Cryptospores from the Hanadir Shale Member of the Qasim Formation of Saudi Arabia: A Darriwilian (Ordovician) base for the land plant spore record

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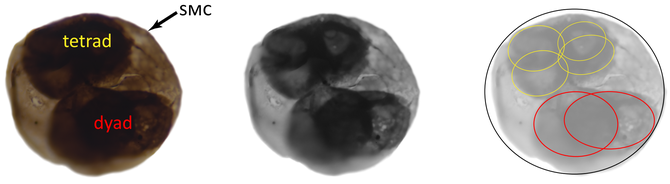
Introduction

The earliest plant axes which are visible to the naked eye do not occur until the Homarian (Wenlock, Silurian). Prior to this time we are dependent on the microfossil record of spores and cryptospores as a fossil proxy to the presence of plants on land. There is common agreement that the trilete spore is indicative of the embryophytes, or true land plants, in because this type of spore is not known amongst the algae. The triradiate suture, or trilete mark, owes its unique structure to the geometric constraint produced by four isometric meiospores formed simultaneously in the spore tetrad. Cryptospores however may occur in tetrads or dyads which are not isometric, reflecting their development from successive meiosis rather than simultaneous cell division in the developing spore tetrad. Successive meiosis occurs in the zygotes of some algae most significantly in *Coleochaete*, one of the proposed ancestral groups to the land plants. What we try to show in this poster is that the occurrence of isometric tetrads begins in the Darriwilian (Middle Ordovician) as documented in the Hanadir Shale Member of the Qasim Fm in Saudi Arabia.

The fossil record of Cambrian and Ordovician cryptospores documents a time of transition between the chlorophytes and the embryophytes. Evidence from both the fossil record and modern studies of bryophyte sporogenesis support the long-standing theory of Bower (1908), who proposed plant spores evolved prior to the plant sporophyte itself. These cryptospores have yet to be fully documented in the literature, they are presently recorded only from Laurentia and China. However, these palynomorphs could become quite important in the future as markers of terrestrial input into sedimentary basins of lowermost Paleozoic age.

Sucessive meiosis in a Cambrian cryptospore

Sucessive meiosis occurs when the formation of the developing spore wall (cytokinesis) is temporally decoupled from the division of the nucleus. Nuclear divisions occur first, and only later are the cell walls constructed around each nucleus to form a spore. When this occurs, we see combinations of dyads (paired cells) that do not conform to uniform sets of tetrads. In the sample illustrated below, from the Middle Cambrian Rogersville Sh (Laurentia) we see exactly that - a combination of a dyad and a tetrad formed within the original zygote, or spore mother cell (SMC) wall. The spore tetrad walls were laid down after two nuclear divisions, but in the dyad pair, the spore wall formed after a single nuclear division.



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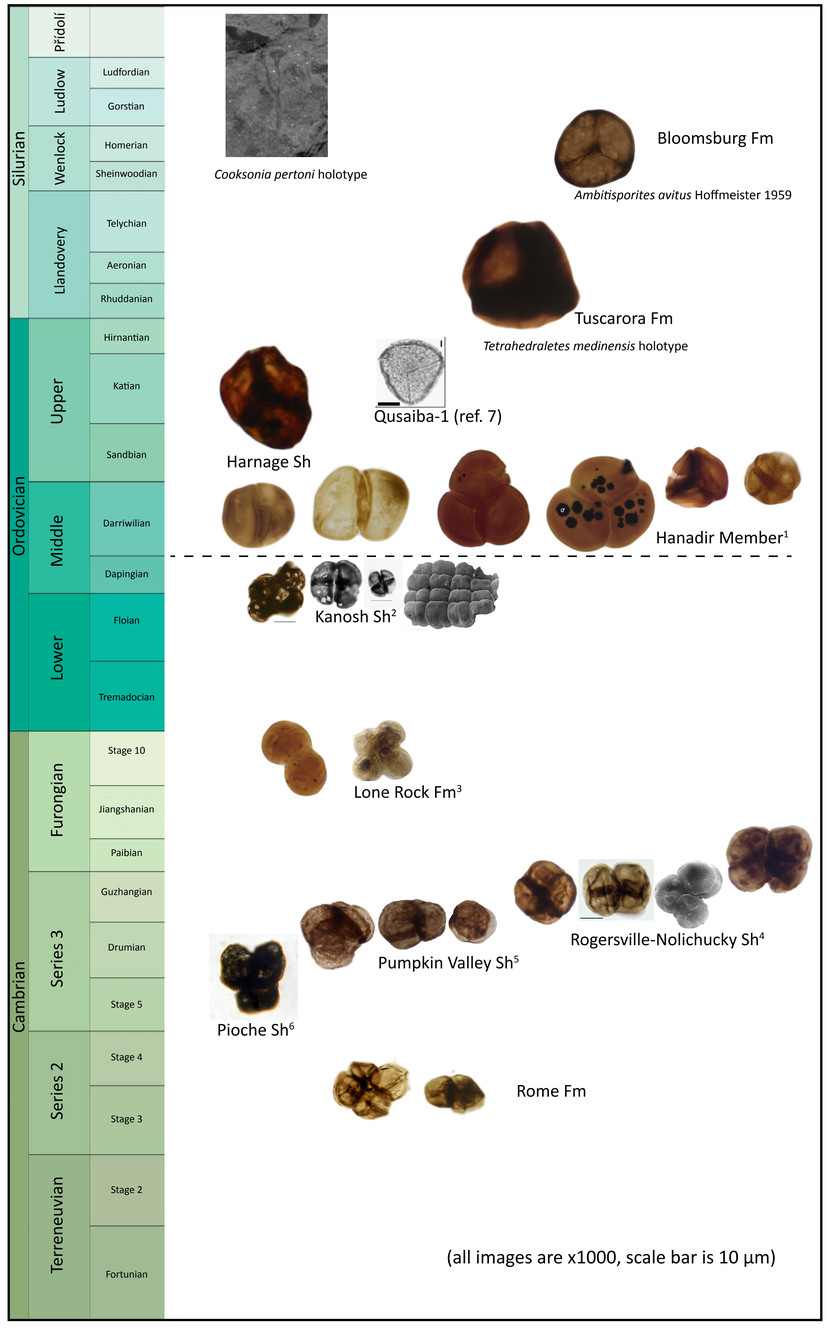
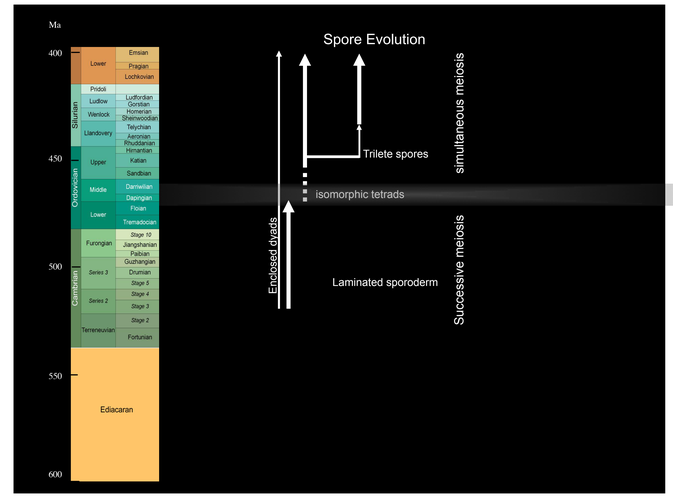


Two phases of spore evolution

Cambrian and Lower Ordovician cryptospores occur principally as dyads or combinations of dyads. They may be enclosed in a membranous wall or free. Isomorphic (tetrahedral) tetrads are found in the fossil record beginning in the Darriwilian of Saudi Arabia. The subsequent evolution of spores, in particular trilete spores, is largely correlated with the origin and diversification of the vascular land plants (tracheophytes) which began during the later part of the Silurian Period.



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