Paleomycology of the Princeton Chert

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Understanding fossil fungi can help us understand the environmental context and taphonomy of the Princeton Chert -- and *vice versa*?

- Taphonomic filters
- Drivers of plant community dynamics
- Response to local environmental change
1) The Princeton Chert
    - regional and stratigraphic context
2) Paleomycological significance
    - techniques
    - fossil comparable to extant fungi
3) Insights into environmental context
    - silicification
    - comparisons with contemporary mires
    - fungi in extant aquatic plants
    - how much of the picture is missing?
(taphonomic filtering of and by microbes)
Stratigraphy and geology
Methods: extended depth of field
Methods: confocal laser scanning

Olympus IX71 microscope with Yokagawa CSU10 spinning disk

Excitation: 488 nm Coherent state laser
Emission: 561 nm Semrock longpass filter
Methods: look in the right place
Fungi preserved in fossil plants

Hosts of Mutualists and Endophytes

Metasequoia milleri Rothwell et Basinger

Pinus arnoldii Miller emend. Klymiuk, Stockey et Rothwell

Eorhiza arnoldii Robison et Person

Hosts of Parasites and/or Saprotrophs

Uhlia allenbyensis Erwin et Stockey

Decodon allenbyensis Cevallos-Ferriz et Stockey

Allenbya collinsoniae Cevallos-Ferriz et Stockey

Princetonia allenbyense Stockey

Eorhiza arnoldii Robison et Person

Dennsteadtiopsis aerenchymata Arnold et Daugherty

Fungi in fossil aquatic plant rhizomes

*Eorhiza arnoldii* Robison et Person

*Denndehiopsis aerenchymata* Arnold et Daugherty

Images (above) courtesy Ruth Stockey
c.f. dark septate endophytes

c.f. *Leptodontidium*

Image courtesy Michael Hough
(2008. MSc thesis, State Univ. NY)
c.f. *Xylomyces giganteus*
c.f. *Thielaviopsis*, c.f. *Brachysporiella*
c.f. Monodictys

Seifert et al. 2011. CBS Biodiversity Series 9
Biology and ecology of fossil fungi

- Dark septate endophytes (N acquisition?)
- Root pathogen
- Saprotrophs (moist soils)
- Saprotrophs (submerged substrates)
Silicification
Table 4. Volatile trace element compositions. (ppm)

<table>
<thead>
<tr>
<th></th>
<th>Sb</th>
<th>As</th>
<th>Hg</th>
<th>Au</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Allenby Formation: Princeton Chert site</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC-10 chert</td>
<td>0.6</td>
<td>&lt;2</td>
<td>&lt;1</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>PC-24 chert</td>
<td>0.4</td>
<td>&lt;2</td>
<td>&lt;1</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>PC-32 chert</td>
<td>0.4</td>
<td>&lt;2</td>
<td>&lt;1</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>PC-37 chert</td>
<td>0.4</td>
<td>&lt;2</td>
<td>&lt;1</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td><strong>Average values from modern and ancient hot spring sediments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steamboat Hot Springs, Nevada(^a) ((n = 9))</td>
<td>1400</td>
<td>200</td>
<td>350</td>
<td>0.5</td>
</tr>
<tr>
<td>Yellowstone Park, Wyoming(^b) ((n = 24))</td>
<td>193</td>
<td>520</td>
<td>24</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Taupo volcanic zone, New Zealand(^c) ((n = 8))</td>
<td>235</td>
<td>356</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Virgin Valley, Nevada (Miocene)(^d) ((n = 20))</td>
<td>21</td>
<td>140</td>
<td>1</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Rhynie Chert, Scotland (Devonian)(^e) ((n = 18))</td>
<td>&lt;7</td>
<td>98</td>
<td>ND</td>
<td>20</td>
</tr>
</tbody>
</table>

Modern mires
SiO$_2$ solubility is **decreased** by
• pressure/heat reduction
• evaporation
• lower pH
• presence of sulfate reducing bacteria

SiO$_2$ solubility is **increased** by
• complexation with humic substances
• higher pH (= circumneutral)
Modern mires

Arbuscular mycorrhizal fungi (Glomeromycota) in plant roots

Mycelial saprotrophs (Ascomycota, Basidiomycota)

Yeasts (Ascomycota)
Predicting taphonomic sequences?

Colonized during life:
- dark septate endophytes (N acquisition?)
- root pathogen

Colonized in senescence or post-mortem:
- saprotroph (moist soils)
- saprotrophs (submerged substrates)
Fungi in living aquatic plants?
Baseline diversity in aquatic roots

Images (above) courtesy Abby Glauser
Concluding remarks

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@AzKlymiuk

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