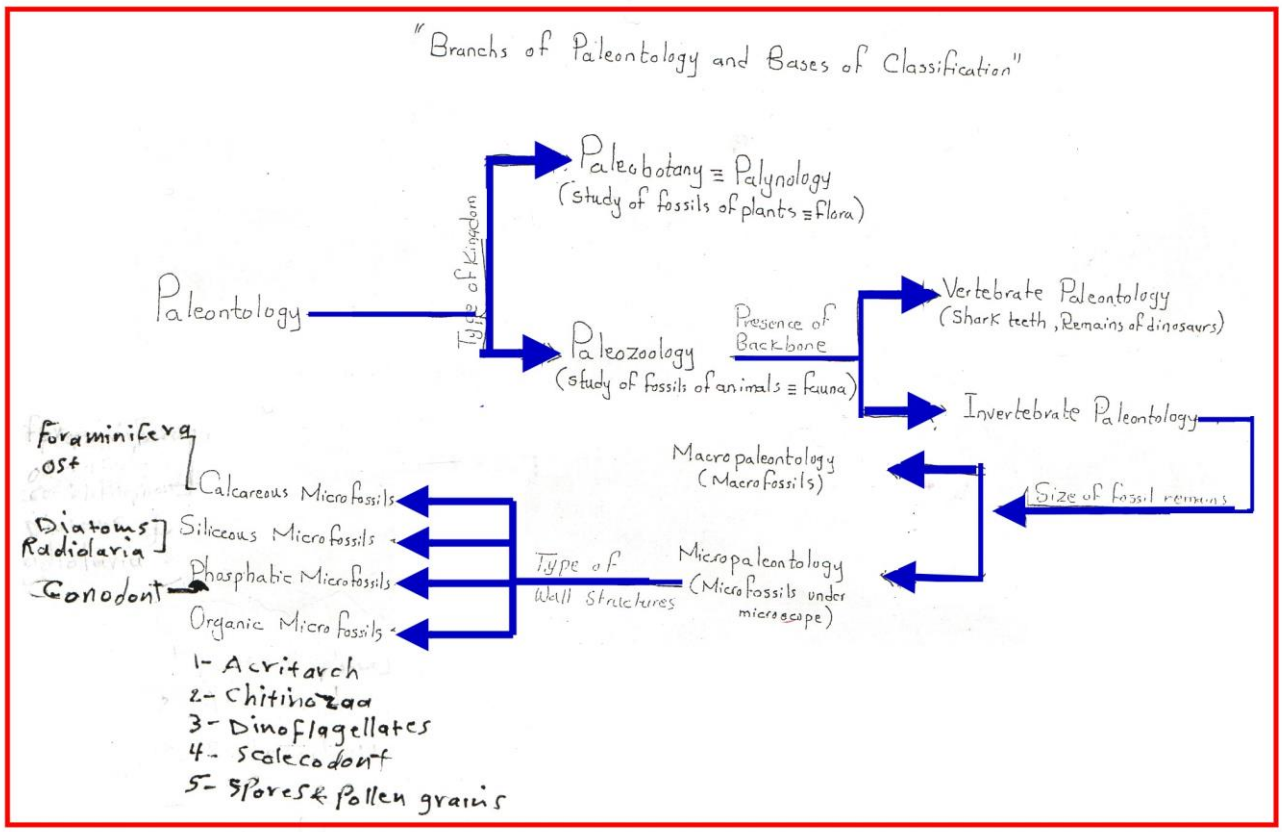
Micropaleontology

The study of microfossils, that must be examine with a microscope or microscopic parts of macroscopic organisms, it includes unrelated and related taxonomically groups.

Most microfossils are protistst (unicellular), others are multicellular.

Microfossils have a practical value in historical geology due to their minute size, abundant occurrence and of wide geographic distribution.



Mode of life

1) Planktonic microfossils such as (radiolaria, foraminifera, cocolithophores and silicoflagellates).
2) Benthic microfossils: either vagile or sessile such as benthic foraminifera.
3) Some forms contained both benthic and planktonic phases such as dinoflagellates.
4) Pseudoplankton: forms are attached to the soft body of planktonic animals such as conodont.
5) Others regarded sessile (terrestrial) plants including spores and pollen grains which derived from land plants.

Classification

Whittaker (1969) classified organisms into five life kingdoms they are:

1-Kingdom Monera (procaryotic) single cell, lack nucleus include:
a-Cyanophyta (blue-green algae)
b-Schizomycophyta (bacteria)

other four kingdoms regards (eucaryotic)

2-Kingdom Protista: motile unicellular organisms such as dinoflagellates, foraminifera and radiolarian.

3-Kingdom Fungi (feeding by absorption of preformed organic matter)

4-Kingdom Animalia: multicellular (invertebrates and vertebrates)

5-Kingdom Plantae: multicellular algae and advanced plants have photosynthetic pigment

Procaryotic organisms	Eucaryotic organisms
1. Unicellular	1. Unicellular + Multicellular
2. Absence of Nucleous	2. Presence of Nucleous
3. Absence of vesicular cells	3. Presence of vesicular cells
4. No sexual reproduction, only asexual	4. Sexual and asexual reproduction
5. Feeding (Photosynthesis, Parasites)	5. Photosynthesis (Plants), Absorption (Funji), Variable (Protista), Ingestion (Animalia)
6. Includs only Monera: Cyanophyta (Blue-Green Algae), Schizomycophyta (Bacteria)	6. Includs Protista, Funji, Plants and Animalia

Types of microfossils wall compositions

I) Mineral walled microfossils includes:

1-Calcareous microfossils (ostracod, calcareous foraminifera, calcareous algae and cocolithophores)
2-Siliceous microfossils (radiolarian, diatoms and silicoflagellates)

3-Phosphatic microfossils (conodont)

II) Organic walled microfossils includes (spores and pollen grains, acritarch, chitinozoa and dinoflagellate)

Palynology

The study of spores and pollen grains which represent the products of continental vegetation, their size about (5-150 micron)

Spores: a single celled body or a few celled body, which produced as a means of propagating a new individual. The produced by bacteria, algae, protista which rarely fossilized where spores of vascular plants since Silurian time are very common as fossils. Their are two types of spores:

1) Homospores (isospores): identical spores in shapes and size, produced by (Lowly) primitive vascular plants during Silurian and Early Devonian)

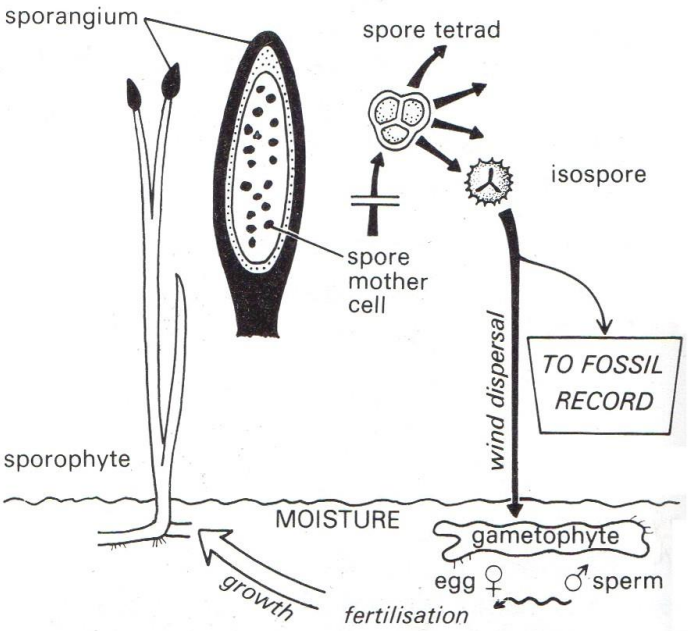


Figure 10.1 Reconstructed life cycle of a homosporous plant, the Devonian psilopsid *Rhynia*.

2) Heterospores: two types of spores that produced in more advanced free-sporing vascular plants, from late Devonian which includes:

a) Microspores: spores about 20-50 micron in diameter, over than 200 microspore occurred in microsporangia near tip on cones. They developed to small male (gametophytes)

b) Megaspores: spores about 200-400 micron in diameter, about 1-16 megaspores in megasporangia near the base of cones, after libration and dispersal, the developed to large female (gametophytes). When male and female fertilize a new sporophyte plant produced.

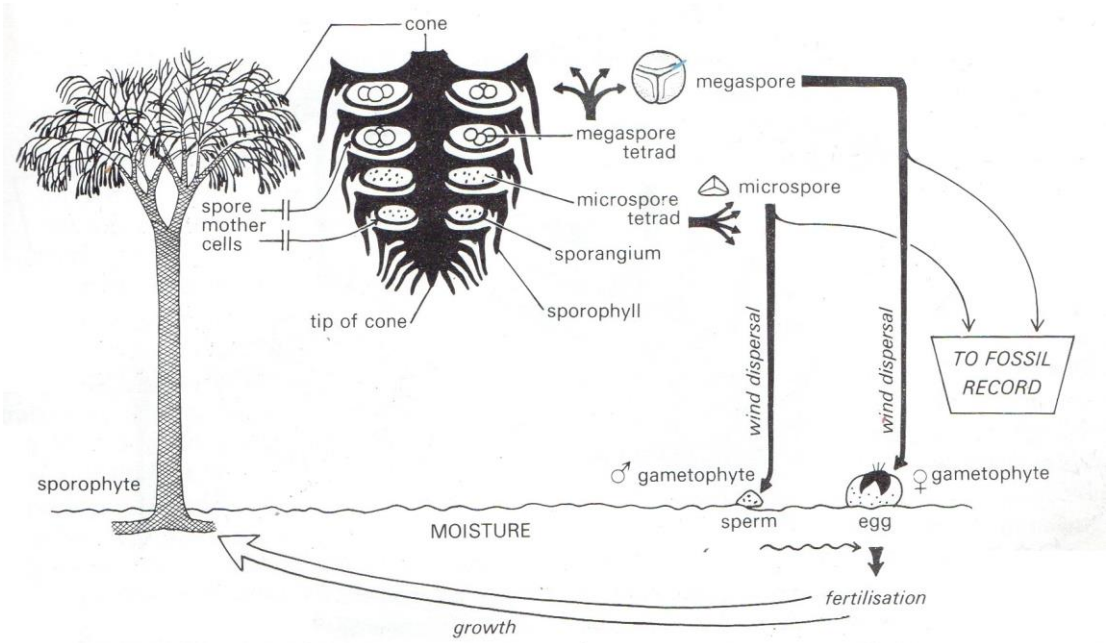


Figure 10.2 Reconstructed life cycle of a heterosporous plant, the Carboniferous lycopsid *Lepidodendron*.

3) Seed bearing plants (gymnosperm): such as conifers from middle Carboniferous. The megaspores within megasporangia which situated in the cones divided to four pollen grains of tetrad which alights on the ovule and grows along pollen tube to connect with egg cells when they fertilise and growing to become new sporophyte plant (asexual).

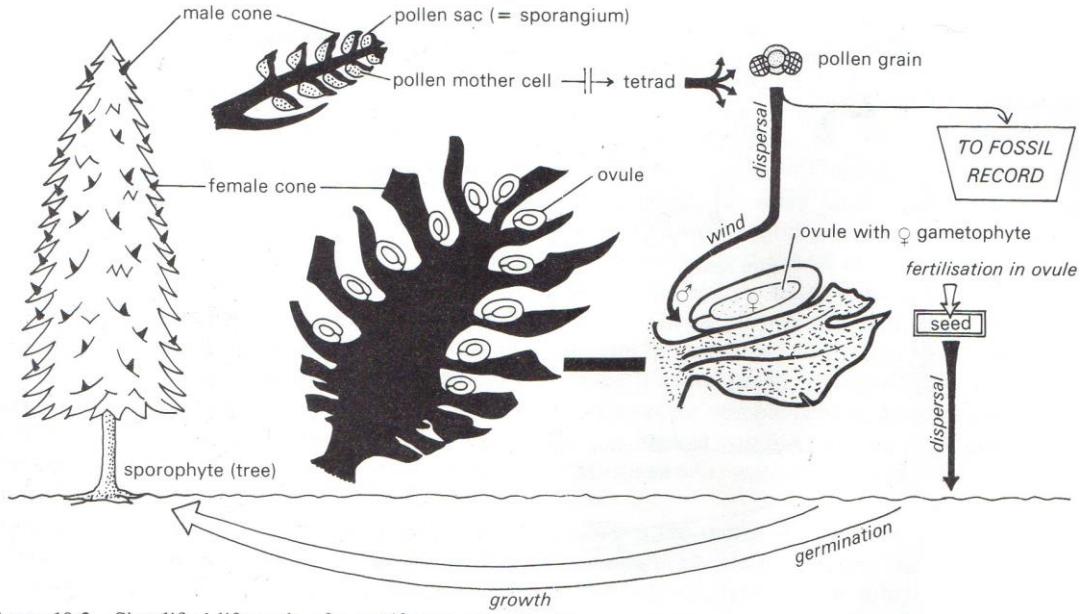


Figure 10.3 Simplified life cycle of a coniferous gymnosperm.

4) Angiosperm or flowering plants from Lower Cretaceous. The pollen (male) in microsporangia (anther) on stamen, when the pollen tube grow (pollination) and alight on stigma on a style and when reached the ovule fertilize the egg cell, seed will produce.

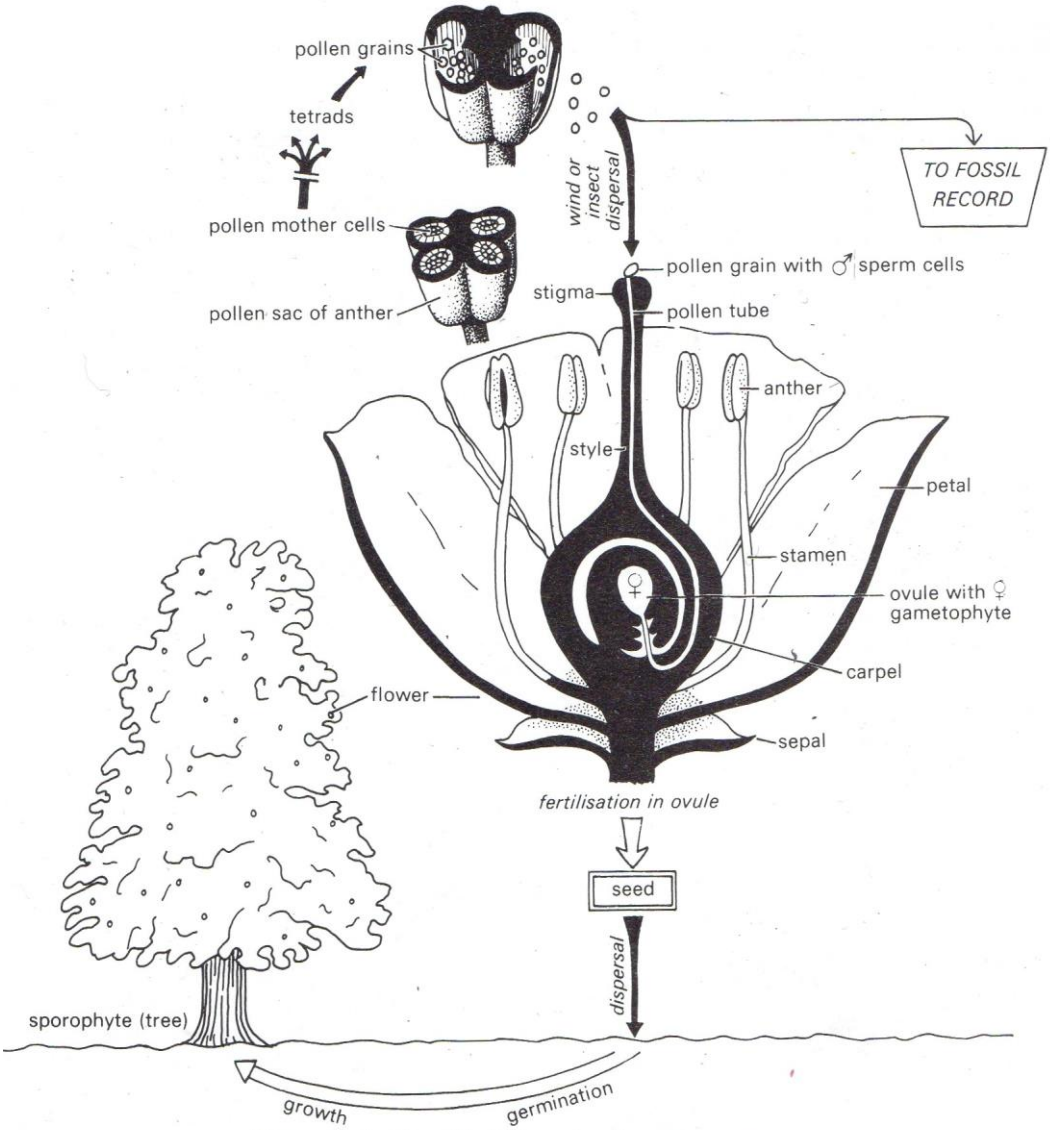


Figure 10.4 Simplified life cycle of an angiosperm.

Alternation Generation

An alternation of life cycle between spore producing sporophyte generation and a gamete producing gametophyte generation (male and female).

Sporangia:
Capsules that include spore or pollen mother cells each have the same chromosomes as sporophyte plant which divided to four spores or pollen in tetrad by simultaneous or successive meiosis.

Meiosis:
The process that divided the spore or pollen mother cell in sporangia to four spores or pollen each has half chromosomes of spore mother cell which grow to gametophyte generation.

Spores and Pollen Grains Morphology

Spores and pollen grains can be describe according to their (1) shape (2) aperture (3) wall structure (4) wall sculpture (5) size.

(1) **Shape**: the spores and pollen grains shapes due to the nature of meiosis either simultaneous or successive of the spore or pollen mother cell:

a-in simultaneous meiosis the mother cell splits simultaneously into a tetrad consisting of four smaller cells (spores), each arranged at the corner of a tetrahedron. Having a space for all round growth and are subspherical or oblate shape (fig 10-5).

b-in successive meiosis the mother cell divides first into two cells then will subdivide further along plane at right angle to the first division. The tetrad are tetragonal and may more resemble the segments of an orange in shape (prolate shape) (fig. 10-5).

Meiosis and the production of Spores"

Successive Meiosis	Simultaneous Meiosis
1. Mother cell divides at first into two cells which then subdivide further along a single plane at right angles to the first division, or along two planes at right angles.	1. Mother cell splits simultaneously into a tetrad consisting of four smaller cells, each arranged as if at the corner of a tetrahedron.
2. The tetrads here are tetragonal and may more resemble the segments of an orange in shape.	2. Tetrahedral tetrads have ample room for all-round growth and are often subspherical in shape.
3. Bilateral Symmetry	3. Radial Symmetry
4. Monolete mark	4. Trilete mark

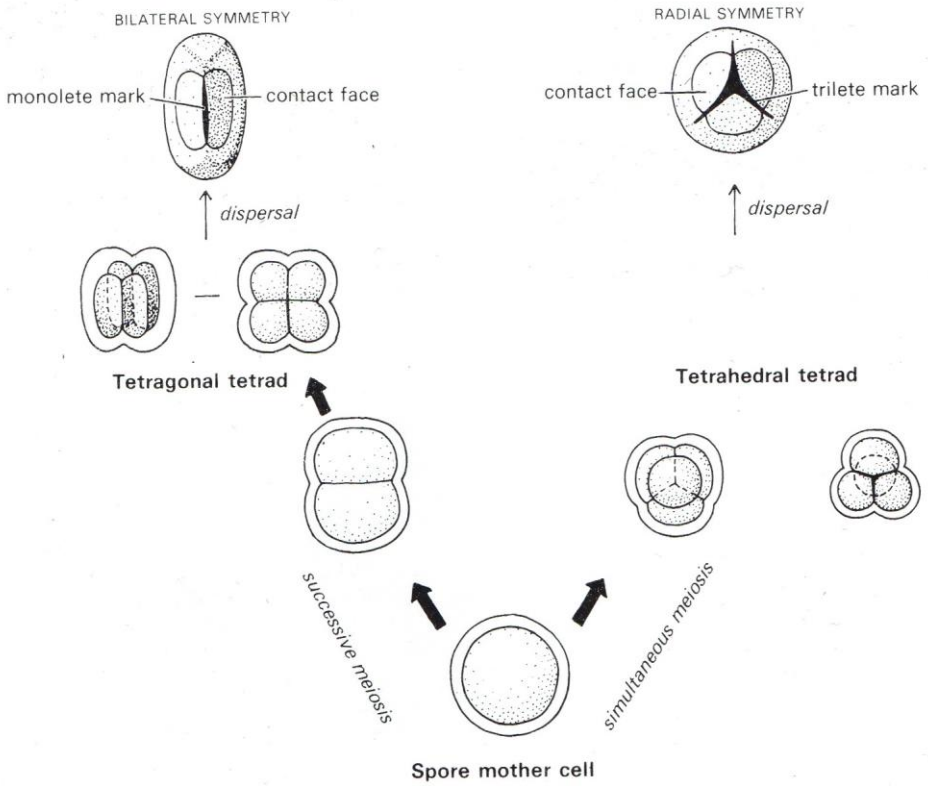


Figure 10.5 Meiosis and the production of bilateral or radially symmetrical spores.

The spore surface turned to the center of the tetrad is called the proximal polar face, the opposite surface of the spore is the distal polar face. The two are connected by polar axis and separated by an equator.

There are three types of shape:

(1) Prolate: spore where the polar axis exceeds the equatorial axis in length.
(2) Oblate: spore where the equatorial axis exceeds the polar axis in length.
(3) Spheroid: spore equidimantional in length (polar axis equal to equatorial axis in length).

Prolate Oblate Spheroid

Description of spores is assisted by a proximal view to reveal the equator or amb and the aperture and by an equatorial view. In pollen grains a distal view is more useful.

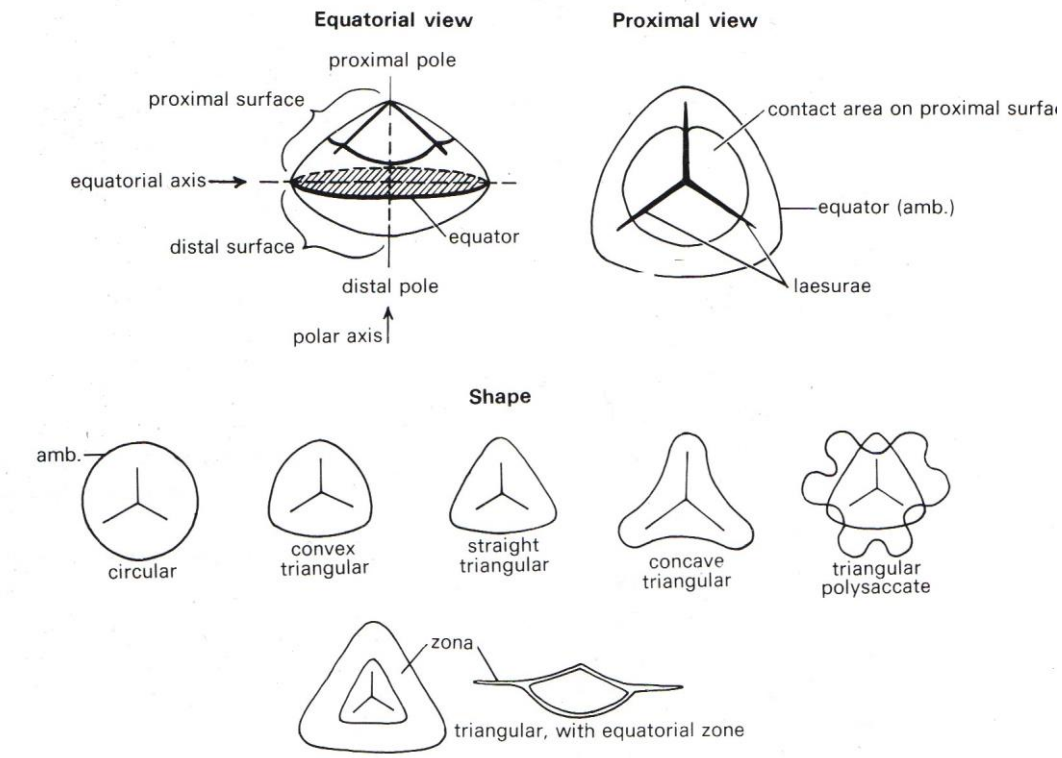


Figure 10.6 Morphology and terminology of trilete spores.

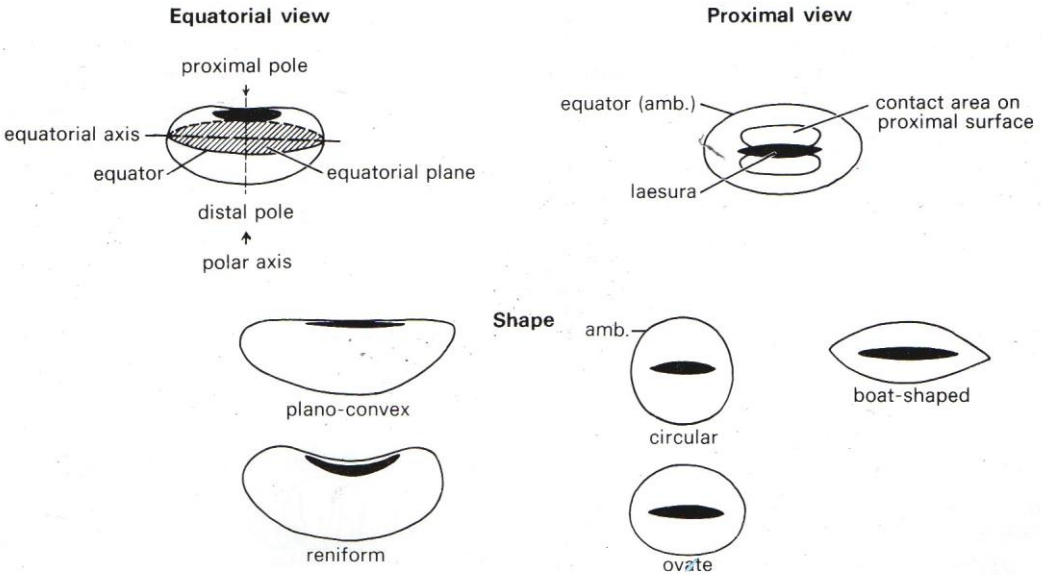


Figure 10.7 Morphology and terminology of monolete spores.

(2) **Aperture**: its openings or thinnings of part of exine in spores and pollen caused by the connecting among the spores or pollen in tetrad by simultaneous or successive of the spore or pollen mother cell. It serve in germination to exit the prothallus in spores or to exit the pollen tube in pollen and to accommodate size changes by humidity, there are six basic kinds of apertures:

Apertures in spores

Situated on proximal surface

1-trilete mark (triradiate) most common type (fig. 10-6).
Its three radiating sutures from proximal pole at 120 degree apart incluces three contact areas in spheroidal or oblate spores of homosporous plants.
2-monolete mark (one laesura) less common (fig. 10-7).
A sigle laesura separated to contact areas in spores in heterosporous plants.
3-alete spores
No obvious laesura.

Apertures in pollen grains

Situated on distal surface. They are two types:

a-sulci: furrow parallel to equator
colpi: furrow perpendicular to equator (monocolpate, tricolpate, …) (fig.10-9)

b-pores: isodiametric apertures, one or more pores (monoporate, diporate, triporate, …)

4-monosulcate pollen: (fig. 10-8)
A single sulcus along distal face produced by successive meiosis of pollen mother cell in gemnosperms and flowering plants.

5-tricolpate and multicolpate pollen: (fig. 10-9)
a-tricolpate: three furrow (colpi) arranged 120 degree apart in spheroid or prolate pollen (fig. 10-9).
b-triporate apertures: reduction of the furrows to small pores (fig. 10-9).
c-tricolporate pollen: pores situated within the colpi (fig. 10-9).

Multicolpate: (four = tetra, five = penta, six = hexa) prefixed with colpate, colporate or porate.

6-Asulcate or acolpate pollen: no obvious apertures

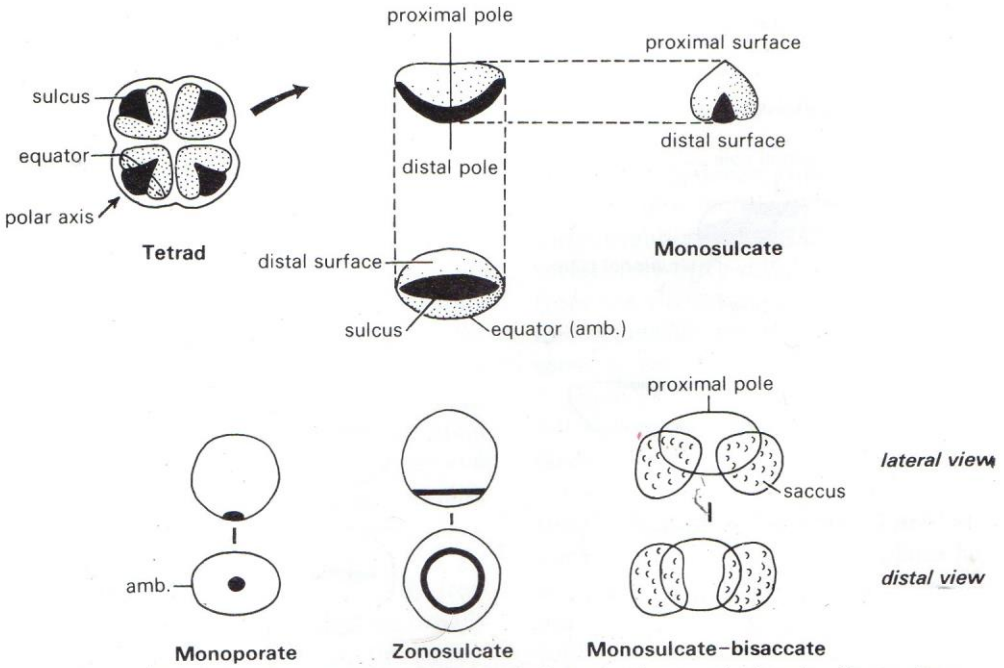


Figure 10.8 Morphology and terminology of monosulcate and related pollen grains.

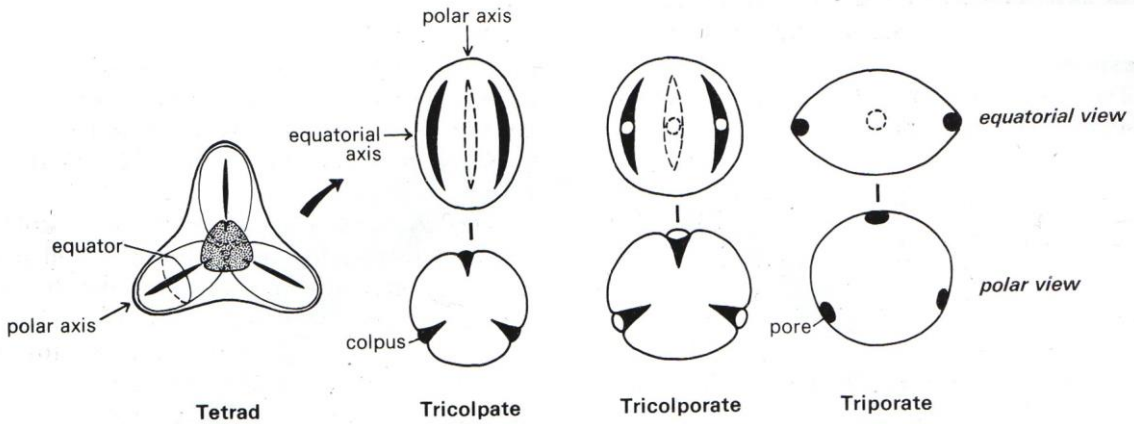


Figure 10.9 Morphology and terminology of tricolpate and related pollen grains.

(3) **Wall structure**: spores and pollen grains a double layer 1) entine: inner layer, 2) exine: outer layer

resistant waxy material called sporopollenin
there are two types of wall structures:

1-atectate wall: in spores, the exine a-homogeneous consists of one layer, b-stratified exine consists of two layers separated by air sac in cavate spores (e.g. Densosporites) or saccate pollen.

2-tectate wall: consists of inner non sculptured layer (nexine) and outer sculptured layer (sexine) which divided into rod-like columellae supporting the roof tectum (fig. 10-10).

(4) **Sculptures**: are important in description and classification various kinds of sculptures are illustrated in fig. 10-10

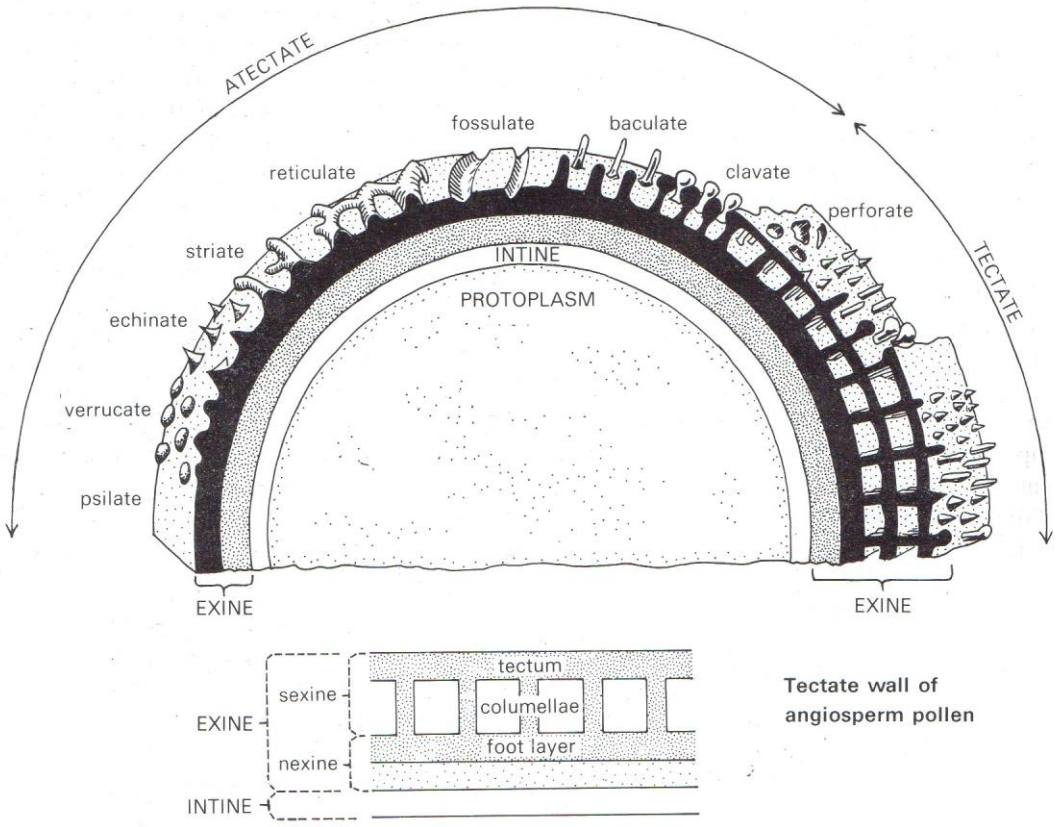


Figure 10.10 Exine sculpture and structure (diagrammatic).

(5) **Size:** The size of isospores, microspores and pollen grains (known a miospores) ranged from 5-200 micron in diameter. And megaspores tend to exceed 200 micron in maximum diameter.