

normal pollen grains are dark brown, while the exine of the aborted pollen grains becomes pale yellow. The acetolysed, aborted pollen grains also collapse when they are mounted in glycerine jelly. We suspect that this difference is due to a difference in chemistry of the pollen walls of the two types, or due to variation in wall thickness (not distinct with the light microscope). Immature pollen grains are not taken into consideration because they often stain like the aborted pollen grains.

We think that the basic exine pattern is not controlled entirely by the haploid protoplast, but is established by the proto-exine (primexine) during early stages of microsporogenesis, when the microspores are in the quartet stage, enclosed in a thick, callose wall. After the microspores are released into the anther locules, wall building substrates (sporopollenin) begin to deposit on the proto-exine framework, resulting in a similar ektexine pattern, irrespective of the presence of the pollen grain protoplast.

During the sporopollenin deposition the microspores increase in size and secondary spinules are added to the ektexine of the pollen grains by the Ubisch bodies (orbicules), regardless of their normal or aborted nature, and finally a characteristic, mature ektexine pattern of the species is formed.

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5. The structure of the Ubisch bodies (orbicules) and their control on mature ektexine pattern of grass pollen grains.

Zea mays and its related species were chosen for this investigation. The results reported here are based on electron microscopic observations. Among grasses, the Ubisch bodies (orbicules) are small, spinulate, spheroidal structures which are formed on the inner tangential, and partly on the radial surfaces, of the tapetal cells that are exposed to the thecal fluid (periplasmodium) of the anther locules. In fact, these minute structures are formed as a part of the tapetal membranes, as reported earlier by Banerjee (1967) and Banerjee and Barghoorn (1969). In the palynological literature, it has been often reported that either the function of these objects is unknown or they are a functionless,

space-filling material around and between the tetraspores (microspores) (Frey-Wyssling and Muhlethaler, 1965). We have made histochemical tests to check the chemical composition of these structures; it is found to be similar to that of the pollen grain exine, i.e. sporopollenin. Ontogenetically, the formation of these bodies begins either prior to or after the microspores are released from the quartet into the thecal fluid of the anther locules. It is at this phase, when maximum deposition of sporopollenin occurs on the templated protoexine (primexine, chemically, which is cellulosic in nature) of the microspores, and simultaneously on the inner face (tapetal surface) of the locules, that Ubisch bodies are formed. Almost simultaneously the microspores orient themselves within the locule (the germ pore facing outwards), and then enlarge in size and come in close contact with the Ubisch bodies. New spinules are added to the microspore ectexine at this stage by the formation of physical continuities between the microspores and the Ubisch body spinules, forming sporopollenin strands. In Zea mays microspores, Skvarla and Larson (1966) have shown that during early developmental stages the spinules of the ectexine are essentially extensions of the supporting columellae, further indicating that no spinules are added after template formation. But, at exine maturity, they were unable to match the number of spinules of the ectexine with the number of columellae present. Our observations clearly indicate that new spinules (secondary spinules) are added to the ectexine by the Ubisch bodies after the increase in size of the pollen grain and its orientation.

In our earlier report we have also shown that shortly before anther dehiscence the contacts of the sporopollenin strands between the Ubisch body spinules and the pollen grain spinules are lost, which allows the pollen grains to disperse at anther dehiscence.

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