

# Donaldson, Joseph

## Use of ESEM and Energy-Dispersive X-Ray Microanalysis to Study Leaf Surfaces of Austrian Pine

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The following is a report of an investigation on the effects of air pollution on Austrian pine needles. The report will state the initial question, how the report was carried out, the results of the investigation, and our conclusions. Additionally, it will report on publication and presentation of the research.

It has been suggested that air pollution in Utah Valley is detrimental to human health. We postulated that air pollution may similarly be detrimental to the health of Austrian pine, a common conifer tree in Utah Valley.

Needles were collected from Utah Valley and observed under a environmental scanning electron microscope (ESEM) by which we were able to observe the stoma of the pine needles without washing out particles as in preparation to observe the sample using a regular scanning electron microscope (SEM). Other needles were collected from Austrian pine in Western Idaho and were similarly observed using ESEM. Both the Utah Valley and the Western Idaho needles were also studied using energy dispersive x-ray microanalysis. Western Idaho has relatively little air pollution due to prevailing winds which blow air pollution out of the area. Pine trees maintain needles for a number of years making it possible to observe the effects of air pollution on pine needles over time.

Utah Valley needles from years 2002, 2001, 2000, and 1999 were compared with Western Idaho needles from 2002, 2001, and 2000. The 1999 Western Idaho needles had already fallen before they were collected. Upon observation of Western Idaho and Utah Valley needles using ESEM it was found that occlusion of the stoma was slightly greater in Western Idaho needles than in Utah Valley needles. Upon x-ray microanalysis, however, it was found that the Utah Valley samples were occluded more by unnatural particles such as Fe. ESEM observations additionally revealed that there is significantly more wax degradation on the surface of the Utah Valley samples than the Western Idaho samples.

Wax naturally occludes the stoma as a needle gets older. The slightly greater occlusion of the stoma in the Western Idaho samples may be because of the absence wax of degradating factors which are present in Utah Valley. Geneva Steel, a Utah Valley steel mill completely closed down in 2002. If a comparison of needles from forth coming years shows an absence of wax degradation similar to those in Western Idaho it may be plausible to conclude that Geneva Steel steel production contributed to wax degradation in Austrian pine needles.

Though we consider our last year's investigation preliminary research we were able to conclude that there are factors in Utah Valley that degrade the wax of Utah Valley Austrian Pine needles. We were also able to show that the newly developed environmental scanning electron microscope (ESEM) is ideal for research on the effects of particulate matter and air pollution. Dr.

Wilford M. Hess and I were able to attend an international scanning electron microscopy conference where I presented our results. An abstract of our investigation was published in the conference journal<sup>1</sup>.

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<sup>1</sup> J. Donaldson and W.M. Hess. "Use of ESEM and energy-dispersive x-ray analysis to study leaf surfaces of Austrian pine." *Scanning* 2003.