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NAAC ACCREDITED ‘A’ GRADE

Topic:	PALEOBOTANY AND PALYNOLOGY
Course Title:	PLANT DIVERSITY II
Paper:	BOT-G-CC-2-2-TH
Unit:	3.4
Semester:	II
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Sporopollenin

Introduction:

It was first observed and named as “sporonin” by John (1814) and later characterized by Berzelius (1830).

Fossil green algae dating back to the Devonian period have been shown to contain sporopollenin. The oldest sporopolleninous acritarchs occurring in Precambrian rocks, 1.2-1.4 billion years old.

The green algae are presumably responsible for the development of sporopollenin and its introduction into the armament of higher green plants, where its principal function is protection against oxidation and desiccation.

Distribution:

- It forms the basic structure of the resistant wall of most palynomorphs, like spores, pollen, dinoflagellates, and acritarchs.
- It is also distributed in the spores of some fungi like *Aspergillus niger* and several algae like, in the cell wall of *Phycopeltis epiphyton* and spores of Bryophytes, Pteridophytes, pollen of Gymnosperms and Angiosperms.

- In general it is limited to the outer wall, the exine however, fern spores and some gymnosperm pollen have an additional sporopollenin-bearing wall, the perine or perispore.

Chemistry of Sporopollenin:

- It is extremely difficult to characterize this highly inert N_2 free substance. However, Zetzsche (1937) determined that the sporopollenin is an oxygenated hydrocarbon and contains hydroxyl and C-methyl groups and substantial level of unsaturation.
- Shaw and Yeadon (1966) proposed that sporopollenin was a mixed polymer of lipids and phenylpropanoid units were rapidly replaced by a chemical structure based on the polymerization of carotenoids and carotenoid esters.
- Its empirical formula was worked out by Zetzsche (1937) in *Lycopodium* as $C_{90}H_{144}O_{27}$
- It is probably the most inert C-H-O organic compound that resists acetolysis, but degrades in strong oxidants like H_2O_2, or Cr_2O_3 and exhibits secondary fluorescence when stained with primuline.
- The work of Heslop-Harrison (1968) and Brooks (1969) has been suggested that sporopollenin is a copolymer of β-carotene, and xanthophylls such as antheraxanthin, and fatty acids (Fig.2.6).

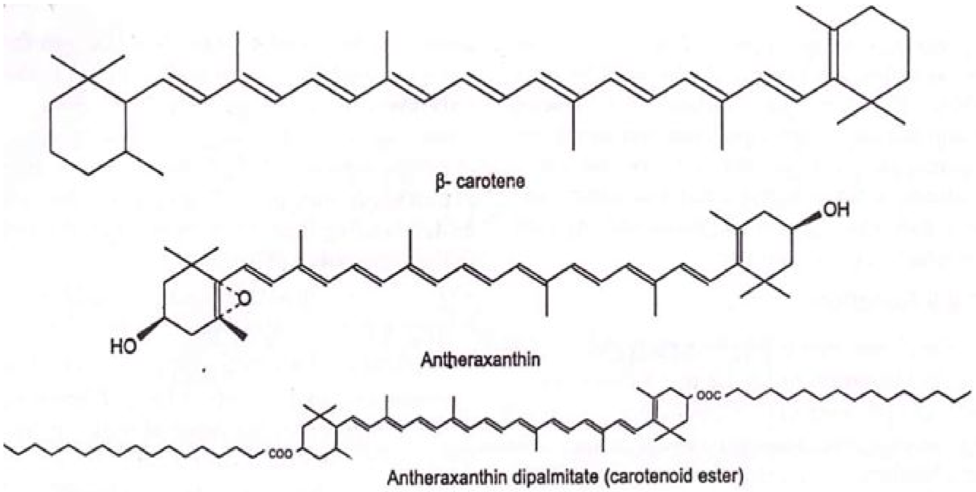

Fig. 2. 6 : Proposed structural units of sporopollenin

- A further re-evaluation of its chemical structure has cast doubt on the role of carotenoids and favours the idea that sporopollenin is a mixed polymer of phenylpropanoid and fatty acid derivatives.
- At present it is assumed that sporopollenin is a polymer consisting mainly of unbranched aliphatics with a variable amount of aromatics.
- Its natural colour is pale yellow, but with thermal maturation, as the sporopollenin increases in rank, with loss of O and H and increasing percentage of C, the colour deepens through dark yellow, orange, reddish brown, finally to black. During this series the reflectance increases.
- The staining and solubility differences between the ektexine and endexine indicate that the sporopollenin of these two layers differ chemically. If the wall is stained with basic fuchsin the ektexine, which is actually the sexine plus nexine 1, becomes heavily stained before the endexine or nexine 2.

- Further, it has been shown that the ektexine of some pollen grains is soluble in hot 2-aminoethanol and several related substances while the endexine is left unaffected.
- It is not affected by enzymes, so pollen and spore exine pass through most animal guts unchanged. It has been shown that the fern spores can even germinate in fair numbers after passing through the gut of a locust.
- Moreover, it has been seen that some fungi can digest sporopollenin and can attack spores/pollen, apparently after deposition in sediments. Some bacteria can also accomplish this task presumably by their natural hydrolytic nature.
- It is well preserved in sediments and remains unchanged when extant pollen grains are heated to 300 degree celcius or treated with concentrated acid and bases.
- Sporopollenin can be degraded by ozonolysis.

Function of Sporopollenin:

a) The presence of this unique plant polymer in early sediments (in Precambrian rocks) has important implications for investigations into the origin of life. In these early forms of life sporopollenin probably played the role of protector of the protoplasm against ultraviolet radiation.

b) It is evident that the pollen exine has a basic function in the physiological complex of fertilization, since it has developed in almost all terrestrial plants irrespective whether they use wind or animals as pollination vectors.

The sporopolleninous exine has been claimed to protect the protoplast from the rapid water loss. The barrier function of the exine for water, low molecular weight solutes and polymers is well established.

c) Higher concentration of sporopollenin and its greater deposition in the outer part of the pollen wall (ektexine or sexine) make the exine more durable, thus extending its viability.

b) Palaeopalynological significant property of sporopollenin is sporopollenin- bearing palynomorphs. Once delivered to sediment, they tend to stay there, though the contents and the other wall layers of the palynomorphs are quickly lost.

Such an assemblage of varied palynomorphs by virtue of the sporopollenin help in the **reconstruction of past vegetation, predicting climatic changes, understanding the evolution of plant life, and in the exploration of hydrocarbons (petroleum and coal)** by using parameters like TAI (Thermal Maturation Index), and degree of carbonization.

However, oxidizing and highly alkaline environment, carbonization (= coalification), thermal maturation, as a result of relatively low temperature elevation over a long time, high temperature (due to volcanic intrusion) and recrystallization of minerals in the sediments degrade the sporopollenin, thus depriving us in understanding the evolution of plant life.