Microscopy Techniques for the Examination of Waterlogged Archaeological Wood

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INTRODUCTION

Waterlogged archaeological wood (WAW) is an important source of information about the past. When WAW is removed from its environment, it is difficult to preserve the material.

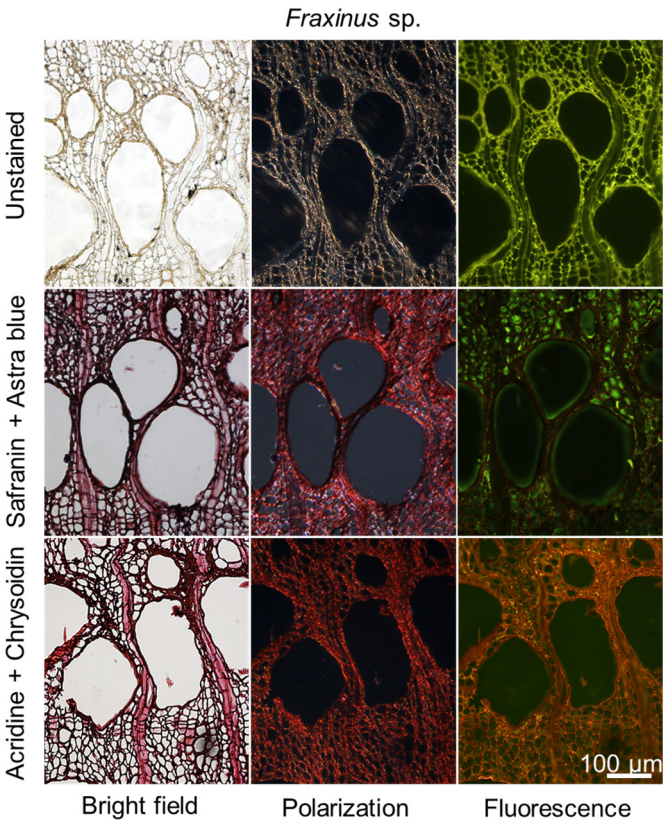
Conservation is only possible if we understand the extent and cause of degradation. Varying degrees of degradation can be visible at the microscopic level within the anatomical structure.

AIM, MATERIALS & METHODS

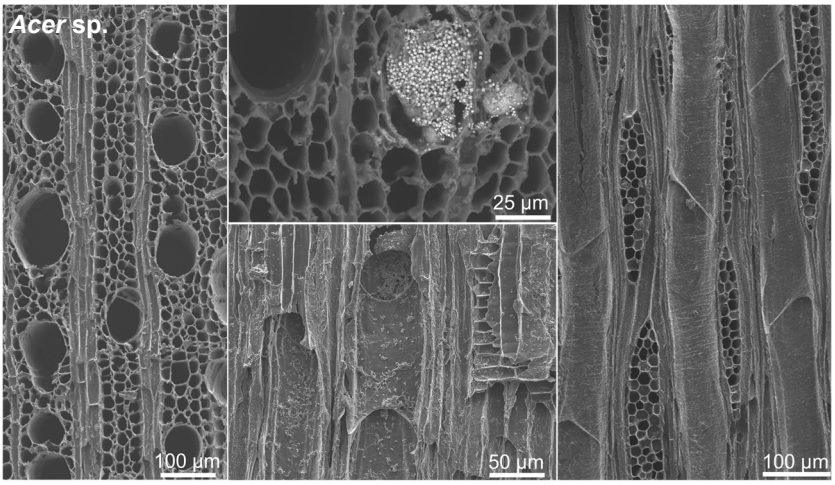
WAW with an age of about 4,500 years from prehistoric pile-dwelling settlement in Ljubljansko barje, Slovenia, was examined using various microscopic techniques. We have performed light microscopy (LM) using bright field, polarization and fluorescence modes with different sample preparation methods (frozen cut, embedding in paraffin) and staining (unstained, safranin-astra blue, acridine orange-chrysoidin). We developed an improved protocol for scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDX) based on the observation of sections obtained with a razor blade from frozen samples and fixed with glycerin albumin on supports to prevent their cracking.

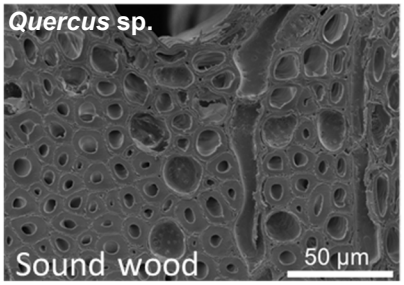
RESULTS

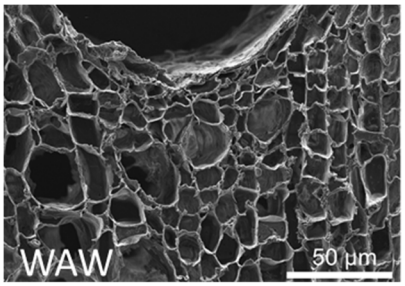
Quercus, *Faxinus*, *Acer*, *Salix* and *Populus* species were identified. Thicker and larger hand-cut sections allowed recognition of cellular and tissue level structures with LM, but due to the thickness it was not possible to observe minute details. By embedding in paraffin we were able to better observe the preservation of cell walls at higher magnification but the thin sections tended to tear. Polarized light allowed to determine the loss of cellulose while epi-fluorescence on stained sections emphasized the wood anatomical features and the lignin content.



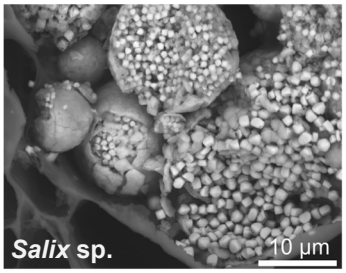
SEM provided together high quality images of large sections at lower magnifications for wood identification at high magnifications for the study of cell wall degradation.

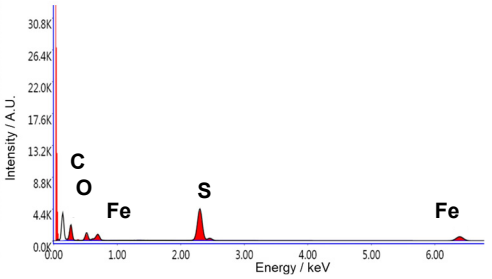






SEM with EDX allowed the observation of the preservation of the cell wall as well as the location, amount, shape and chemical composition of various inclusions with high amounts of Fe, S and Ca found in all taxa studied, while *Populus* also contained increased amounts of Si indicating an early stage of fossilization.





CONCLUSIONS

LM is effective for identification and evaluation of preservation state, but requires different and demanding sample preparation. SEM simultaneously allows viewing larger portions of the wood at lower magnifications or obtaining high resolution images of the 3D wood microstructure. Combined with EDX allows the analysis of the inorganic chemical composition. LM and SEM combined provide complementary information from the morphological to the microstructural and chemical levels of the highly degraded WAW.