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The impact of oxidation on spore and pollen chemistry: an experimental study

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Sporomorphs (pollen and spores) form a major component of the land plant fossil record. Sporomorphs have an outer wall composed of sporopollenin, a highly durable biopolymer, the chemistry of which contains both a signature of ambient ultraviolet-B flux and taxonomic information. Despite the high preservation potential of sporopollenin in the geological record, it is currently unknown how sensitive its chemical signature is to standard palynological processing techniques. Oxidation in particular is known to cause physical degradation to sporomorphs, and it is expected that this should have a concordant impact on sporopollenin chemistry. Here, we test this by experimentally oxidizing Lycopodium (clubmoss) spores using two common oxidation techniques: acetolysis and nitric acid. We also carry out acetolysis on eight angiosperm (flowering plant) taxa to test the generality of our results. Using Fourier Transform infrared (FTIR) spectroscopy, we find that acetolysis removes labile, non-fossilizable components of sporomorphs, but has a limited impact upon the chemistry of sporopollenin under normal processing durations. Nitric acid is more aggressive and does break down sporopollenin and reorganize its chemical structure, but when limited to short treatments (i.e. $\leq$10 min) at room temperature sporomorphs still contain most of the original chemical signal. These findings suggest that when used carefully oxidation does not adversely affect sporopollenin chemistry, and that palaeoclimatic and taxonomic signatures contained within the sporomorph wall are recoverable from standard palynological preparations.