but neither necessary nor inevitable—for the megaspore and its megagametophyte to be retained inside the megasporangium and remain on the parental sporophyte, an important step in the process of seed evolution.

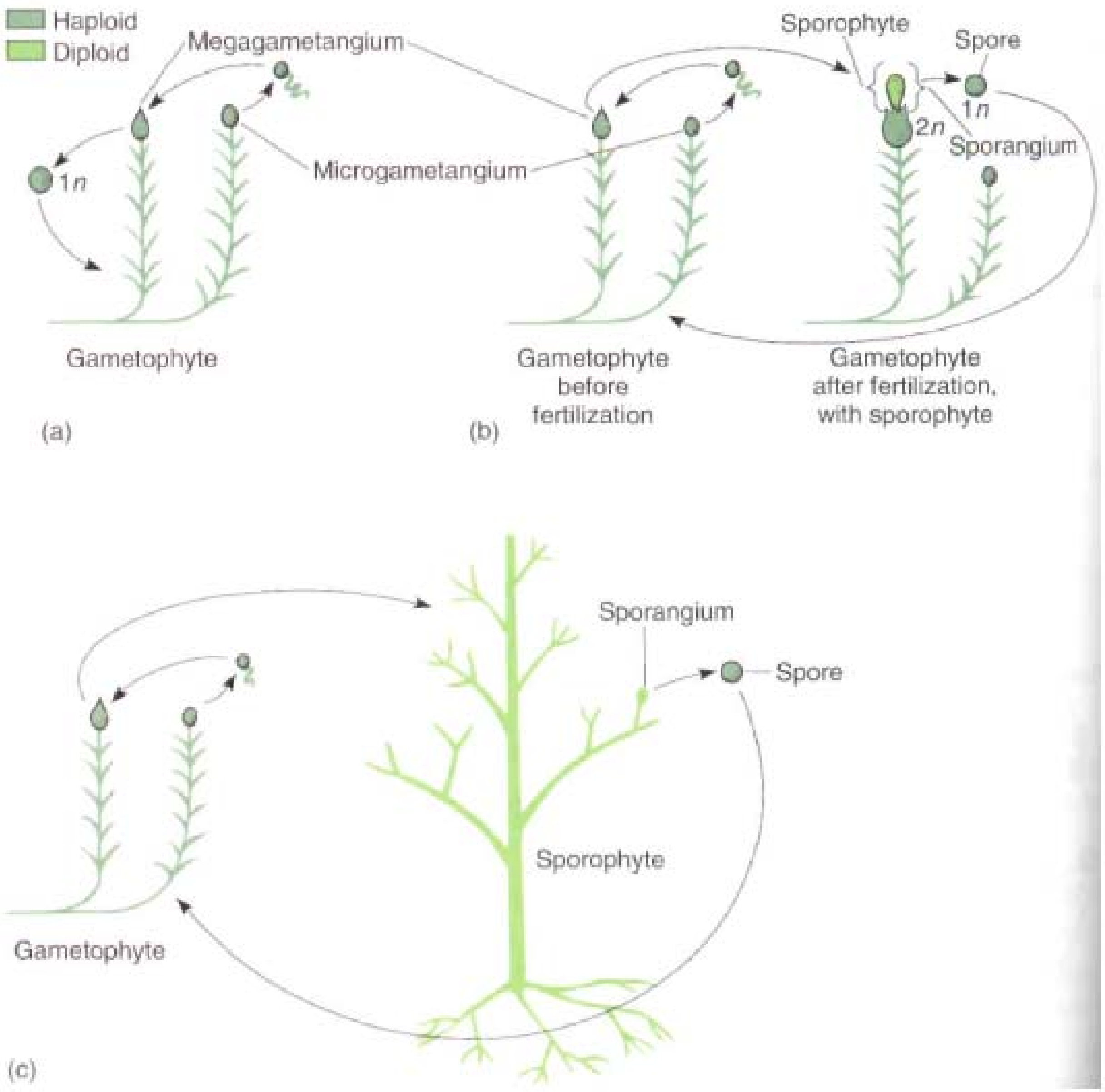


FIGURE 23.8

The interpolation theory. (a) The very earliest land plants were postulated to have no sporophyte; instead the zygote "germinated" by meiosis. (b) At a later stage in evolution, the zygote would germinate mitotically and produce a simple sporophyte that in the early stages would have consisted of a sporangium and perhaps also a foot. (c) With continued evolution, the sporophyte would have become progressively more elaborate while the gametophytes became simpler.

interpolation hypothesis:

- An alternative hypothesis, the **interpolation hypothesis**, postulates that the earliest plants were monobiontic without a multicellular sporophyte (Fig. 23.8).

- A small sporophyte was presumed to come into existence when a zygote germinated mitotically instead of meiotically. The sporophyte generation would have gradually evolved in complexity while the gametophyte generation remained small.

- A sporophyte generation would be inserted (interpolated) into the monobiontic life cycle. In this hypothesis, nonvascular plants such as mosses are thought to be intermediates in the progression from green algae to vascular plants (Fig. 23.8).

- We have no way to decide which hypothesis more accurately approximates the actual origin of terrestrial sporophytes. The presence of *Horneophyton, Lyonophyton,* and *Sciadophyton* supports the transformation hypothesis, as does the similarity between *Anthoceros* and *Horneophyton.*

- But in mosses and liverworts, several species with the most complex capsules (sporophyte phase), seem to be the most derived species. Perhaps mosses and liverworts arose separately from green algae by interpolation. At present, data are insufficient to be certain.

Form Genera

❑Although we can be fairly sure that a plant like *Sciadophyton* was the gametophyte of a plant like *Rhynia* or *Cooksonia,* we can probably never know for certain. **These fossils are the separate pieces of a life cycle, just as the individual fossils of spores, leaves, fruits, flowers, stems, and roots are the pieces of plants. How do we know which fossil parts came from the same species?**

❑As a plant dies, its leaves and flowers usually abscise, so we have numerous individual leaf and flower fossils mixed with the remains of bare stems; usually many species grow mixed together. **We find many types of fossil leaves mixed with many types of fossil stems, flowers, wood, and other plant parts.**

❑If we find a branch with leaves or flowers still attached, that is, if there is an organic connection, we can establish which organs are part of one plant. **Until we know which parts were portions of the same species, we must use form genera, which are created for types of isolated organs, tissues, spores, or pollen. If a fossil leaf is found which appears to be distinct from all others, it is named as a new form genus of leaf.**

❑We may be almost certain that the leaves have been produced by the twigs, based on this correlation of common occurrence at the same time and the same place. However, the leaves cannot be assigned to the form genus of the wood unless they are actually found still connected to a twig. Only when an organic connection has been established can two form genera be combined. For spores and pollen, no organic connection ever occurs, but occasionally an unopened sporangium or anther is found, so certain spores or pollen grains can be associated with those sporangia or anthers. **Even when two form genera have been shown to be parts of the same species, it is still often much simpler to continue using the names of the form genera.**