Podium Presentation, Session 3, Thursday 14:20 – 16:00

Preserve and protect: non-destructive screening for protein preservation in ancient skeletal material

Helen Fewlass[1,2], Sam Presslee[3,4], Dorothea Mylopotamitaki[5,6], Francesca Tait[1], Mia Williams[1], Claudio Berto[7], Malgorzata Kot[7], Abdulmajeed Alhuraish[8], Marta Arzarello[9], Nick Ashton[10], Omry Barzilai[11], Miriam Belmaker[12], Kate Britton[13], Silviu Constantin[14,15], Love Dalen[16], Marc Dickinson[4], Gonzalo Oteo Garcia[16], Jean-Jacques Hublin[5,6], Matthew Jeffries[29], Andrew Kitchener[17], Matthew G. Knight[17], Louise Martin[18], Edouard Masson-Maclean[13], Roger Matthews[8], Wendy Matthews[8], Gwen Maurer[8], Ionut Cornel Mirea[14], Ahmed Nassr[19], Simon Parfitt[18,20], Alexandru Petculescu[14], Zeljko Rezek[5], Marius Robu[14,20], William Sellers[22], Nikolay Sirakov[23], Geoff M. Smith[8,24], Tsenka Tsanova[25], Jaroslaw Wilczynski[26], Helen R. Flynn[27], J. Mark Skehel[27], Frido Welker[28], Kirsty Penkman[4], Pontus Skoglund[1]

1 - Ancient Genomics Lab, The Francis Crick Institute, London, UK · 2 - Department of Anthropology and Archaeology, University of Bristol, Bristol, UK · 3 - BioArCh, Department of Archaeology, University of York, York, UK · 4 - BioArCh, Department of Chemistry, University of York, York, UK · 5 - Chaire de Paléoanthropologie, CIRB (UMR 724 – U1050), Collège de France, Paris, France · 6 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 7 - Faculty of Archaeology, University of Warsaw, Warsaw, Poland · 8 - Department of Archaeology, University of Reading, Reading, UK · 9 - Department of Humanities, University of Ferrara, Ferrara, Italy · 10 - British Museum, London, UK · 11 - School of Archaeology and Maritime Cultures, University of Haifa, Haifa, Israel · 12 - Department of Anthropology and Sociology, The University of Tulsa, Tulsa, OK, USA · 13 - Department of Archaeology, University of Aberdeen, Aberdeen, Scotland, UK · 14 - Department of Geospeleology and Paleontology, Emil Racovita Institute of Speleology, Bucharest, Romania · 15 - Centro Nacional de Investigación sobre la Evolución Humana, CENIEH, Burgos, Spain · 16 - Centre for Palaeogenetics, Stockholm University, Stockholm, Sweden · 17 - National Museums Scotland, Edinburgh, UK · 18 - Institute of Archaeology, University College London, London, UK · 19 - University of Ha'il, Department of Tourism and Archaeology, Saudi Arabia · 20 - Centre for Human Evolution Research, The Natural History Museum, London, UK · 21 - The Research Institute of the University of Bucharest, Bucharest, Romania · 22 - School of Natural Sciences, University of Manchester, Manchester, UK · 23 - National Institute of Archaeology with Museum, Bulgarian Academy of Sciences, Sofia, Bulgaria · 24 - School of Anthropology and Conservation, University of Kent, Canterbury, UK · 25 - Department of Chemistry "Giacomo Ciamician", University of Bologna, Bologna, Italy · 26 - Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Krakow, Poland · 27 - Mass Spectrometry Proteomics Science Technology Platform, The Francis Crick Institute, London, UK · 28 - Globe Institute, University of Copenhagen, Copenhagen, Denmark · 29 - Independent Researcher

Protein preserved in ancient bone provides us with phylogenetic, chronological and behavioural insights that are crucial for understanding human prehistory. Yet given the destructive nature of these biomolecular analyses, it is beneficial to determine the likely protein preservation of ancient skeletal material prior to analysis, to limit destructive sampling where chances of successfully retrieving data are low. A range of methods are used to assess organic preservation in skeletal material prior to sampling for aDNA, proteomic, isotopic or radiocarbon dating [e.g. 1-2], but these methods generally require destructive sampling of small amounts of material (several milligrams) and exportation to a lab. Near infrared (NIR) spectroscopy has been shown to be a useful method for assessing the bulk collagen content of bone before extraction for isotopic or radiocarbon analysis [3]. NIR pre-screening is fast, the instruments are transportable and, crucially, scanning is completely non-destructive. The approach has been successfully applied as a screening method for Pleistocene assemblages prior to dating [4]. As palaeoproteomic analysis using tandem mass spectrometry can be successfully carried out at much lower levels of protein preservation than radicoarbon dating, we tested the potential of NIR as a pre-screening method across a wide range of protein preservation levels. We analysed an extensive set of bones and teeth aged between ~100 to more than 1,000,000 years from >30 archaeological and palaeontological sites using NIR, chiral amino acid analysis, Fourier transform infrared spectroscopy (FTIR) and liquid chromatography tandem mass spectrometry (LC-MS/MS) and used this data to develop predictive NIR models. We compare the accuracy of the different screening methods for predicting successful data retrieval with LC-MS/MS, using Middle Pleistocene skeletal material from Tunel Wielki Cave, Poland (MIS 14 – 12) as a case study [5], a key site in European prehistory which has yielded Lower Palaeolithic artefacts. The results confirm the potential of non-destructive NIR screening of ancient skeletal material prior to palaeoproteomics, radiocarbon dating or isotopic analysis across a diverse range of environments and time periods.

This research was funded by the Francis Crick Institute and an EMBO Postdoctoral Fellowship awarded to HF (EMBO ALTF 590-2021)

References: [1] Kontopoulos, I., Penkman, K., Mullin, V.E., Winkelbach, L., Unterländer, M., Scheu, A., Kreutzer, S., Hansen, H.B., Margaryan, A., Teasdale, M.D., Gehlen, B., Street, M., Lynnerup, N., Liritzis, I., Sampson, A., Papageorgopoulou, C., Allentoft, M.E., Burger, J., Bradley, D.G., Collins, M.J., 2020. Screening archaeological bone for palaeogenetic and palaeoproteomic studies. PLOS ONE. 15, e0235146. [2] Presslee, S., Penkman, K., Fischer, R., Richards-Slidel, E., Southon, J., Hospitaleche, C.A., Collins, M., MacPhee, R., 2021. Assessment of different screening methods for