



The Research for Extant Analogs for Early Land Plant Algal Progenitors

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Abstract

The aquatic algal ancestors that gave rise to the earliest terrestrial plants are not normally expected to have left much in the way of fossil remains. The one possible exception to this is the dispersal bodies (spores). Paleontologists have long recognized the widespread and continuous record of microscopic, acid-insoluble, acetolysis-resistant bodies from various depositional environments, but have had mixed success at efforts to establish their biological affinities. One potential source of extant analogues structure that has been relatively unexplored is desiccated algal monocultures. We collected and sampled algal taxa from the UW Madison culture collection and desiccation tolerant algal taxa provided by Dr. Louise Lewis. We examined and photographed the taxa, then subjected those with evidence of possible resistant cells to acetolysis to see if recognizable remains survived. The resistant structures were then analyzed with scanning electron microscopy (SEM) and transmission electron microscopy (TEM). This approach has application to a broad array of modern taxa under conditions that may be expected to have forced extant organisms to form representative structures in the fossil record. Despite previous reports in the literature of resistant wall components in several of the tested taxa, only three survived acetolysis with anything beyond fragmentary or amorphous remains: *Botryococcus*, *Chlorokybus*, *Myrmecia* and *Protosiphon*. TEM examination of these remains is ongoing. This is one approach in a multipronged study that includes field collections in the desert southwest of the US and the dry valleys of Australia in the coming year.

Background

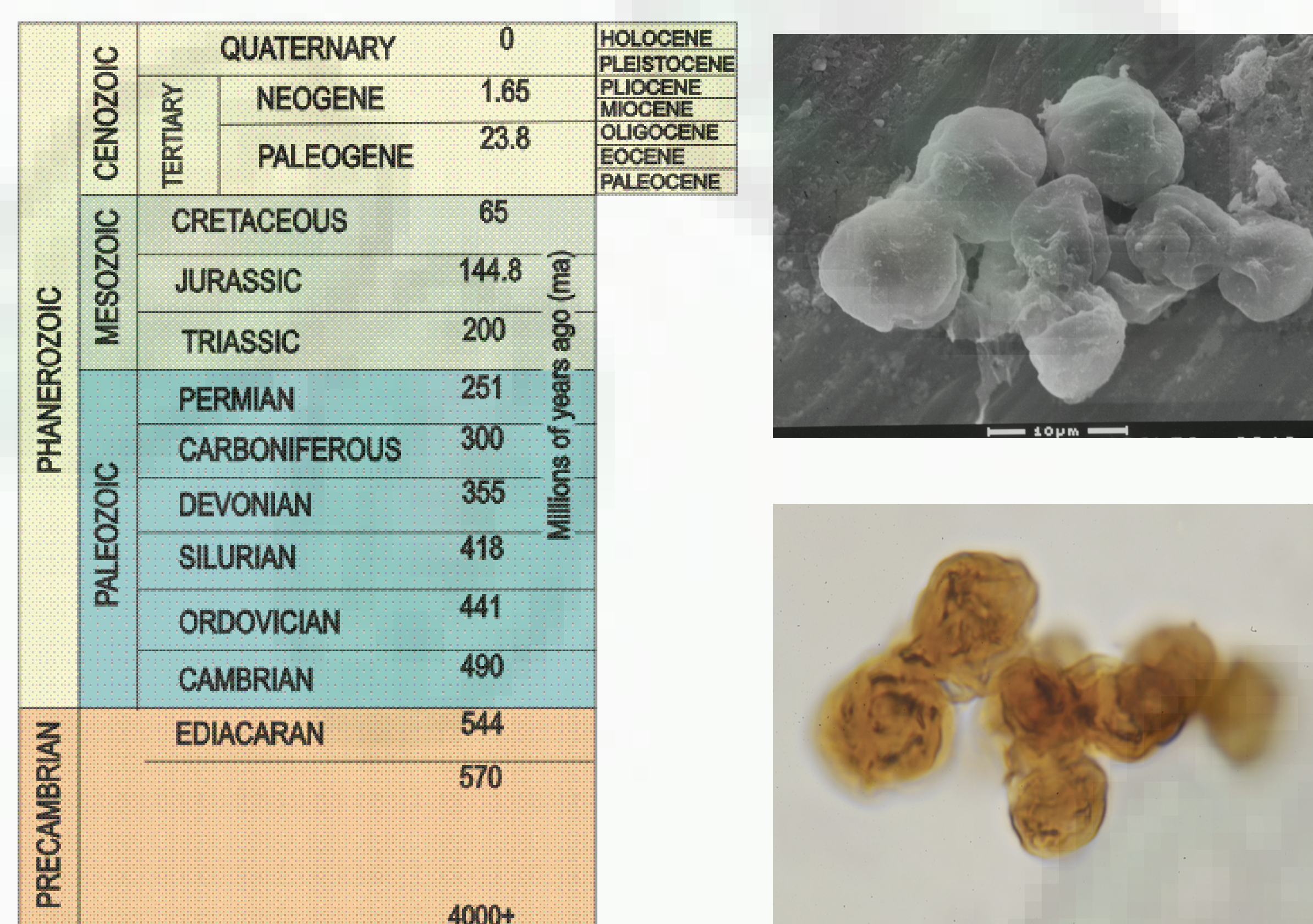


Figure1. Geological time scale of earth and TEM, SEM images of circular spore-like fossils recovered from the Kanosh Shale at Fossil Mountain, Utah. The fossils were dated to the Cambrian Era, 480 million years ago.

Spore-like fossils in deposits laid down during the Cambrian Era were identified (figure1). It has been proposed modern land plants evolved from an algal ancestor. The life cycles of many algae include spore stages that could be representative of the fossil spores.

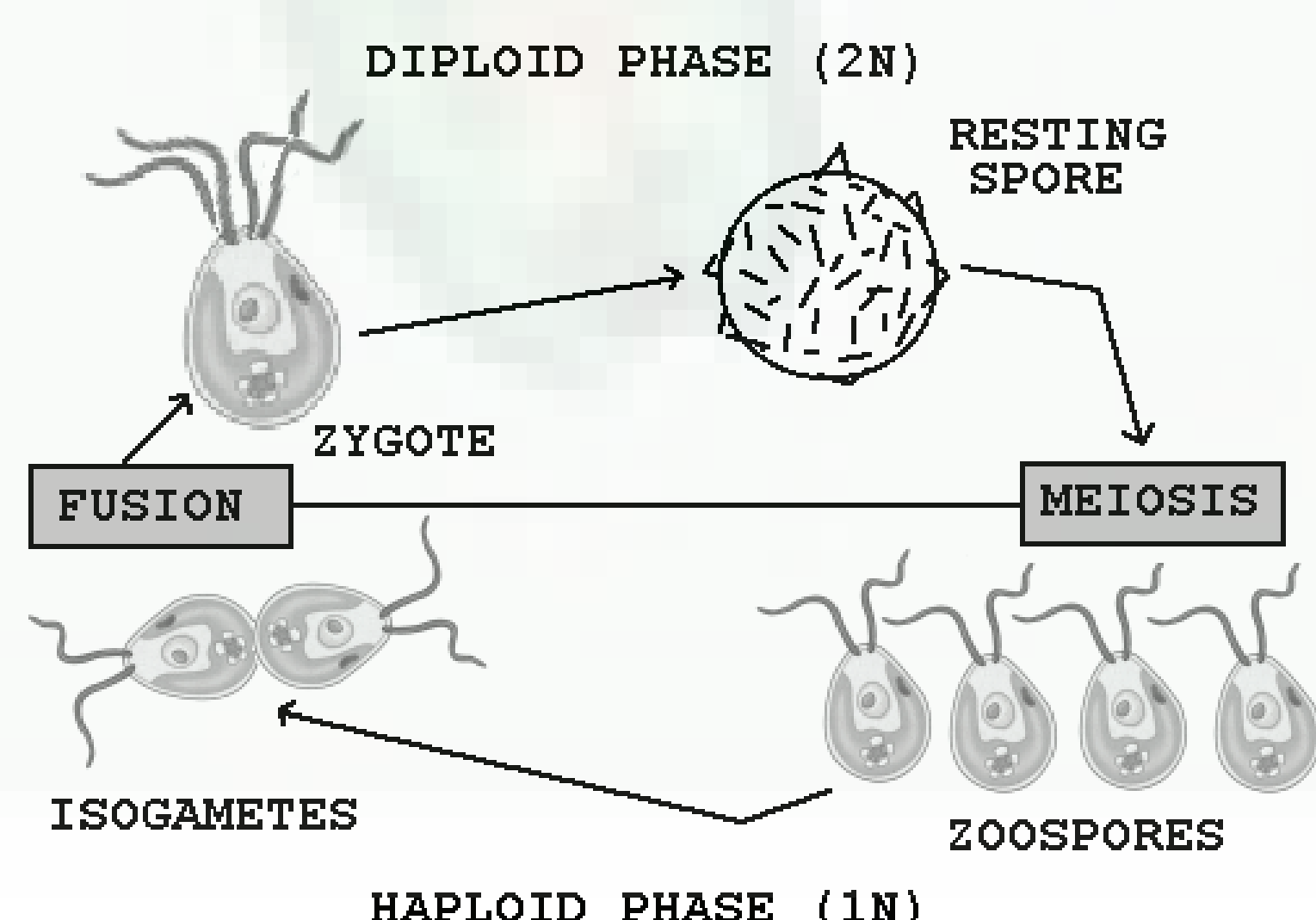


Figure2. Life cycle of the green alga *Chlamydomonas* showing spore life stages common to many algae.

Research Questions

What produced these fossil spores?
Are these fossils the ancestors of modern plants?
Do extant analogue algae exist?

Hypotheses

1) Defunct cultures of extant algae would produce resistant spore like bodies like those seen in the fossil record.
2) Examining algae at different developmental stages may be more likely to result in the identification of acetolysis resistant structures.

Two Pronged Approach

A. Inquiry of extant algae - possible resistant algae were identified via searching the literature and analyzing algal taxa from the UW Madison culture collection via light microscopy. Algae with thick cell-walled, circular structures were selected for further analysis

B. Analysis of desiccation resistant algae - desiccation resistant algae provided by Dr. Louise Lewis were desiccated and analyzed with light microscopy.

Basic Methodology



Identification of resistant algae - Algae with circular structures and thick cell walls were selected for further analysis.



Acetolysis of resistant algae - The identified resistant algae were acetolysed to mimic the fossilization process.

Embedding of acetolysis resistant structures - Algae with acetolysis resistant structures were embedded in a epoxy resin and cut with an ultramicrotome.



SEM and TEM - The sectioned specimens were analyzed with SEM and TEM for resistant-walled structures.

Results

Species	Desiccation Resistant	Acetolysis Resistant
<i>Protosiphon</i>	Yes	Yes
<i>Botryococcus</i>	Yes	Yes
<i>Myrmecia</i>	Yes	Yes
<i>Chlorokybus</i>	Yes	Yes

Table1. Identified resistant algae to desiccation and acetolysis.

Hypothesis 1- The acetolysis data indicate extant algae have resistant spore-like bodies.

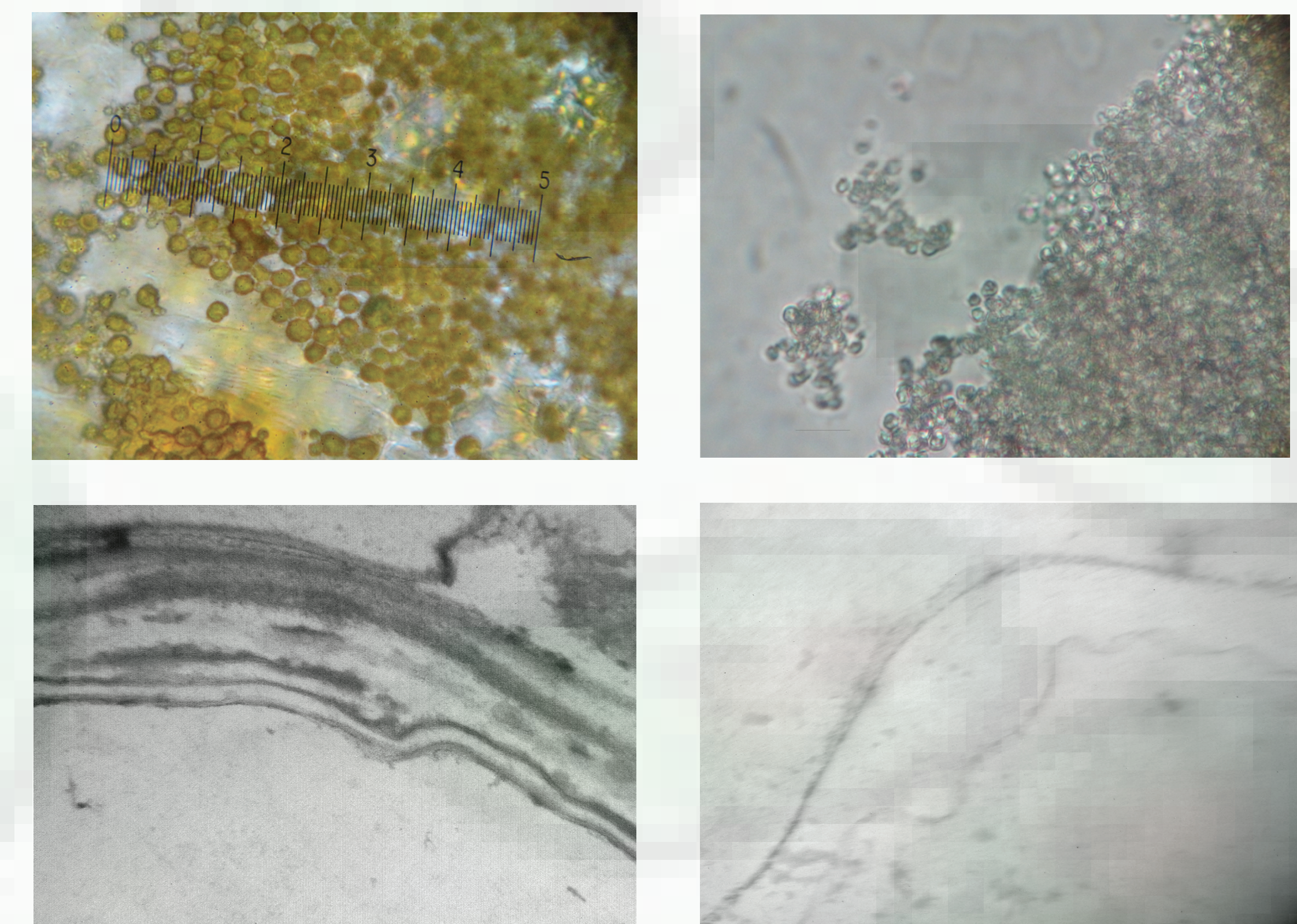


Figure3. Before (top left) and after (top right) acetolysis light microscope images and TEM images (bottom right and left) of acetolysis resistant cell wall of *Protosiphon*.

Hypothesis 2- The acetolysis data demonstrate the different life stages of extant algae have varying resistance to acetolysis.

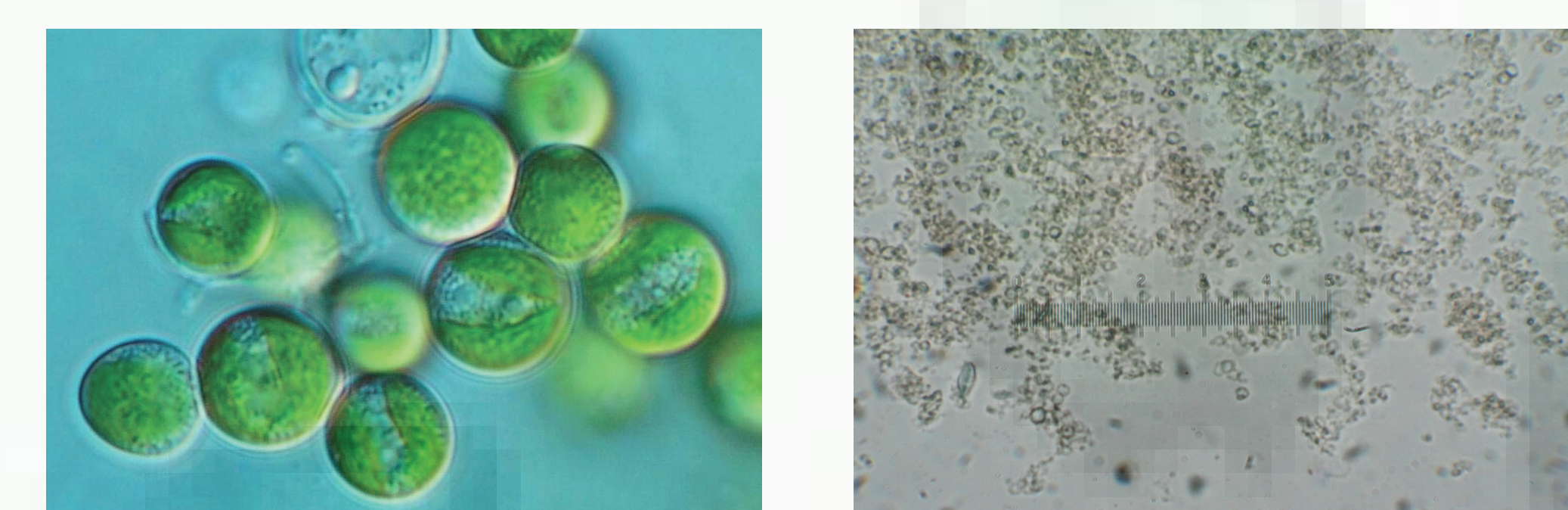


Figure4. Before(left) and after(right) acetolysis light microscope images of *Myrmecia*. The non-defunct culture did not survive acetolysis. The defunct culture developed a hard film and had acetolysis resistant structures (right).

Discussion

This study has demonstrated extant algal monocultures have potential for elucidating the biological affinities for unidentified structures in the fossil record. The extant algae acetolysis data have demonstrated algae possess acetolysis resistant structures and the different algal life stages have varying resistance. It is important to note that most of the analyzed algae did not survive acetolysis and thus likely do not represent fossilization material. Further study is required to determine the mechanism of acetolysis resistance. We hypothesize some algae secrete a substance in response to desiccation which confers acetolysis resistance.

Acknowledgments

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