X-ray fluorescence as a tool for interpreting fossilized pigmentary colours

N. ÁLVAREZ ARMADA[1]*, M.E. MCNAMARA[1], S.M. WEBB[2], F.L. GILL[3]

[1] School of BEES, University College Cork, Distillery Fields, North Mall, Cork T23 TK30, Ireland (*correspondence: nalvarez@ucc.ie, maria.mcnamara@ucc.ie)

[2] SSRL/SLAC Building 137, MS 69, 2575 Sand Hill Road, Menlo Park, CA 94025, USA (samwebb@slac.stanford.edu)

[3] School of Earth and Environment, The University of Leeds, Leeds LS2 9JT, UK (f.gill@leeds.ac.uk)

Many insects exhibit striking colour patterns on their cuticle, which are produced primarily by pigments such as melanins, carotenoids and pterins. Fossil specimens can exhibit similar patterns, but the origins of this fossil patterning and the nature of the pigments responsible are unknown. We resolve these issues using non-destructive synchrotron-X-ray fluorescence (XRF) to characterize the spatial distributions of trace elements in the cuticles of fossil and modern insects. We mapped the concentrations of 11 trace elements in cuticle regions that possess different pigments. Principal Component Analysis (PCA) of the concentrations of each element reveal a strong taxonomic signal whereby members of the same family show similar concentrations of trace elements. Within families, cuticle regions with different pigments have distinct trace element chemistries, suggesting that the broad taxonomic signal is overprinted by a strong pigment-specific signal. The trace element chemistry of fossil insect cuticle differs to that of the modern analogues, indicating diagenetic overprinting. These results will enhance our ability to interpret the original pigmentary colours of fossil insects, thus informing models of the evolution of colour and its ecological functions in insects through deep time.