

Chapter 3

Paper:

Wellman, Charles H., Peter L. Osterloff, and Uzma Mohiuddin. "Fragments of the earliest land plants." *Nature* 425, no. 6955 (2003): 282-285.

Questions:

1. **What is the difference between a microfossil and a megafossil?** ANSWER: A microfossil refers to a fossil with dimensions in the micron scale. For example, fossil pollen and spores with diameters ranging from 10 to 80 microns are classed as microfossils. Megafossils on the other hand refer to fossils with dimensions of centimetres or more. Fossil leaves, fruits, seeds, wood etc. would be classed as megafossils.
2. **What is the name of the geological member in which the fragments of the earliest land plants were found?** ANSWER: The fossils were found in the Hasirah Member of the Safiq Formation which belongs to the Haima Supergroup in Oman.
3. **What age and type of sediment were the fossils found in?** ANSWER: The fossils come from terrestrial sediments within the Hasirah member.
4. **What types of evidence/data is the age assignment of the fossils based on?** ANSWER: The sediment in which the fossil specimens were discovered is dated to Late Ordovician (Caradoc) in age based on both biostratigraphic dating and sequence stratigraphy. Biostratigraphy relies on the presence of age diagnostic pollen and spores. In the case of this paper, the age estimates are based on terrestrial palynomorphs (pollen and spores) as well as marine palynomorphs from two marker horizons which are continuous over a wide region and are reliably dated.
5. **Describe briefly the methodology that was used to extract microfossils and larger plant fragments from the sediment samples.** ANSWER: Large bulk samples of sediments from the targeted locations were extracted from the sediment using acid maceration to break the rock down and then sieved using 100 µm mesh sieves to isolate large fragments of the fossil plant material which produce spores.
6. **Define the terms sporangium, spore tetrad and dyad.** ANSWER: A sporangium is a structure of a land plant (embryophyte) which produces spores by meiosis and protects the spores before they are released from the sporangium. A spore tetrad consists of four spores, all the product of meiotic division to produce four daughter cells. Dyads consist of two spores. Both dyads and tetrads can be dispersed as whole units of two and four spores respectively (referred to as permanent) or they can be dispersed individually if they separate from their tetrad or dyad formation before dispersal.
7. **How can you differentiate between a fossil coprolite containing spore remains and a fossil sporangium containing spores?** ANSWER: Although both can be a similar size there are a

number of important distinguishing features. Coprolites contain spores of different sizes and often contain other plant debris such as cuticle. Sporangia however contain a covering structure, and similar spore sizes with no other plant debris.

8. **The quality of preservation of spore walls is dependent on two primary processes. What are they?** ANSWER: It depends on the stage of development of the spore wall (which is referred to as ontogenetic stage) and is also influenced by diagenetic effects which are any alterations that take place (chemical, morphological, etc.) during the fossilization process.
9. **The authors suggest that the earliest vegetation of the Earth was extremely homogenous worldwide. What is the main line of evidence supporting this suggestion?** ANSWER: The main argument comes from the fact that analysis of spore samples of Ordovician age across different localities all show very homogenous compositions including spores of unusual morphology termed cryptospores. The spore assemblages consist of permanent spore tetrads, dyads and monads that are naked or are protected within an envelope.
10. **What are the main lines of evidence supporting the interpretation that the Oman microfossils and mesofossils described in this paper are from land plants?** ANSWER: (1) They are found predominantly in terrestrial sediments and not in marine sediments, suggesting a land origin of the source producer organism; (2) the size and overall morphology of some of the spore tetrads and the ultrastructure of some of the permanent tetrad spore walls are very similar to those produced by living Liverworts, which are land plants belonging to the bryophytes; (3) the spores were produced in large numbers within sporangia (a uniquely embryophyte (land plant) trait); (4) the dispersed spores (i.e. those not contained within sporangia) are morphologically very similar to those found in sporangia of well-preserved land plant macrofossils from the Silurian and Devonian.
11. **What group of living plants share the closest morphological affinity with the Oman fossil land plant fragments? What lines of evidence support this association?** ANSWER: Liverworts. The fossil spores have an spore wall ultrastructure which shows parallel lamellae. Only Liverworts have such ultrastructure at maturity, which supports the likely affinity of the new fossils with Liverworts.
12. **What are elaters and why was it surprising to the authors that they were not found together with spores within the earliest land plant sporangia?** ANSWER: Elaters are cells found in the sporangia of living Liverworts and Hornworts and on the spores of *Equisetum* which function to widely disperse the spores through the air by hygroscopic movements. It is surprising that they have not been found together with the earliest spores because the fossils share so many other traits with living Liverworts. It is possible that elaters were present but were not fossilized or alternatively that they evolved much later.