“Zoom-in” to Explore Fossil Cells

Mike Viney

In the summer of 1964, my family visited Colorado Petrified Forest, a privately-owned tourist attraction situated in a mountain valley just south of the town of Florissant in Teller County, Colorado. On August 20, 1969, just five years later, this famous fossil site would become a national monument (Leopold and Meyer, 2012). Florissant Fossil Beds National Monument preserves one of the world’s most precious late Eocene fossil deposits (Meyer, 2003). I was just two and a half years old when my father took a picture of my mother and older brother standing near the Big Stump, Fig. 1.

Figure 1. Colorado Petrified Forest Summer 1964. Wynona and Don Viney stand by the Big Stump, Peggy Ashworth holds Mike Viney age 2 ½.

In July of 1967 my family vacationed west, Petrified Forest National Park in Arizona, established just five years earlier on December 9, 1962 was among our destinations. I asked my dad, “what is a petrified forest?” “A forest that has turned to stone,” answered my dad. As we drove along Route 66, I looked out over the high plains desert dominated by shrubs and grass. I was now 5 ½ years old and much more sophisticated—I knew what I was looking for. Still no signs of a forest that had turned to stone, in fact, no trees at all. I asked my dad when we would arrive. To my astonishment he answered that we had arrived. Shock and confusion, I could see no evidence of a forest that had turned to stone! My dad started pointing out rocks possessing the form of logs scattered on the ground, Fig 2. The standing trees with branches and needles turned to stone that I anticipated were absent, a true anticlimax. Nevertheless, the magnificent form and color of the fossils assuaged my disappointment and I quickly became a great fan of petrified wood!

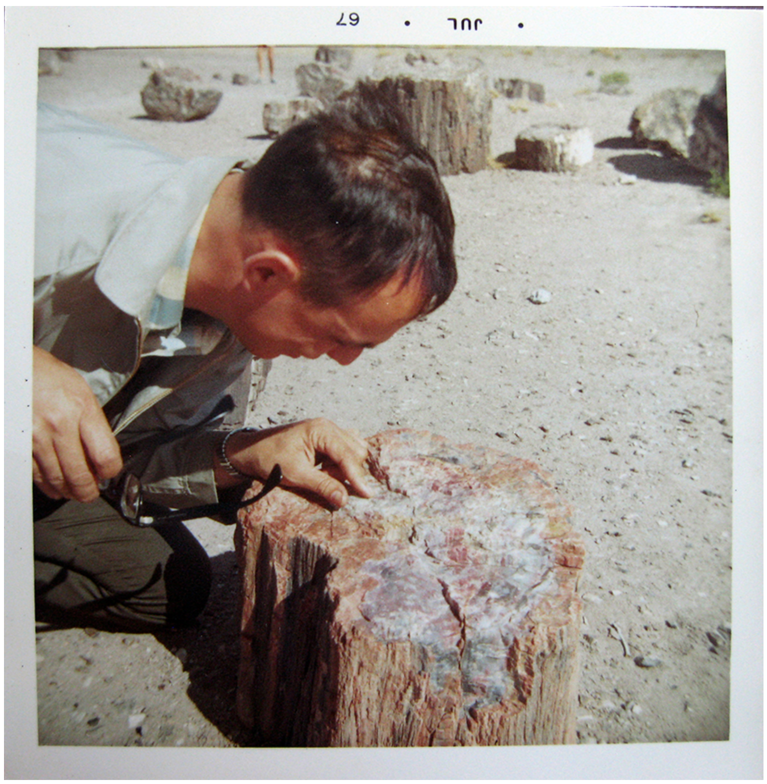

Figure 2. My dad, Wayne Viney, examines Arizona petrified wood, July 1967.

To this day I never pass up a chance to explore petrified wood and very much appreciate specimens that display great external morphology and color like the ones my dad introduced me to in Arizona 53 years ago. Nevertheless, much of my time examining mineralized wood as an adult is spent looking through a 10x or 20x loupe to explore fossilized cell structure. In cell structure there is information and beauty not available to the unaided senses—information that may lead to identification and aesthetic pleasure that awakens wonder at the functional architecture of once living plants. Creating a series of images for a fossil wood specimen which connects what we can see with our unaided eyes to that observed under magnification is a self-made hobby of mine (Viney, 2018).

Palmoxylon fiber is composed of scattered vascular bundles embedded in a groundmass of parenchyma cells, giving a "spotted" appearance to specimens viewed in transverse section—a pattern that can often be discerned without the use of magnification, Fig. 3.

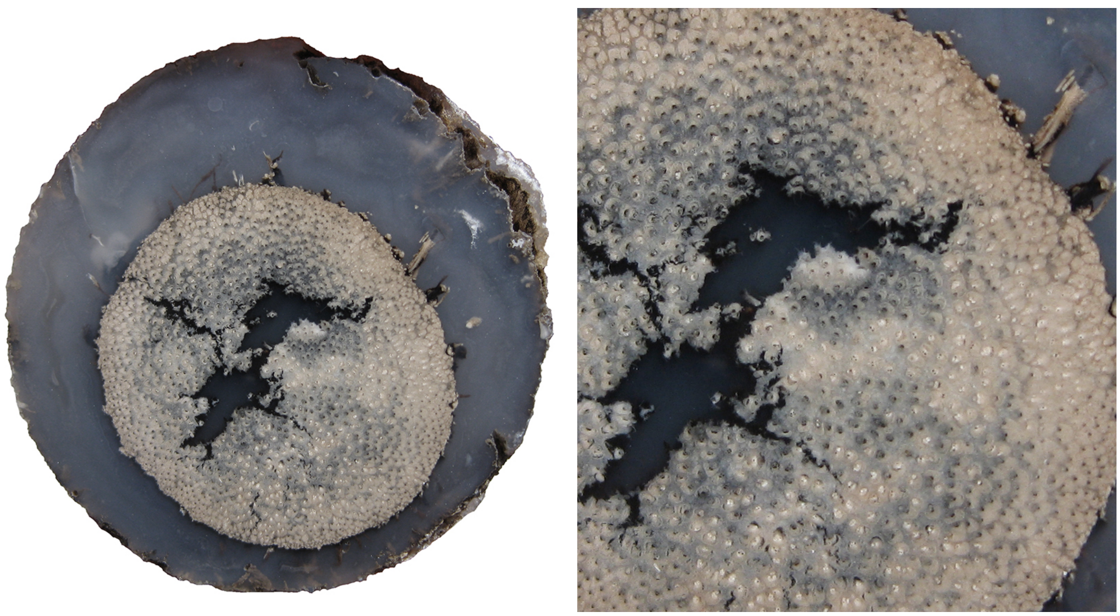

Figure 3. *Palmoxylon*, Big Sandy Reservoir, Wyoming, 2.8 cm diameter specimen illustrated in *Ancient Forests*, p. 82. Image taken with Canon PowerShot SD770 IS Digital ELPH 10.0 Mega Pixels, true color adjusted using Adobe. Photoshop CS6. The image to the right brings us closer to the vascular bundles.

The first two images of the *Palmoxylon* specimen were taken with the Canon digital camera. The second image is oriented so that we can relate what we see to the first image. Adobe Photoshop was used to process the images and to make sure the color is similar to what is experienced in person. We switch to using a Dino-Lite digital microscope to make our next two images, Fig 4. The magnification allows us to "zoom in" on the fossilized cells making up individual fibrovascular bundles.

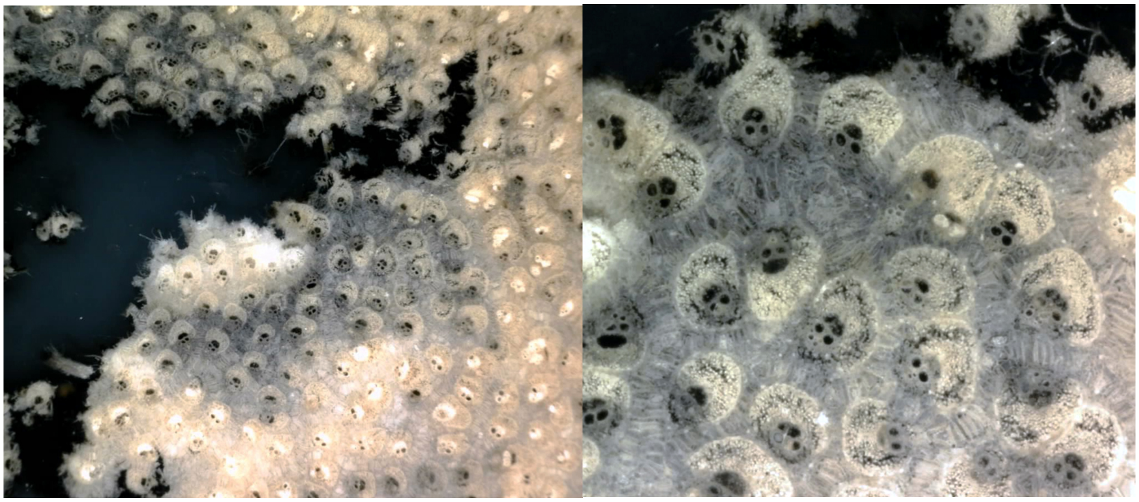

Figure 4. *Left*: The scattered fibrovascular bundles come into view at 60x. *Right*: The fossil cells making up the fibrovascular bundles become apparent at 150x. Images taken with a Dino-Lite AD7013 MT 5.0 Mega pixels and processed with Adobe Photoshop CS6.

Each fibrovascular bundle contains cells adapted for: conducting water, transporting food made in photosynthetic tissues, and providing structural support.

At 150x the vascular bundles in transverse view remind me of smiling men with beards, Figure 5 right. The “eyes” are vessels, making up the xylem or water conducting tissue of the palm. The “mouth” is an area once occupied by the phloem or food conducting tissue of the palm, which exhibits incomplete preservation in this specimen. When alive, the phloem was composed of sieve tube members and their companion cells. The “beard” was made of sclerenchyma cells that provided structural support for the stem. The tissue making up the groundmass between the fibrovascular bundles was composed of parenchyma cells.

The fossil *Palmoxylon* found near Big Sandy Reservoir, north of Farson, Wyoming grew along the shores of Lake Gosiute approximately 50 million years ago in a subtropical/tropical environment. This is in sharp contrast to the sagebrush steppe ecosystem that dominates the high plains desert in this region today.

Schinoxylon produced woody stems of secondary xylem and when viewed in transverse section exhibit the familiar solid woody cylinders of modern hardwood trees, Fig. 5. *Schinoxylon* is considered a member of the cashew family.

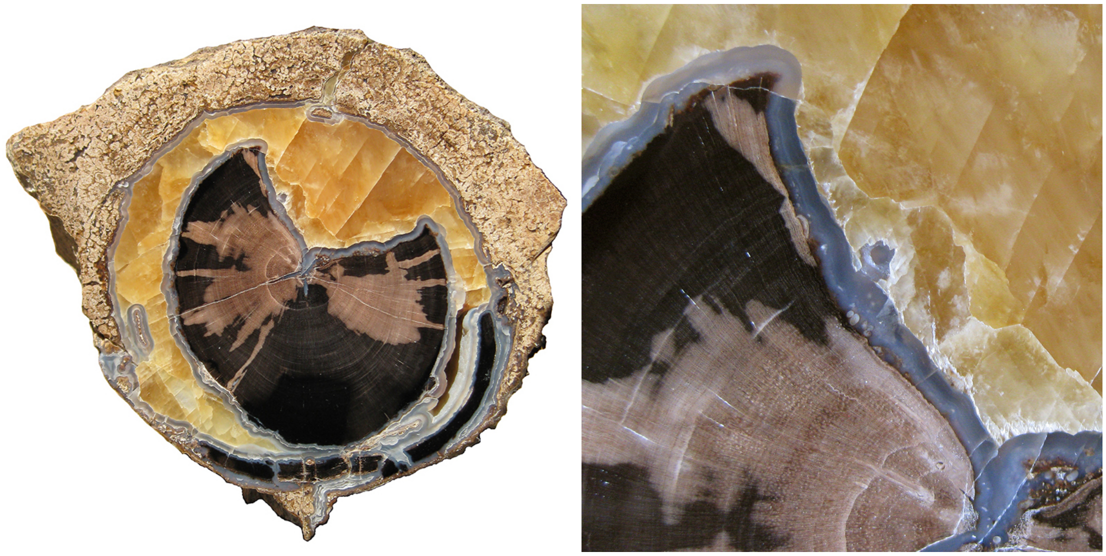

Figure 5. Left: *Schinoxylon*, Blue Forest, Wyoming, stromatolitic mantle and limb 12.5 cm across. Images taken with Canon PowerShot SD770 IS Digital ELPH 10.0 Mega Pixels, true color adjusted using Adobe Photoshop CS6. The image to the right brings us closer to the wood structure.

The *Schinoxylon* from Blue Forest and the *Palmoxylon* from Big Sandy represent two traditional groups of Angiosperms or flowing plants that produce seeds enveloped in fruits. The two groups, monocots and dicots derive their name from the number of cotyledons or seed leaves that the embryo uses to absorb nutrients as it sprouts from the seed. Monocots such as palms, grasses and orchids have one seed leaf, while dicots, such as oaks, maples, and sunflowers have two.

The arborescent forms of flowering plants representing these two groups differ in their arrangement of vascular bundles. The vascular bundles of monocots, such as *Palmoxylon* are scattered, while in dicots, such as *Schinoxylon* they are arranged in concentric rings. Like most arborescent monocots the material making up palm trunks is referred to as fiber because it results from primary growth. The trunks and stems of arborescent dicots are made of wood. Wood results from secondary growth and increases the girth of the stem. Without secondary growth palm trunks do not increase in girth. The next pair of images zoom-in to reveal the fossil cells making up the *Schinoxylon* silicified wood, Fig. 6.

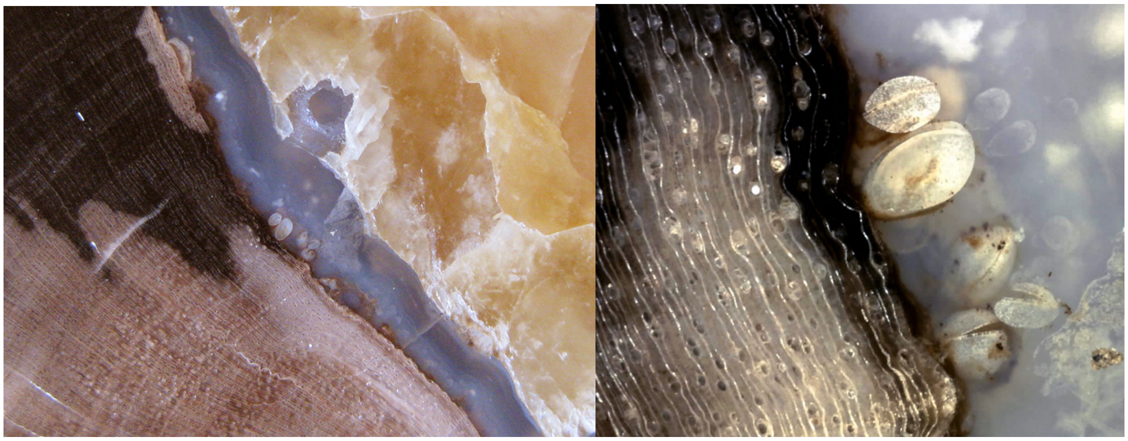

Figure 6*. Left*: *Schinoxylon* close-up using Canon PowerShot SD770 IS Digital ELPH 10.0 Mega Pixels. *Right*: *Schinoxylon* at 100x taken with a Dino-Lite AD7013 MT 5.0 Mega pixels. Both images processed with Adobe Photoshop CS6.

The silicified wood exhibits indistinct growth rings, an indication that it was growing in an environment that lacked significant seasonal changes in temperature or in the availability of water. The small water conducting vessels become clearly visible at 150x and are found individually or in groups of up to four. The pore size of the vessels remains fairly constant at around 30 μm in diameter across the indistinct growth rings, defining this wood as diffuse porous. Silicified ostracod shells are preserved in the chalcedony that encrusts the fossil wood. The uppermost shell measures 438 μm in length.

Gymnosperms develop their seeds “naked” on scales or leaves that often take the form of cones. Arborescent gymnosperms, like dicots, form stems constructed as solid woody cylinders. *Cupressinoxylon* is considered to be in the cypress family and constructed woody stems from secondary growth, Fig. 7. Gymnosperms are a rare find at the Blue Forest and this specimen, in contrast to the previous one, did not retain its bark and exhibits distinct growth rings. The *Schinoxylon* and *Cupressinoxylon* specimens were found in the same deposit not far from each other. The lack of bark and distinct growth rings may indicate that the gymnosperm was growing at higher elevation and was transported to Lake Gosiute where it became fossilized.

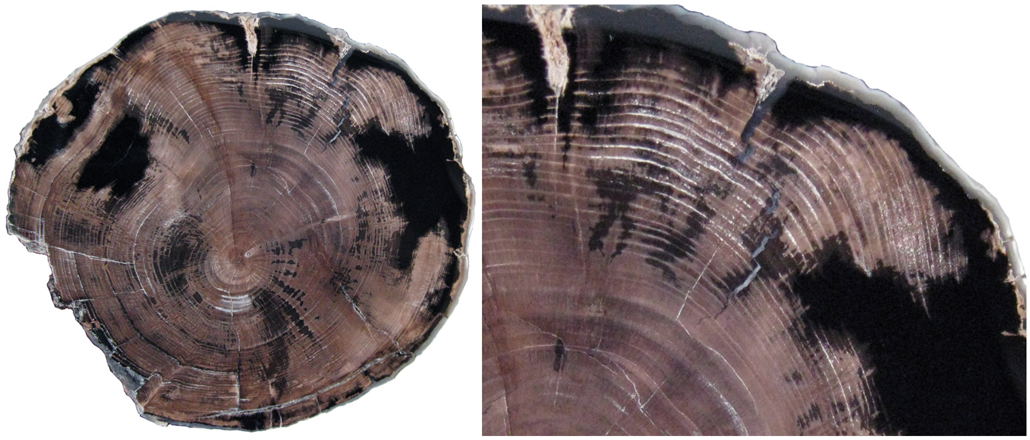

Figure 7. Left: *Cupressinoxylon*, Blue Forest, Wyoming, 11 cm diameter. Both images taken with a Canon PowerShot SD770 IS Digital ELPH 10.0 Mega Pixels, true color adjusted using Adobe Photoshop CS6.

The water conducting cells making up the wood or secondary xylem of gymnosperms are almost exclusively tracheids. The tracheids of gymnosperms are typically smaller than vessels and are arranged in radially aligned rows, Fig. 8.

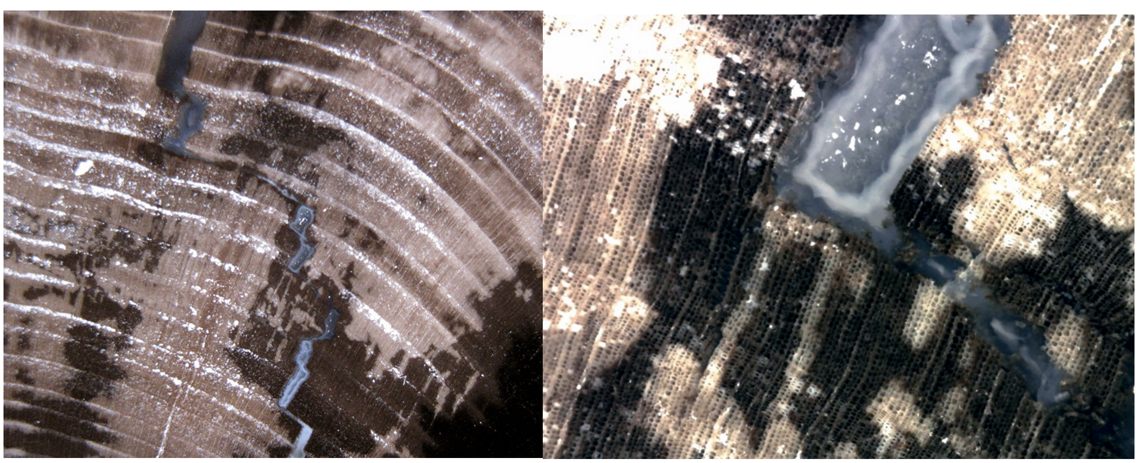

Figure 8. *Left*: Close-up of *Cupressinoxylon* taken with a Canon PowerShot SD770 IS Digital ELPH 10.0 Mega Pixels. *Right*: At 150x the tracheids, arranged in radially aligned rows, can be easily observed. Image taken with a Dino-Lite AD7013 MT 5.0 Mega pixels. Both images processed with Adobe Photoshop CS6.

Tracheids measure approximately 19 μm in this specimen. Learning to distinguish between arborescent gymnosperms and angiosperms (both monocots and dicots) in transverse section is a good place to start developing your identification skills.

Many fossil wood enthusiasts use *Identifying Wood* by Bruce Hoadley to become familiar with terminology used in basic wood identification (Hoadley, 1990).

Our last “zoom-in” specimen comes from a fossil site near Tri Territory Road and is also associated with Lake Gosiute. Petiole sections of the fern *Acrostichum* and the wood of flowering plants can be found at this site. Many preserved *Acrostichum* petiole sections exhibit a distinctive v-shaped adaxial groove, Fig. 9 (Tidwell, 1998). While these silicified specimens are small, their preserved tissue and cell structures can be quite aesthetically pleasing.

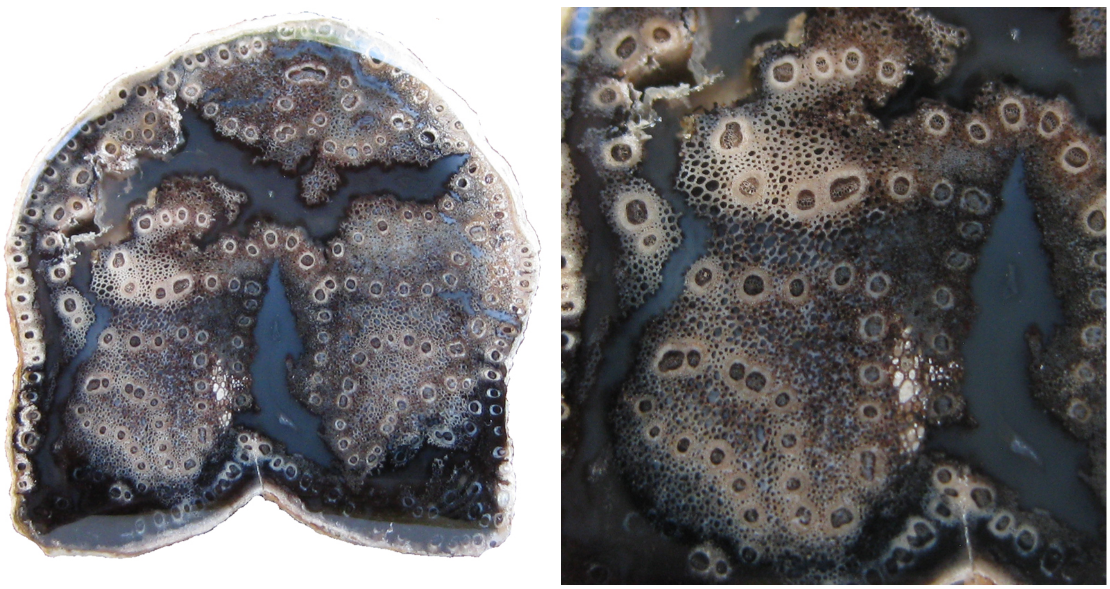

Figure 9. *Left*: *Acrostichum* transverse section, 2 cm wide. *Right*: Same specimen enlarged. Vascular bundles are clearly visible even without magnification. Both images taken with a Canon PowerShot SD770 IS Digital ELPH 10.0 Mega Pixels, true color adjusted using Adobe Photoshop CS6.

At approximately 700 μm in diameter the vascular bundles are visible without magnification in the transverse view. The fossilized cells making up the vascular bundles come into view at 110x, Fig. 10. A circle of sclerenchyma cells forms a supportive sheath around the water conducting xylem and food conducting phloem tissues. The water conducting xylem cells stretch across the center of the circular-shaped vascular bundles. Smaller food conducting phloem cells, only partially preserved occupy the space above and below the xylem. The tube-like vascular bundles are surrounded by aerenchyma, a spongy tissue that formed air chambers within the petiole when the plant was alive but that is now filled with blue chalcedony. A desiccation crack on the left side of the image is also filled with chalcedony.

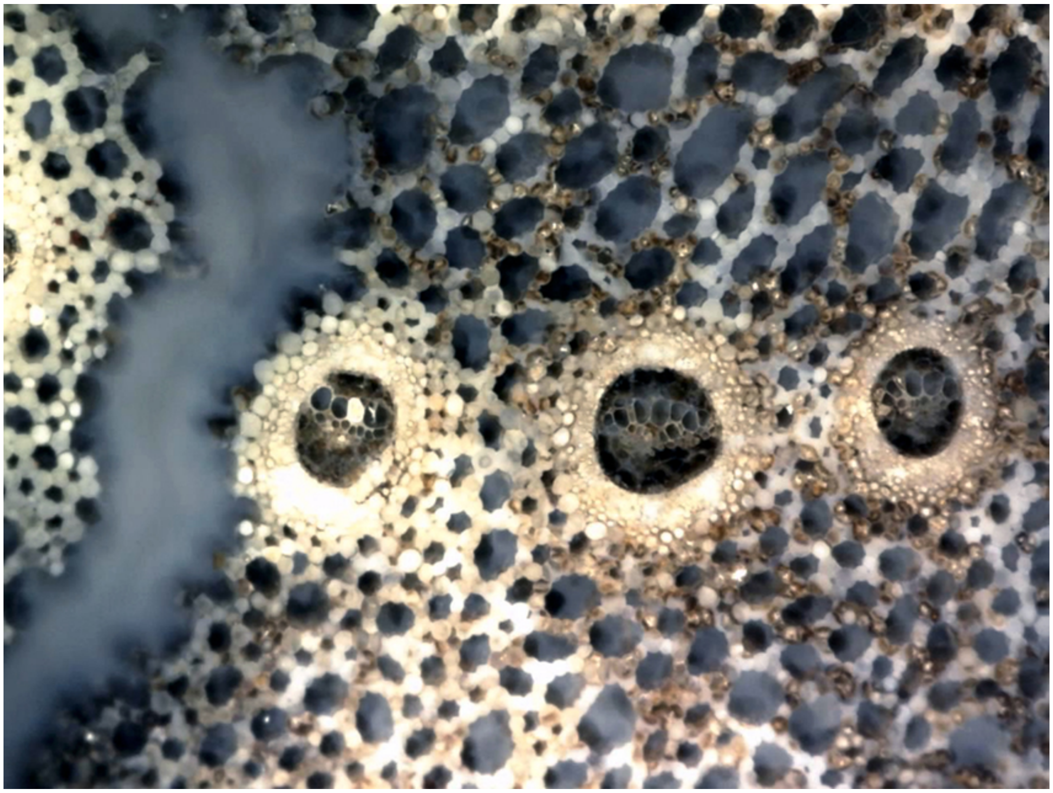

Figure 10. *Acrostichum* silicified vascular bundles and aerenchyma tissue at 110x. Image taken with a Dino-Lite AD7013 MT 5.0 Mega pixels and processed with Adobe Photoshop CS6.

It is important to note that serious scientific identification of silicified trunks and stems often requires the use of thin sections made in transverse, radial, and tangential orientations; even so, many categories of arborescent plant life can be recognized in transverse view alone (Viney, 2008). Exploring the microscopic world of silicified plant fossils opens up a new world of enjoyment and study that includes learning to identify fossil tissues and cells. You may even want to create a series of "zoom-in" images to celebrate the hidden beauty of a favorite example in your collection.

References

Hoadley, R. B. 1990. *Identifying Wood: Accurate results with simple tools*. New Town Connecticut: The Taunton Press.

Leopold E. B. and Meyer, H. W. 2012. Saved in Time: *The Fight to Establish Florissant Fossil Beds National Monument*. Albuquerque: University of New Mexico Press.

Meyer, H. W. 2003. *The Fossils of Florissant*. Washington: Smithsonian Books.

Tidwell, W. D. 1998. *Common Fossil Plants of Western North America*. [2nd Edition]. Smithsonian Institution Press: Washington.

Viney M. Images of Cells Preserved in Stone. *Deposits*. Issue 53 (2018): 8-13. Revised January 29, 2019 accessed 15 October 2020, https://www.researchgate.net/publication/323588136_Images_of_Cells_Preserved_in_Stone

Viney, M. Petrified Wood: The Anatomy of Arborescent Plant Life Through Time. *The Petrified Wood Museum*, Revised October 2013 edition accessed 15 October 2020, https://www.researchgate.net/publication/237575070_Petrified_Wood_The_Anatomy_of_Arborescent_Plant_Life_through_Time