14TH ANNUAL MEETING OF THE EUROPEAN SOCIETY FOR THE STUDY OF HUMAN EVOLUTION ABSTRACTS
ZAGREB, 11–15 SEPTEMBER 2024

Poster Presentation Number 1, Session 1, Thursday 18:00 – 19:30

Shifting procurement strategies: exploring non-flint materials in flint-based assemblages of Abri du Maras between MIS 3 and MIS 7

Ana Abrunhosa[1,2,3], M. Gema Chacón[1,2,4], Marie-Hélène Moncel[4]

1 - IPHES-CERCA - Institut Català de Paleoecologia Humana i Evolució Social, Spain · 2 - Universitat Rovira i Virgili (URV), Departament d'Història i Història de l'Art, Tarragona, Spain · 3 - ICArEHB - Interdisciplinary Center for Archaeology and Evolution of Human Behaviour, FCHS - Universidade do Algarve, Portugal · 4 - UMR7194 – HNHP (MNHN - CNRS –UPVD – Sorbonne Universités), Paris, France

The Ardèche River valley was recurrently occupied by different human groups throughout the Middle and Upper Palaeolithic, as evidenced by numerous known sites along its banks. The study of raw materials is one of the main sources of information about mobility strategies in the landscape. Although there are many detailed studies on the exploitation and management of lithic raw materials, primarily focusing on flint-rich lithic assemblages, it is common for lithic assemblages, especially from the Middle Palaeolithic, to include other raw materials that have often been overlooked in analysis. This oversight may be due to the assumption that these materials are of local origin and therefore do not contribute significantly to our understanding of the mobility patterns of past populations and are interpreted predominantly as the result of an engagement in incipient and expedient exploitation models.

Abri du Maras, located near the banks of the Ardèche River, is a rock shelter occupied between MIS 3 and MIS 7, whose sequence allows for a chronostratigraphic interpretation of lithic resource management strategies. While levels 4.1, 4.2, 5 and 6 comprise mostly flint, which has been extensively studied and published previously, strategies for procuring other local materials are less well understood and have only recently received attention. The presence of non-flint raw materials varies between c. 10% for level 4.1. and 40% of the assemblage for level 6.

For this study, a multiproxy approach was applied based on: i) the identification of lithic raw materials by macro and microscopic analysis following geological standard descriptive procedures, ii) the distribution of groups and sub-groups of raw materials identified by techno-typology (e.g. hammerstones, cores, flakes, retouched elements), iii) survey of the local landscape to understand raw material availability and accessibility, iv) and correlation of the times of occupation of the site with the geomorphological evolution of the Ardèche River and its terraces. The set of data obtained makes it possible to distinguish moments of different access to potential sources of raw materials depending on acce ssibility and their representation in the lithic assemblage.

Few studies have analysed diachronical changes in procurement strategies during the Middle Palaeolithic, with transitional periods (e.g. between the Middle and Upper Palaeolithic) receiving most of the attention. However, a more detailed study of the Abri du Maras occupation sequence makes it possible to detect changes in procurement strategies taking place in the Ardèche Valley between MIS 7 and MIS3. During this long period in which the rock shelter was frequently visited by Neandertal groups, the surrounding landscape underwent changes related above all to the incision of the Ardèche River and sedimentation phases of the adjacent terraces. Studying a sequence of occupations in an area where the landscape has changed allows for correlating landscape alterations with potential shifts in raw material procurement strategies and the relationship of Neanderthals with the local environment.

PaleoAnthropology **2024:2: 365–558.** **https://doi.org/10.48738/2024.iss2.1209** **ISSN 1545-0031**
Paleoanthropology Society & European Society for the study of Human Evolution.

In conclusion, based on the study of non-flint raw materials it is possible to see changes in raw material procurement strategies that correlate with the Ardèche river activity in the Middle to Upper Pleistocene and possible shifts in local raw material accessibility. This study contributes to understanding the extent of Neanderthals' capacity to use and exploit materials with various physical and mechanical characteristics, shedding light on their behaviour, particularly in daily group interactions within local environments, as well as changes in procurement strategies, landscape alterations, and raw material accessibility in the Ardèche river valley.

Ana Abrunhosa is an MSCA-COFUND R2STAIR Fellow (GA 101034349), with research supported by the Spanish Ministry of Science and Innovation through the "María de Maeztu" excellence accreditation (CEX2019-000945-M), by GAUR through 2021 SGR - Group of Analyses on Socio-ecological Processes, Cultural Changes and Population dynamics during Prehistory (GAPS) (2021 SGR 01237) and Project NEANDIVERSITY2 - Neanderthal behaviour and paleoecology in Mediterranean ecosystems (2) (ref. PID2022-138590NB-C41) funded by the Spanish MICINN I+D. We thank all the student volunteers at the Abri du Maras 2023 field campaign who collaborated in the survey and sample collection for this study.

Poster Presentation Number 2, Session 1, Thursday 18:00 – 19:30

Socially responsive practice in human evolution: a case study of the HUMANITY museum exhibition

Rebecca R. Ackermann[1,2], Tessa J. Campbell[3,4], Nkosingiphile Mazibuko[4], Amy J. Sephton[4], Robyn Pickering[1,5], Wendy Black[1,3,4]

1 - Human Evolution Research Institute, University of Cape Town · 2 - Department of Archaeology, University of Cape Town · 3 - Archaeology Unit, Research & Exhibitions Department, Iziko Museums of South Africa · 4 - Exhibition Production & Design, Research & Exhibitions Department, Iziko Museums of South Africa · 5 - Department of Geological Sciences, University of Cape Town

Social responsiveness is an umbrella term used to refer to all forms of academic engagement with non-academic constituencies. For academic staff (as opposed to students or administrators), this takes the form of engaged scholarship linked to disciplinary expertise, with an intentional public purpose or benefit. Although some research is itself socially-responsive, for many researchers – including palaeoanthropologists and other human evolution experts – such engagement primarily takes the form of dissemination of scientific knowledge to the public through e.g. lectures, workshops, or museum exhibitions. Museum exhibitions in particular can impact large numbers of people from diverse backgrounds, making them a key site for best practice. One challenge in presenting human origins research to diverse communities lies in a disciplinary history that is colonial, and the manifestations of this, including narratives centering White/Western exploration, and the primitivisation of Black bodies. Even today natural history museums that house human origins exhibits also maintain displays of living non-European people, sometimes alongside animals from the same regions, a racist legacy of a colonial past that studied living people as proxies for understanding our primitive ancestors. In this context, we would like to challenge human evolution researchers to engage with socially responsive practice as a means for decolonising the discipline, in contrast to the more common unidirectional dissemination of scientific knowledge from privileged spaces. As a case study, here we discuss the process by which we produced a new permanent human evolution museum exhibit, entitled HUMANITY, at the Iziko South African Museum in Cape Town. From its inception, this exhibit was co-created with the input of a wide range of people, including curators, researchers, community leaders, artists, educators, students, design teams, and others, using practices of active community engagement. All exhibition components were developed to create a welcoming, inclusive space, that shares our human origin story as a collective, with care to avoid approaches, language, and visuals that might suggest that any people are superior or inferior relative to others. This process defined both content and design. Arguably the most striking aspect of the exhibit is its overall build, which is reminiscent of being in a giant basket, and is a direct result of critical engagement that made it clear that typical Western museum design is alienating to many people. Rather than centering scientists and their discoveries, the multilingual story unfolds by considering the biological and cultural diversity of people in South Africa today, as an inroad for exploring how that diversity came to be evolutionarily. The exhibit openly acknowledges the negative legacies of human evolution researchers and museum practice, including body collection, and encourages critical reflection on race, skin color variation, and privilege. In the place of dioramas, popular art and imagination are used to recreate the past; there are no images or sculptures of dark-skinned primitive-looking hominins. The thread of complex human interconnectedness runs through the exhibit, consistent with our current understanding of the braided stream narrative for human origins, but also relevant to dismantling the idea of biological race. Our hope is that by presenting the science of human evolution in this manner we create a space of engagement, one where future generations can see themselves entering the discipline without feeling alienated or othered, thereby transforming the discipline going forward.

Exhibition Funding: National Research Foundation (UID 136535), University of Cape Town #AdvancingWomen Grant, GENUS Centre of Excellence in Palaeosciences, Palaeontological Scientific Trust, European Society for Evolutionary Biology, Globe Institute, University of Copenhagen.

Poster Presentation Number 3, Session 1, Thursday 18:00 – 19:30

The context and nature of Initial Upper Paleolithic occupations from Bacho Kiro Cave (Bulgaria)

Vera Aldeias[1], Sarah Pederzani[2,3], Shannon P. McPherron[1,4], Zeljko Rezek[5], Nikolay Sirakov[6], Tsenka Tsanova[7], Jean-Jacques Hublin[4,8]

1 - ICArEHB University of Algarve, Faro, Portugal · 2 - Department of Geology & Geophysics, University of Utah, USA · 3 - AMBI-Lab, IUBO-AG, University of La Laguna, Spain · 4 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 5 - Département of Paleoanthropology, Collège de France, Paris · 6 - National Institute of Archaeology With Museum, Bulgarian Academy of Sciences, Sofia, Bulgaria · 7 - Department of Chemistry G. Ciamician, Alma Mater Studiorum, University of Bologna, Bologna, Italy · 8 - Chaire de Paléoanthropologie, CIRB, Collège de France, Université PSL, CNRS, INSERM, Paris, France.

The site of Bacho Kiro Cave was initially excavated by D. Garrod, followed by more extensive excavations by J. Kozlowski and B. Ginter between 1971-1975 [1]. These excavations exposed an archaeological sequence spanning the Middle to Upper Paleolithic transition, namely a level 11 containing so-called "Bachokirian" industries. This techno-cultural attribution has undergone several changes over the last half-century [2]. More recent excavations (2015-2021) have shown that this layer is a variant of the Initial Upper Paleolithic (IUP) with an age of ~45-42 ka cal BP [3] and associated with early *H. sapiens* [4] individuals with a recent Neanderthal ancestry [5]. Stratigraphically, this layer is a markedly distinctive organic dark deposit associated with abundant archaeological artefacts.

Here we present data on site formation and the nature of the human activities focusing on the IUP (Layer I – previously layer 11 – and Layer J – previously layer 11a) and the Middle Paleolithic deposits (Layer K). Our methodology incorporates soil micromorphological, micro-X-ray florescence mapping and lipid biomarker analysis. Our results show that the basal Middle Paleolithic Layer K is crudely bedded, with common limestone clasts and lenses of coarse sand pointing to episodic periods of run-off and possible freeze-thaw features. Its contact with Layer J above is often diffuse. Layer J is greenish brown loamy clay with common limestone clasts, some of which show phosphatic rims associated with weathering and the effects of reaction to bat guano-rich accumulations. This evidence suggests exposure as a surface for an unknown period of time. The contact with Layer I above is clear. Layer I is very rich in bones, flints and charcoal dispersed in an organic (non-calcitic) matrix associated with anthropogenically driven site formation processes. The jumbled nature of the anthropogenic components, representing an unorganized mix of burned and unburned components, is probably linked to site maintenance and discard/dumping activities closer to the cave wall. Discrete silt and clay-rich lenses within Layer I point to breaks in anthropogenically derived sediments and can be associated with periods of surface runoff. Lipid biomarker results provide additional information about the nature of the organic components of these deposits, particularly the presence and origin of combustion residues. The IUP Layer I deposit was covered by low-intensity water bedded and well sorted sands and silts that include reworked carnivore coprolites and clay aggregates. These deposits have flown from inside the karst system towards the cave mouth.

These results show that depositional processes at the site varied through time. The intensity and nature of IUP human activities during the formation of Layer I resulted in strikingly distinctive sediments from others in the stratigraphic sequence.

The archaeological work at Bacho Kiro Cave was funded by the Max Planck Society, with excavations conducted by the National Archaeological Institute with Museum, Sofia (Bulgaria) and the Max Planck Institute for Evolutionary Anthropology, Leipzig (MPI-EVA, Germany). S. Pederzani was supported by the German Academy of Sciences Leopoldina (LPDS 2021-13). V. Aldeias is funded by the European Union (ERC, MATRIX project n°101041245). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Council Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

References:[1] Kozlowski, J.K., 1982. Excavation in the Bacho Kiro Cave (Bulgaria). Państwowe Wydawnictwo Naukowe.
[2] Tsanova, T., 2008. Les débuts du Paléolithique supérieur dans l'Est des Balkans: Réflexion à partir de l'étude taphonomique et techno-économique des ensembles lithiques des sites de Bacho Kiro (couche 11), Temnata (couches VI et 4) et Kozarnika (niveau VII). British Archeaological Reports. 1752. [3] Fewlass, H., Talamo, S., Wacker, L., Kromer, B., Tuna, T., Fagault, Y., Bard, E., McPherron, S.P., Aldeias, V., Maria, R., Martisius, N.L., Paskulin, L., Rezek, Z., Sinet-Mathiot, V., Sirakova, S., Smith, G.M., Spasov, R., Welker, F., Sirakov, N., Tsanova, T., Hublin, J.-J., 2020. A ^{14}C chronology for the Middle to Upper Palaeolithic transition at Bacho Kiro Cave, Bulgaria. Nature Ecology & Evolution. 4, 794–801. [4] Hublin, J.J., Sirakov, N., Aldeias, V., Bailey, S., Bard, E., Delvigne, V., Endarova, E., Fagault, Y., Fewlass, H., Hajdinjak, M., Kromer, B., Krumov, I., Marreiros, J., Martisius, N.L., Paskulin, L., Sinet-Mathiot, V., Meyer, M., Pääbo, S., Popov, V., Rezek, Z., Sirakova, S., Skinner, M.M., Smith, G.M., Spasov, R., Talamo, S., Tuna, T., Wacker, L., Welker, F., Wilcke, A., Zahariev, N., McPherron, S.P., Tsanova, T., 2020. Initial Upper Palaeolithic *Homo sapiens* from Bacho Kiro Cave, Bulgaria. Nature. 581, 299–302. [5] Hajdinjak, M., Mafessoni, F., Skov, L., Vernot, B., Hübner, A., Fu, Q., Essel, E., Nagel, S., Nickel, B., Richter, J., Moldovan, O.T., Constantin, S., Endarova, E., Zahariev, N., Spasov, R., Welker, F., Smith, G.M., Sinet-Mathiot, V., Paskulin, L., Fewlass, H., Talamo, S., Rezek, Z., Sirakova, S., Sirakov, N., McPherron, S.P., Tsanova, T., Hublin, J.-J., Peter, B.M., Meyer, M., Skoglund, P., Kelso, J., Pääbo, S., 2021. Initial Upper Palaeolithic humans in Europe had recent Neanderthal ancestry. Nature. 592, 253–257.

Poster Presentation Number 4, Session 1, Thursday 18:00 – 19:30

Investigation of admixture between Neanderthal, Denisova and Central and Southeast Asian populations

Charlotte Antoine[1], Céline Bon[1], Raphaëlle Chaix[1], Evelyne Heyer[1], Romain Laurent[1], Bruno Toupance[1]

1 - UMR7206 - Éco-Anthropologie (EA), Muséum National d'Histoire Naturelle, CNRS, Université Paris Cité, Musée de l'Homme, Paris, France

When the human species left Africa about 100,000 to 70,000 years ago, it encountered other hominins that had already been established in Eurasia for tens of thousands of years: Neanderthals and Denisovans. Thanks to paleogenetics, we now know that admixture events occurred between these species and ours, leading to the introgression of archaic haplotypes into the genome of the ancestors of present-day Eurasian populations. Most studies interested in the admixture between our species and archaic hominins focused on Western European, East Asian, and Oceanian populations. These studies showed that these populations possess between 1% and 3% of their genome inherited from Neanderthals. East Asian and Oceanian populations also inherited a part of their genome from another archaic hominin, Denisova. The Denisovan ancestry in East Asian is lower than 1% in East Asian populations but reach 4% in Oceanians. Yet, the level of admixture with archaic populations remains largely unknown for Central and Southeast Asian populations despite their significance in addressing questions related to archaic admixture, particularly given their geographical proximity to East Asian and Oceanian populations. Moreover, archaic hominin fossils suspected to be Neanderthal, or Denisova were excavated in areas where current Central and Southeast Asian populations reside. Therefore, in this project we investigated traces of admixture between Neanderthals, Denisovans and the ancestors of present-day Central and continental Southeast Asian populations. We show that gene flow occurred between Neanderthals and Central and Southeast Asian populations. Central Asian populations inherited around 1.8% of their genome from Neanderthals while Southeast Asian populations inherited around 2.1%. This gene flow seems to be the result of a unique event of admixture in the ancestors of all these populations with a unique Neanderthal population genetically close to Neanderthal from Vindija. We also highlight that Central and South-East Asian populations inherited a small part of their genome (less than 1%) from Denisovans. In contrast to Neanderthal's genetic heritage, Denisovan's one seems to be the result of several admixture events with different Denisovan populations, whose genetic distance from the Altai Denisovan genome is variable.

Pecha Kucha Presentation, Session 7, Friday 13:30 – 15:00

Exploring intraspecific variance in the fossil record: insights from upper and lower limb long bones

Julia Aramendi[1], Lloyd A. Courtenay[2]

1 - McDonald Institute for Archaeological Research, University of Cambridge, UK · 2 - Université de Bordeaux, CNRS, PACEA UMR5199, Pessac, France

Levels of intraspecific variance in the fossil record are difficult to assess due to their sparsity. Working on postcranial remains complicates such studies further because these specimens often appear in isolation, without associated cranial or dental remains that can aid in taxonomic allocations. Additionally, the usual high fragmentation of postcranial remains in the fossil record makes it difficult to find homologous fossil samples for comprehensive analyses.

Here, we present an exploratory geometric morphometric analysis of morphological variance within species and genera in the femur and humerus of modern great apes. We considered different living groups within *Pongo* (*Pongo abelii* and *Pongo pygmaeus*), *Pan* (*Pan paniscus* and *Pan troglodytes*), and *Gorilla* (*Gorilla gorilla* and *Gorilla beringei*), as well as the only living *Homo* species, *Homo sapiens*. Group variance was established using only adult individuals with fused epiphyses, representing both male and female individuals, that were digitized and landmarked using 40 landmarks for each element.

Additionally, *Homo naledi* femora and humeri available on Morphosource were included in the analyses to assess morphological variance in the fossil record. *Homo naledi* is considered to represent a single biological population with marked morphological uniformity [1], allowing us to avoid potential morphological changes due to large chronological gaps in the fossil record present in other fossil hominin species. We also utilized *Homo naledi* previously reconstructed missing data using the Reverse Engineering method [2] to provide the most comprehensive analysis possible.

Our results indicate that levels of morphological variance and uniqueness vary in the upper and lower limbs not only according to higher levels of sexual dimorphism in certain groups but also in relation to the specialization of the limbs for specific locomotor patterns. Additionally, different morphological signals can be observed depending on the portion of the bone analysed, which should be considered when studying fragmentary remains in the hominin fossil record.

J.A. is supported by a British Academy Newton International Fellowship (grant number: NIF22\220310). This study was also supported by the McDonald Grants and Awards Fund. We would like to thank the curators of the Natural History Museums of Barcelona and Vienna, the Royal Museum for Central Africa, and the Duckworth collection of the University of Cambridge for their assistance in the collection of the modern data. We would also like to thank the Rising Star project for sharing the 3D volumes of the major specimens of Homo naledi; the researchers and technicians within the NMNH of the Smithsonian Institution and the AMNH Mammalogy project for generating and providing free access to great ape long bone 3D meshes. We are also deeply grateful to MorphoSource, the Digital Morphology Museum KUPRI, and the NMDID for providing the web support to make the files available.

References:[1] Berger, L.R., Hawks, J., de Ruiter, D.J., Churchill, S.E., Schmid, P., Delezene, L.K., Kivell, T.L., Garvin, H.M., Williams, S.A., DeSilva, J.M., Skinner, M.M., Musiba, C.M., Cameron, N., Holliday, T.W., Harcourt-Smith, W., Ackermann, R.R., Bastir, M., Bogin, B., Bolter, D., Brophy, J., Cofran, Z.D., Congdon, K.A., Deane, A.S., Dembo, M., Drapeau, M., Elliott, M.C., Feuerriegel, E.M., Garcia-Martinez, D., Green, D.J., Gurtov, A., Irish, J.D., Kruger, A., Laird, M.F., Marchi, D., Meyer, M.R., Nalla, S., Negash, E.W., Orr, C.M., Radovcic, D., Schroeder, L., Scott, J.E., Throckmorton, Z., Tocheri, M.W., VanSickle, C., Walker, C.S., Wei, P., Zipfel, B., 2015. *Homo naledi*, a new species of the genus *Homo* from the Dinaledi Chamber, South Africa. eLife. 4, e09560. [2] Courtenay, L.A., Aramendi, J., 2023. The "Reverse Engineering" approach to hominin long bone reconstruction: Transforming human evolution studies. Bulletins et mémoires de la société d'anthropologie de Paris. 36.

Poster Presentation Number 5, Session 1, Thursday 18:00 – 19:30

Deciphering evolutionary dynamics in the hands and feet of modern humans

Mikel Arlegi[1], Adrián Pablos[2,3,4], Carlos Lorenzo[5,6]

1 - McDonald Institute for Archaeological Research, University of Cambridge, UK · 2 - Departamento de geodinámica, estratigrafía y paleontología. Universidad Complutense de Madrid · 3 - Departamento de Prehistoria y Arqueología, Universidad de Sevilla, Sevilla, Spain · 4 - Centro Nacional de Investigación sobre la Evolución Humana-CENIEH, Burgos, Spain · 5 - Universitat Rovira i Virgili, Departament d'Història i Història de l'Art, Tarragona, Spain · 6 - Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Spain

The morphology of human hands and feet has distinct features that distinguish us from apes. The human foot exhibits a relatively long and robust fully adducted and non-opposable hallux, short and straight pedal phalanges from digits II-V, medial longitudinal and tarsal transverse arches, which, together with the well-developed plantar aponeurosis and intrinsic muscles, provide necessary stiffness against the tarsal break. The hand is distinguished by a long thumb relative to fingers, built with an enlarged thenar muscular complex, providing a unique range of rotation, stabilization, and grasping capacities. Additionally, the human hand displays short and straight metacarpals and non-pollical digits, along with a reoriented carpal-metacarpal articulation of the wrist via the first metacarpal-trapezium-scaphoid.

These autapomorphies enable humans to achieve two distinctive hallmarks: fully bipedal locomotion and unique manipulation abilities. Classic literature proposed the evolution of human autopods as an adaptive independent response to hand manipulation abilities for tool use and the acquisition of committed bipedalism, respectively. However, later investigations proposed different hypotheses, including the possibility that the modern human hand and feet co-evolved [1]. Specifically, this hypothesis suggests that the proportions of the hand represent a by-product of morphological adaptations for bipedalism in the foot. This hypothesis is based on the principle that hands and feet are serially homologous elements, sharing similar genetic and developmental architecture, and thus are initially strongly integrated [2]. Patterns and magnitudes of integration can be relatively modified due to functional factors [3], however, the shared genetic structure of the autopods constrains their ability to evolve independently.

In this study, we aim to shed light on the coevolution of hands and feet by quantifying the ability of modern human hands and feet to respond to selection demands in a coordinated manner. To do so, we apply a framework developed for evolutionary quantitative genetics to each homologous metapodial and phalanx skeletal element (n = 19) using nine linear variables. We subjected the autopods to three different evolutionary selection regimes: 1) random selection acting on both elements, 2) relaxation of selection in the hands, and 3) a scenario of no selection in the feet. The preliminary results indicate that, except for the second digit, all other digits exhibit significant negative values of coevolvability, indicating divergent random selection. However, the first two digits show increased positive coevolvability values when selection is acting only on the foot, while the third to fifth digits display even higher negative values. When analyzing individual skeletal elements, under random selection, all metapodials exhibit positive coevolutionary values, with the exception of the first metapodial, which shows low negative values in three selective regimes. Phalanges generally demonstrate negative coevolvability values, except for the II proximal phalanx, V middle phalanx, and I distal phalanx.

We extend our sincere gratitude to Y. Haile-Selassie and L. Jellema of the Cleveland Museum of Natural History (CMNH) for generously providing access to the Hamann-Todd Osteological Collection and for their invaluable technical assistance. The first author is benefitted by an International Fellowship from the British Academy (IF23\100647). A. Pablos was funded by a research grant from Junta de Andalucía, Spain (EMERGIA20_00403). This research was also supported by the FEDER/Ministerio de Ciencia e Innovación-Agencia Estatal de Investigación (project project PID2021-122355NB-C31 funded by MCIN/AEI/10.13039/501100011033/ FEDER, UE).

References:[1] Rolian, C., Lieberman, D.E., Hallgrímsson, B., 2010. The coevolution of human hands and feet. Evolution. 64, 1558-1568. [2] Young, N.M., HallgrÍmsson, B., 2005. Serial homology and the evolution of mammalian limb covariation structure. Evolution. 59, 2691-2704. [3] Rolian, C., 2009. Integration and evolvability in primate hands and feet. Evolutionary Biology. 36, 100-117.

Podium Presentation, Session 11, Saturday 13:50 – 15:30

Human skeletal proteome variation

Ragnheiður Diljá Ásmundsdóttir[1], Gaudry Troché[1], Jesper V. Olsen[2], Sarah Schrader[3], Frido Welker[1]

1 - Globe Institute, Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark · 2 - Novo Nordisk Foundation Center for Protein Research, Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark · 3 - Faculty of Archaeology, Leiden University, Leiden, the Netherlands

Most fields involved in biomolecular human evolutionary research have optimised their sampling strategies. The main reasons for optimised sampling strategies are to protect the limited resource that archaeological remains are. Within the field of palaeoproteomics this has, however, not been done so far. For example, the human bone proteome is generally considered to be uniform across the skeleton, implying that the same information can be acquired regardless of what bone or bone element is sampled. Based on bone biology this is unlikely to be the case. To optimise palaeoproteomic sampling strategies we propose to intertwine the biology of the living bone and proteomic preservation of archaeological bone by focusing on two major aspects of bone biology, bone formation and maintenance. How the skeletal biology, mainly bone formation and maintenance, of living bone affects the proteome in human archaeological material has previously not been extensively studied.

Firstly, the skeleton is largely formed through two ossification processes, endochondral and intramembranous ossification. These two processes are different on a cellular level, with endochondral ossification taking place on a cartilage template of the forming bone, while intramembranous ossification takes place directly within the soft tissues. This difference is likely to influence the proteome composition of fully formed bone, as bone formed through endochondral ossification would potentially retain cartilage-related proteins that are absent in bone formed through intramembranous ossification [1-2].

Secondly, bone maintenance varies throughout the skeleton. Most bones are composed of two bone types, cortical and trabecular bone, that differ in structure and maintenance. Trabecular bone has a larger surface area and is more metabolically active with higher remodelling rate per year, suggesting faster renewal of proteins. In contrast and at the same time, trabecular bone would be less favourable for protein preservation through time due to its lower mineral density and higher relative surface area [3-4].

Here we present how these two major aspects of bone biology influence the bone proteome composition and variation in archaeological human remains from post-Medieval Netherlands. We observe variation in terms of protein composition, the proteins identified, between ossification and tissue types, as well as differences in proteome size, mainly through protein concentration and the number of unique peptides identified. These results have direct implications on the sampling of archaeological bone specimens across the Pleistocene and the Holocene. By increasing our understanding of the variability in the human archaeological bone proteome composition, our insights result in optimised sampling strategies that potentially reduce or eliminate the risk associated with sampling hominin remains, whether unnecessary and/or destructive sampling, allowing for better conservation of highly precious remains.

This study has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (grant agreement No 948365) and the Leakey Foundation.

References: [1] Mackie, E.J., Tatarczuch, L., Mirams, M., 2011. The skeleton: a multi-functional complex organ: the growth plate chondrocyte and endochondral ossification. The Journal of Endocrinology. 211, 109–121. [2] Hallett, S.A., Ono, W., Ono, N., 2021. The hypertrophic chondrocyte: To be or not to be. Histology and histopathology. 36, 1021–1036. [3] Parfitt, A.M., 1994. Osteonal and hemi-osteonal remodeling: the spatial and temporal framework for signal traffic in adult human bone. Journal of Cellular Biochemistry. 55, 273–286. [4] Ásmundsdóttir, R.D., Hansen, J., Fagernäs, Z., Troché, G., Olsen, J.V., Saña Seguí, M., Welker, F., 2024. Early Holocene preservation differences between cortical and trabecular bone proteomes. Journal of archaeological science, reports. 57, 104643.

Poster Presentation Number 6, Session 1, Thursday 18:00 – 19:30

Exploration of the (co)variation signal between cortical bone and dentine volumes across the arm/forearm bones and anterior teeth in a modern human sample

Mathilde Augoyard[1], Clément Zanolli[1], Antonio Profico[2], Adrien Thibeault[1], Anna C. Oettlé[3], Ericka N. L'Abbé[4], Marine Cazenave[5,6,7], Jakobus Hoffman[8], Priscilla Bayle[1]

1 - Univ. Bordeaux, CNRS, MCC, PACEA, UMR 5199, Pessac, France · 2 - Department of Biology, University of Pisa, Pisa, Italy · 3 - Department of Anatomy and Histology, Sefako Makgatho Health Sciences University, Ga-Rankuwa, Pretoria, South Africa · 4 - Forensic Anthropology Research Centre, Department of Anatomy, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa · 5 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 6 - Division of Anthropology, American Museum of Natural History, New York, NY, USA · 7 - Department of Anatomy, Faculty of Health Sciences, University of Pretoria, South Africa · 8 - South African Nuclear Energy Corporation SOC Ltd., Pelindaba, South Africa

Cortical bone and dentine share the same embryological origin, developmental, and genetic background, distinct from those of the enamel [1]. Understanding the relationship between these mineralized tissues in individuals is crucial to decipher the factors acting on their morphogenesis, and ultimately to understand the mechanisms responsible for the different patterns of tissue proportions in human evolution. Despite their genetic and developmental similarities, few studies have investigated the potential correlation between cortical bone and dentine volumes in humans. A recent study on distal radii and upper canines found moderate to strong positive correlations between cortical bone and dentine volumes in modern adults, with a weaker covariation signal between cortical bone and enamel [2]. We aim to expand this study to the arm and forearm bones (humerus, ulna, radius) and anterior teeth (central and lateral maxillary incisors, maxillary canines) of modern humans. Due to shared structural, genetic, and developmental characteristics, our primary hypothesis postulates a coordinated variation between cortical bone and dentine volumes, while such a relationship is not expected between cortical bone and enamel volumes. Additionally, considering the varying sensitivity of upper limb bones and anterior teeth to functional factors, resulting in local variations in tissue thickness, we anticipate a stronger covariation signal in bone and teeth portions subjected to fewer mechanical constraints.

The analytical sample comprises 56 adults of African and European ancestries from South African contemporary osteological collections. Initially, two-dimensional morphometric maps were generated for cortical thickness across the entire diaphysis of the humerus, ulna, and radius, as well as for dentine thickness in the anterior tooth roots [3]. Multiple regression analysis was then conducted on these maps to investigate how tissue thickness varies with different environmental factors [4]. This allowed for the identification of bone and tooth regions of interest, whose volumes were subsequently computed, followed by an exploration of their potential covariation using correlation tests.

Multiple regression analysis revealed a significant increase in cortical thickness across the 65-80% humerus shaft, 35-65% ulna, and 30-45% radius portions, possibly aligning with specific tendon and ligament attachments. We hypothesized that these shaft portions are more functionally constrained and less likely to covary with dentine volumes.

Correlation tests revealed strong positive correlations between cortical bone and dentine volumes, regardless of the bone or tooth considered. Conversely, the correlations between cortical bone and enamel were weak or negligible. Additionally, we observed a disto-mesial covariation trend, with upper canines exhibiting the strongest covariation with cortical bone volumes, followed by lateral incisors and central incisors. We also noted the influence of functional loads on the covariation signal in humeri and ulnae, as weaker correlation coefficients were observed between bone portions most sensitive to these loads and dentine volumes. However, for the radius, the covariation signal remained constant along the entire diaphysis.

These findings could offer valuable insights into the factors influencing the local variation of cortical bone and dentine distribution along the bone shaft and dental root. Further research on the cortical bone-dentine covariation across different skeletal parts, including lower limb elements, would enhance our understanding of the effects of both endogenous and exogenous factors on the development of the mineralized tissues. This may shed light on the pattern of joint tissue thickening observed in the palaeoanthropological record, and especially in the majority of Neandertal specimens [5].

Research supported by the "Ministère de l'Enseignement supérieur et de la Recherche", the CNRS, the "Investments for the future" program IdEx Bordeaux (3Dent'in project, ANR-10-IDEX-03-02, coord.: P. Bayle; STEP ITAP project, OPE-2018-0181, coord.: P. Bayle and J.-G. Bordes), the Région Nouvelle-Aquitaine (NATCH project, 2016-1R40204, coord.: J.-Ph. Faivre), the Département des Sciences Archéologiques de Bordeaux (CartoTiss project, coord.: M. Augoyard), and the Bakeng se Afrika project 597924-EPP-1-2018-1-ZAEPPKA2-CBHE-JP, an Erasmus plus project of the EU (coord.: E. L'Abbé). This research benefited from the scientific framework of the University of Bordeaux's IdEx "Investments for the Future" program / GPR "Human Past". For the South African sample, ethical approval was obtained from the Faculty of Health Sciences Research Ethics Committee of the University of Pretoria (ref. no. 685/2021). For access to the specimens and technical support, we thank J. Hoffman, E.N. L'Abbé, and A. Oettlé.

References: [1] Burr, D.B., Allen, M.R., 2019. Basic and Applied Bone Biology (2nd ed). Academic Press, Amsterdam, The Netherlands. [2] Augoyard, M., Zanolli, C., Santos, F., Oettlé, A.C., L'Abbé, E.N., Le Luyer, M., Cazenave, M., Colard, T., Hoffman, J., Profico, A., Bayle, P., 2023. Evaluation of age, sex, and ancestry-related variation in cortical bone and dentine volumes in modern humans, and a preliminary assessment of cortical bone-dentine covariation in later *Homo*. Journal of Anthropological Sciences 101, 143-169. [3] Profico, A., Bondioli, L., Raia, P., O'Higgins, P., Marchi, D., 2021. morphomap: An R package for long bone landmarking, cortical thickness, and cross-sectional geometry mapping. American Journal of Physical Anthropology. 174, 129-139. [4] Profico, A., Zeppilli, C., Micarelli, I., Mondanaro, A., Raia, P., Marchi, D., Manzi, G., O'Higgins, P., 2021. Morphometric maps of bilateral asymmetry in the human humerus: An implementation in the R Package Morphomap. Symmetry. 13, 1711. [5] Churchill, S.E., 1998. Cold adaptation, heterochrony, and neandertals. Evolutionary Anthropology: Issues, News, and Reviews. 7, 46-60.

Poster Presentation Number 7, Session 1, Thursday 18:00 – 19:30

Trigonid crest patterning of the deciduous lower third and fourth premolars in Neanderthals and *Homo sapiens*

Shara E. Bailey[1,2], Mykolas D. Imbrasas[2], Matthew M. Skinner[2]

1 - Department of Anthropology, Center for the Study of Human Origins, New York University, New York, USA · 2 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

MicroCT technology and geometric morphometric (GM) methods have allowed us to quantify and compare dental morphological variation in novel ways. However, virtual technology is not always possible; and even when it is, teeth may be too worn or damaged to conduct useful GM analyses. In these cases, non-metric traits like accessory crests and cusps can provide useful taxonomic information. Bailey [1] identified a number of non-metric traits in the permanent dentitions of Neanderthals and *Homo sapiens* that are useful for distinguishing between the two groups, especially when used in combination [2]. Being able to distinguish these groups is important. They overlap in time and space, and linking cultural remains to hominin remains continues to be a topic of debate [3].

The occlusal crest pattern of the permanent lower molars is one of these diagnostic non-metric traits [4-5]. The middle trigonid crest (MTC) joins the protoconid and metaconid with a continuous ridge. Its strong expression and high frequency have proven to be diagnostic of Neanderthals [4]. We might assume that the frequency, expression and distribution of the MTC on the deciduous premolars would mirror that of the permanent molars, but this hypothesis is yet to be tested. Given the considerable frequency with which deciduous teeth are encountered in the fossil record, it is important to do so (this study).

It is most accurate to observe crest patterning at the enamel dentine junction (EDJ), as even light wear can obscure crests and fissures at the outer enamel surface. In this study we examine the frequency and types of crest patterning at the EDJ from microCT-scanned deciduous lower premolars (dP3 and dP4). Our dP3 sample includes 20 recent and 1 fossil *H. sapiens* and 10 Neanderthals; our dP4 sample includes 18 recent and 2 fossil *H. sapiens* and 11 Neanderthals.

We found taxonomically significant differences in frequency and kind of trigonid crests on both dP3 and dP4. The dP3 MTC was present, but weakly expressed, in 72.7% of our *H. sapiens* sample. In contrast, 100% of the dP3s of Neanderthals exhibited a continuous MTC; and in 80% this crest was strong. For the dP4, the taxonomic differences were more marked. We found that 10.5% of our *H. sapiens* dP4 sample exhibited a continuous MTC. In contrast, 80% of the Neanderthal dP4s exhibited a continuous MTC; and the remaining 20% had a mesial trigonid crest joining the protoconid essential crest and the metaconid mesial accessory crest [5].

The distribution and expression of the distal trigonid crest (DTC) – which joins the essential crest of the metaconid and the distal accessory crest of protoconid – was somewhat different than that of the MTC. While the frequency of DTC was twice as high in *H. sapiens* (21.1%) than in Neanderthals (9%), the differences in expression and frequency between the two groups were not statistically significant.

Our results confirm that the significant differences in MTC frequency and expression observed in the permanent molars of *H. sapiens* and Neanderthals are also present on the deciduous premolars. Some additional points can be made. First, we note that the single early *H. sapiens* dP3 (Qafzeh 15) has a high Neanderthal-like MTC and both early *H. sapiens* dP4s (Qafzeh 15, Skhūl 10) possess a continuous MTC. Finding Neanderthal-like MTC expression in these early *H. sapiens* individuals may warrant further study. Second, we note that in some Neanderthal dP4s a portion of the continuous MTC begins to fade at the base of either mesial cusp. In these cases, if the other mesial cusp were missing or worn, the MTC expression would be ambiguous. Therefore, we suggest that accurately assessing the MTC expression requires observations on both mesial cusps. Finally, these results provide a framework to examine the presence and expression of the MTC in the deciduous premolars of geochronologically older hominin species.

This project has received funding from the European Research Council (grant agreement No. 819960) and the Max Planck Society.

References: [1] Bailey, S.E., 2002. Neandertal Dental Morphology: Implications for modern human origins. (Ph.D. Dissertation), Arizona State University, Tempe. [2] Bailey SE, Weaver TD, Hublin J-J., 2009. Who made the Aurignacian and other early Upper Paleolithic industries? Journal of Human Evolution. 57, 11-26. [3] Bailey, S.E., Skinner, M.M., Hublin, J., 2011. What lies beneath? An evaluation of lower molar trigonid crest patterns based on both dentine and enamel expression. American Journal of Physical Anthropology. 145, 505–518. [5] De Pinillos, M.M., Martinón-Torres, M., Skinner, M.M., Arsuaga, J.L., Gracia-Téllez, A., Martínez, I., Martín-Francés, L., De Castro, J.M.B., 2014. Trigonid crests expression in Atapuerca-Sima de los Huesos lower molars: Internal and external morphological expression and evolutionary inferences. Comptes Rendus. Palévol/Comptes Rendus PaléVol. 13, 205–221.

Poster Presentation Number 8, Session 1, Thursday 18:00 – 19:30

The effects of mobility patterns on Neanderthal technological variability: insights from Velika pećina in Kličevica (Croatia)

Marko Banda[1], Nikola Vukosavljević[1], Ivor Karavanić[1]

1 - Department of Archaeology, University of Zagreb Faculty of Humanities and Social Sciences

For the past several decades, increased research activity in the Adriatic Basin has resulted in a substantial number of Middle Palaeolithic (MP) sites, some of which preserve well-dated multi-layered stratigraphic sequences [1-2]. These include clusters of sites in Northeastern and Southeastern Italy, the Istrian peninsula and Dalmatia in Croatia, the Montenegrin hinterlands, and Northwestern Albania. In most sites, deposits dating to MIS 3 (c. 60-30 ka), with the associated archaeological record of Late Neanderthals, have been preserved. The consequence of this work is the increasing variability seen in lithic technology, both in terms of the main ways lithic blanks were produced, and also in patterns of tool consumption. However, studies using attribute-based approaches have shown that some of the intra- and inter-site variability observed in this regional context does not necessarily correlate with the predominance of specific knapping procedures [3]. Thus, an explanation beyond the realm of established MP techno-complexes is necessary.

One of the regional facies often invoked in assemblage classification, at least in the Eastern Adriatic coast and hinterlands, is the Micromousterian. This facies is almost exclusively defined on the basis of artifact size, despite the recognition of internal techno-typological variability [4-5]. Despite that, the size threshold required for an assemblage to be attributed to the Micromousterian has never been explicitly established, and assemblages attributed to this facies display size differences between them. Various explanations have been offered for systemic factors contributing to small artifact size, of which the most common one emphasizes the role of initial raw-material size and/or quality [5]. Others, however, have invoked reduction intensity or intentional manufacture as potential drivers of assemblage variability [see 3-4].

This paper aims to contribute to the discussion on the variability within the Micromousterian framework. Our study is based on the lithic analysis of several Late MP assemblages from Velika pećina in Kličevica, a cave site found in Northern Dalmatia (Croatia). Despite problems of post-depositional mixing in most of the site, the entrance area has provided a well-preserved sequence, part of which has been dated with C14, OSL and U-Th to MIS 3 – MIS 4/5a. The MP lithic assemblages are small and highly reduced and have been associated with the strategy of highly mobile Neanderthal groups. Our results suggest that while raw-material characteristics constrain the maximum artifact size, mobility patterns provide another axis of variability through the degree of reduction artifacts are subjected to. The advantage of this model is the ability to compare assemblages both within and across sites, which is demonstrated by using data from previously published papers [3]. Furthermore, this explanatory framework provides an opportunity to integrate the data from the numerous surface open-air sites in Northern Dalmatia [5]. While the model would benefit from a larger sample, the relationship seen between the assemblages in terms of attributes of reduction intensity is robust. This suggests that future research on the Micromousterian, and other small artifact-based MP industries, may need to account for mobility patterns, in addition to raw-material characteristics, prior to considering the role intentional production plays in MP microlithisation.

The research presented was conducted as part of the project "Last Neandertals at the Crossroads of Central Europe and the Mediterranean", financed by the Croatian Science Foundation (IP-2019-04-6649).

References: [1] Karavanić, I., Vukosavljević, N., Janković, I., Ahern, J.C.M., Smith, F.H., 2018. Paleolithic hominins and settlement in Croatia from MIS 6 to MIS 3: Research history and current interpretations. Quaternary International. 494, 152–166. [2] Peresani, M., 2012. Fifty thousand years of flint knapping and tool shaping across the Mousterian and Uluzzian sequence of Fumane cave. Quaternary International. 247, 125–150. [3] Dogandžić, T., Đuričić, L., 2017. Lithic production strategies in the Middle Paleolithic of the southern Balkans. Quaternary International. 450, 68–102. [4] Dogandžić, T., 2023. The Middle Paleolithic of the Balkans: Industrial Variability, Human Biogeography, and Neanderthal Demise. Journal of World Prehistory. 36, 257–338. [5] Vujević, D., Perhoč, Z., Ivančić, T., 2017. Micro-Mousterian in Northern Dalmatia. Quaternary International. 450, 50–67.

Pecha Kucha Presentation, Session 2, Thursday 11:20 – 12:50

First application of ZooMS to Pleistocene bones preserved in resin-impregnated sediment blocks

Larissa Bartsch[1], Thomas Beard[1,2], Susanna Sawyer[1,2], Anna Belfer-Cohen[3], Alexander Mackay[4], Tengiz Meshveliani[5], Teresa Steele[6], Ron Pinhasi[1,2], Katerina Douka[1,2], Mareike Stahlschmidt[1,2]

1 - Department of Evolutionary Anthropology, University of Vienna, Vienna, Austria · 2 - Human Evolution and Archaeological Sciences, University of Vienna, Vienna, Austria · 3 - Institute of Archaeology, Hebrew University of Jerusalem, Jerusalem, Israel· 4 - School of Earth, Atmospheric, and Life Sciences, University of Wollongong, Wollongong, Australia · 5 - Georgian National Museum, Tbilisi, Georgia · 6 - Department of Anthropology, University of California, Davis, United States

Microarchaeological thin section analysis is a a key method for examining site stratigraphy at the microscopic level. To do so, stabilized blocks of sediments are collected and impregnated with resin, representing a snapshot of the site's formation processes and human/animal activities. These blocks may also contain microscale bone remains. The analysis of sediment DNA extracted from such micromorphology blocks has already shown that the impregnation process does not hinder DNA extraction or preservation [1]. However, sedaDNA analysis is costly, and with the emphasis lying on bones, Zooarchaeology by Mass Spectrometry (ZooMS) [2] could instead serve as a powerful identification tool, particularly given the heterogeneity of bone fragments in size, taxon, and preservation.

Our project's main goal, as a proof of concept, is to assess whether collagen extracted from bones preserved in resin-impregnated sediment blocks can be identified taxonomically or whether the process of impregnation, the resin itself and other impurities, could inhibit paleoproteomic analyses.

We implemented ZooMS analysis on bone fragments preserved in micromorphology blocks from three different Pleistocene archaeological sites: Satsurblia Cave (Georgia), Klipfonteinrand rock shelter and Varsche Rivier 003 (both in South Africa). Visually identifiable and well-preserved bone fragments, with varied degrees of heat exposure, were drilled to obtain at least 5 mg of powder. Bone powder samples then underwent acid-insoluble collagen extraction [2-4], followed by mass spectrometric analyses (MALDI-ToF MS) and collagen peptide mass fingerprinting. Further, FTIR analysis was also conducted to assess the heating degree for all the analyzed samples.

Our initial findings indicate that collagen, and therefore ZooMS analysis, remain unaffected by resin, and are effective even with only small amounts of bone powder available, provided the bones have not been heated extensively. In this paper, we will report on our new results and discuss species content in relation to sediment contexts, as well as the implementation of ZooMS as a cost-effective screening method for fragmentated human bones in resin-impregnated sediment blocks. ZooMS analysis on this unusual substrate, in combination with micromorphological analysis of thin sections, has the potential to provide deeper insights into prehistoric (micro)contexts and site formation processes.

This project is funded by a seed grant from Human Evolution and Archaeological Sciences (HEAS), University of Vienna. Furthermore, this work is supported by the ERC grant MicroStratDNA Project No. 101042570 awarded to M. Stahlschmidt and received funding under the European Union's Horizon 2020 Research and Innovation Programme grant agreement No. 715069 (FINDER) to K. Douka.

References: [1] Massilani, D., Morley, M.W., Mentzer, S.M., Aldeias, V., Vernot, B., Miller, C., Stahlschmidt, M., Kozlikin, M.B., Shunkov, M.V., Derevianko, A.P., Conard, N.J., Wurz, S., Henshilwood, C.S., Vasquez, J., Essel, E., Nagel, S., Richter, J., Nickel, B., Roberts, R.G., Pääbo, S., Slon, V., Goldberg, P., Meyer, M., 2021. Microstratigraphic preservation of ancient faunal and hominin DNA in Pleistocene cave sediments. Proceedings of the National Academy of Sciences. 119, e2113666118. [2] Buckley, M., Collins, M., Thomas-Oates, J., Wilson, J.C., 2009. Species identification by analysis of bone collagen using matrix-assisted laser desorption/ionisation time-of-flight mass spectrometry. Rapid Communications in Mass Spectrometry. 23, 3843–3854. [3] Brown, S., Hebestreit, S., Wang, N., Boivin, N., Douka, K., Richter, K.K., 2020. Zooarchaeology by Mass Spectrometry (ZooMS) for bone material - Acid insoluble protocol. protocols.io. [4] Welker, F., Soressi, M., Rendu, W., Hublin, J.-J., Collins, M., 2015. Using ZooMS to identify fragmentary bone from the Late Middle/Early Upper Palaeolithic sequence of Les Cottés, France. Journal of Archaeological Science. 54, 279–286.

Pecha Kucha Presentation, Session 7, Friday 13:30 – 15:00

New hominin cranial remains from the Shungura Formation, Lower Omo Valley (Ethiopia)

Amélie Beaudet[1,2,3], Blade Engda Redae[1,4], Jean-Renaud Boisserie[1,5]

1 - Laboratoire de Paléontologie, Évolution, Paléoécosystèmes et Paléoprimatologie (PALEVOPRIM), UMR 7262 CNRS & Université de Poitiers, France · 2 - Department of Archaeology, University of Cambridge, United-Kingdom · 3 - School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, South Africa · 4 - Institute of Human Origins, Arizona State University, USA · 5 - Centre français des études éthiopiennes, UAR 3137 CNRS & MEAE, Ethiopia

The formations of the Lower Omo Valley, south-western Ethiopia, have played a key role in our understanding of Plio-Pleistocene hominin taxic diversity and biogeography (rev. in [1]). In particular, the continuous fossiliferous deposits of the Shungura Formation (3.75 to 1 Ma) continue to provide rare evidence of evolutionary mechanisms, environmental context and behavioural innovations involved in the emergence of the genus *Homo*. Successive interdisciplinary and international fieldwork programs in the Lower Omo Valley have been responsible for major discoveries, including the description of the taxon *Paranthropus aethiopicus*, that further confirms the relevance of this locality for addressing crucial questions in human evolutionary studies. Since 2006, the Omo Group Research Expedition have been conducting fieldwork with the aim of refining and collecting new information on the ecological, archaeological, geological and fossil record in the Shungura Formation, including identifying new hominin remains [1-2]. Here, we describe two hominin cranial fragments excavated from Member L (Unit L-9) in 2016 and dated to ca. 1.15 Ma. The two cranial fragments, OMO 342-10248a and OMO 342-10248b, are curated at the National Museum of Ethiopia/Ethiopian Heritage Authority and were photographed and measured using a calliper. Measurements of the total cranial thickness and, when possible, of the diploic layer, are compared to extant humans as well as Plio-Pleistocene hominin specimens (*Australopithecus afarensis*, *Australopithecus africanus*, *Paranthropus boisei*, *Paranthropus robustus*, early *Homo*, Asian and African *Homo erectus*) using published databases (e.g., [3-5]). Based on the morphology of the ectocranial and endocranial surfaces, OMO 342-10248a and OMO 342-10248b are identified as a right parietal bone from near the squamous suture and an occipital bone from above the nuchal crest, respectively. Our measurements of the two cranial fragments provide an average cranial thickness of 9.0 mm and 8.5 mm for OMO 342-10248a and OMO 342-10248b, respectively. The average cranial thickness measured in OMO 342-10248a falls within the range of the Asian *Homo erectus* sample and closely approximates individual values measured in some of the African *Homo erectus* specimens (e.g., OH 9, KNM-ER 730, KNM-ER 2592, KNM-ER 1821, KNM ER 3733), in particular the one of the specimen P 996-17a from Unit K-3 of the Shungura Formation. The inner structural arrangement of OMO 342-10248a is diploë-dominated and the diploic layer constitutes more than 80% of the cumulative cranial thickness. The average cranial thickness measured in OMO 342-10248a falls within the range of *Australopithecus africanus*, *Paranthropus boisei* and the African *Homo erectus* sample. The endocranial surface of OMO 342-10248a preserves imprints of the middle branch of the middle meningeal vessels and reveals substantial anastomoses. In terms of cranial thickness and inner structural organisation, OMO 342-10248a and OMO 342-10248b share similarities with *Homo*, and more particularly with *Homo erectus*. Resemblances with P 996-17a further support the possibility of *Homo erectus*-like hominins being present in the Lower Omo Valley 1.15 million years ago.

We thank the French Centre National de Recherche Scientifique (CPJ-Hominines, MITI) and the South African National Research Foundation (#129336) for funding, the Ethiopian Heritage Authority for granting research permit to the OGRE, all OGRE participants for their work, the regional and zonal administrations, the Nyangatom and Dassanetch Weredas, and their people for their help and reception, and all the funding supports (notably Ministry of Europe and Foreign Affairs, ANR, CNRS) to OGRE.

References: [1] Boisserie, J.-R., Guy, F., Delagnes, A., Hlukso, L.J., Bibi, F., Beyene, Y., Guillemot, C., 2008. New palaeoanthropological research in the Plio-Pleistocene Omo Group, Lower Omo Valley, SNNPR (Southern Nations, Nationalities and People Regions), Ethiopia. Comptes Rendus Palevol. 7, 429–439. [2] Daver, G., Berillon, G., Jacquier, C., Ardagna, Y., Yadeta, M., Maurin, T., Souron, A., Blondel, C., Coppens, Y., Boisserie, J.-R., 2018. New hominin postcranial remains from locality OMO 323, Shungura Formation, Lower Omo Valley, southwestern Ethiopia. Journal of Human Evolution. 122, 23–32. [3] Copes, L.E., Kimbel, W.H., 2016. Cranial vault thickness in primates: *Homo erectus* does not have uniquely thick vault bones. Journal of Human Evolution. 90, 120–134. [4] Beaudet, A., Carlson, K.J., Clarke, R.J., de Beer, F., Dhaene, J., Heaton, J.L., Pickering, T.R., Stratford, D., 2018. Cranial vault thickness variation and inner structural organization in the StW 578 hominin cranium from Jacovec Cavern, South Africa. Journal of Human Evolution. 121, 204–220. [5] Beaudet, A., Heaton, J.L., L'Abbé, E.N., Pickering, T.R., Stratford, D., 2018. Hominin cranial fragments from Milner Hall, Sterkfontein, South Africa. South African Journal of Science. 114, 1-6.

Poster Presentation Number 9, Session 1, Thursday 18:00 – 19:30

The contribution of Electron Spin Resonance dating for extending the human timeline in West Africa

Eslem Ben Arous[1,2,3], Mark D. Bateman[4], Mathieu Duval[1,5,6], Khady Niang[2,7], Eleanor Scerri[2,8,9]

1 - Centro Nacional de Investigación sobre la Evolución Humana, Burgos, Spain · 2 - Max Planck Institute of Geoanthropology, Human Palaeosystems Research Group, Jena, Germany · 3 - Museum national d'Histoire naturelle, Histoire naturelle de l'Homme préhistorique, Paris, France · 4 - University of Sheffield, Department of Geography, Sheffield, United Kingdom · 5 - Australian Research Centre for Human Evolution (ARCHE), Griffith University, Brisbane, Australia · 6 - Palaeoscience Labs, Dept. Archaeology and History, La Trobe University, Melbourne Campus, Bundoora, 3086, Victoria, Australia · 7 - Université Cheikh Anta Diop de Dakar, Dakar, Senegal · 8 - University of Cologne, Institute of Prehistoric Archaeology, Cologne, Germany · 9 - University of Malta, Department of Classics and Archaeology, Msida, Malta

West Africa still remains an enigmatic region for understanding human evolution in Africa because of the lack of palaeoanthropological, archaeological and palaeoenvironmental data. Recently-excavated Middle Stone Age (MSA) and Later Stone Age (LSA) sites have started to fill this knowledge gap in the region [1-4] , but there is still a critical need for reliable chronometric dates to establish a secure timeline for the MSA.

Dating West African sites is difficult because well-established dating methods like Radiocarbon, Uranium-series, or Argon-Argon cannot be used in the absence of suitable material (e.g., bones, charcoal, shells, calcite, volcanic minerals). In contrast, quartz is systematically available at all the West African Stone Age sites, opening the possibility to use other methods such as Luminescence, Electron Spin Resonance (ESR) or Cosmogenic radionuclides. The standard Optically Stimulated Luminescence (OSL) applied on quartz has been almost exclusively used as the main alternative dating method to provide chronology for this region. Application of multiple dating methods is an important step to consolidate the chronological framework for the region, and helps to support the reliability of either method for application in the region in the future.

In this context, the Marie Skłodowska-Curie Actions-funded 'WATIME' project (West African Middle Stone Age Timeline using ESR dating of quartz) specifically aims to contribute to the timeline of early MSA and MSA sites in West Africa located in various current ecoregions (tropical forest, savannah, ...) through the application of the ESR method applied to optically-bleached quartz grains. While this key alternative method can provide a numerical age on the exact same material as OSL (i.e. quartz grains), and can potentially date back to between ~1-2 Ma [5], it has nevertheless never been used in West Africa.

The poster aims to present, using examples of work in progress, the potential of ESR dating to establish the chronology of key early MSA and MSA sites in West Africa, based on a comparison of ESR and OSL dating results. The implications of these results for human evolution will be discussed.

Eslem Ben Arous' postdoctoral research has received funding from the Fyssen Foundation and the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 101107408.

References: [1] Douze, K., Lespez, L., Rasse, M., Tribolo, C., Garnier, A., Lebrun, B., Mercier, N., Ndiaye, M., Chevrier, B., Huysecom, E., 2021. A West African Middle Stone Age site dated to the beginning of MIS 5: Archaeology, chronology, and paleoenvironment of the Ravin Blanc I (eastern Senegal). Journal of Human Evolution/Journal of Human Evolution. 154, 102952. [2] Niang, K., Blinkhorn, J., Bateman, M.D., Kiahtipes, C.A., 2023. Longstanding behavioural stability in West Africa extends to the Middle Pleistocene at Bargny, coastal Senegal. Nature Ecology & Evolution. 7, 1141–1151. [3] Ndiaye, M., Lespez, L., Tribolo, C., Rasse, M., Hadjas, I., Davidoux, S., Huysecom, É., Douze, K., 2024. Two new Later Stone Age sites from the Final Pleistocene in the Falémé Valley, eastern Senegal. PloS One. 19, e0294346. [4] Schmid, V., Douze, K., Tribolo, C., Martinez, M.L., Rasse, M., Lespez, L., Lebrun, B., Hérisson, D., Ndiaye, M., Huysecom, E., 2021. Middle Stone Age bifacial technology and pressure flaking at the MIS 3 site of Toumboura III, eastern Senegal. African Archaeological Review. 39, 1–33. [5] Duval, M., Arnold, L.J., Rixhon, G., 2020. Electron spin resonance (ESR) dating in Quaternary studies: evolution, recent advances and applications. Quaternary International. 556, 1–10.

Poster Presentation Number 10, Session 1, Thursday 18:00 – 19:30

Éboulis clast size variations as a frost weathering proxy at Lapa do Picareiro, Portugal

Michael Benedetti[1], Ilona Benedetti[1], Abaigeal Sims-Clark[1], Zoe Collins[1], Dylan White[1], Corinna Santariga[1], Lukas Friedl[2], Jonathan Haws[3]

1 - University of North Carolina Wilmington · 2 - University of West Bohemia · 3 - University of Louisville

Limestone clasts derived from frost weathering (or éboulis) are a common feature of Pleistocene caves that comprise a large proportion of the Paleolithic archaeological record in the middle and high latitudes. Clast size and shape parameters may contain important information on site formation processes and paleoenvironmental conditions, but characterization of clast size is usually rudimentary, employing simplified sketches or broad estimates of modal size. A qualitative approach can succeed in identifying anomalously coarse or fine layers, but more detailed quantitative data are needed if clast size is to be used as a paleoclimate proxy. Unfortunately, clast size depth trends are complicated by methodological difficulties, including disparities between diameter/volume/weight metrics, the destructive nature of sampling, and irregularities in the lateral continuity and homogeneity of strata.

Here we quantify depth variations in clast size at the Paleolithic cave site of Lapa do Picareiro, Portugal. The site contains a >10 m thick sequence of muddy éboulis fill deposited continuously between 9-75 ka, with rich faunal records and a sequence of Middle and Upper Paleolithic human occupations. Limestone clasts typically comprise 65-99% of the sedimentary fill, with modal clast diameters in the range of 25-150 mm [1]. Semi-periodic variations in clast size (alternating coarser/finer beds) appear to mimic the frequency of Late Pleistocene stadial/interstadial climate change. Most of the clasts are presumed to derive from frost weathering of the cave roof and walls during the Pleistocene.

Clast size measurements were collected through a 2.8 m vertical section in archaeological Levels T through II, which are dated by radiocarbon to roughly 25-45 ka and coincide with documented Aurignacian and Gravettian occupations at the site [2]. Three methods of clast size measurement were tested. The "large clast method" is a simple field technique using a ruler to measure the long axis of the 5 largest clasts visible in each 10 cm depth interval of the profile wall. The "screen method" (applied to Levels T-Y only) consists of passing a representative fraction of the sediment removed during excavation through a series of sieves (2-75 mm mesh) to obtain a particle size distribution by weight. The "photogrammetry" method measures the long axis of all visible clasts in a 25 cm-wide section of the profile wall from digital orthophotos. Each method provides unique benefits and drawbacks, with the large clast method being the simplest to employ, the screen method being the most geologically valid, and the photogrammetry method producing the most detailed data set.

All three methods identify levels V, Y, BB, and GG as coarse clast layers (median >40 mm, maximum up to 550 mm), representing intense frost weathering during cold stadials and Heinrich Events. Radiocarbon ages indicate Level V was deposited during HE3, and Level GG during HE4. The levels representing warm stadials (including W, FF) contain smaller clasts and greater fine sediment content, suggesting less intense frost action and increased infiltration through karst openings. These data provide context for ongoing archaeological excavation at the site and complement other paleoenvironmental reconstructions from magnetic susceptibility, geochemistry, and faunal evidence. The earliest Aurignacian occupation at the site occurs within the coarse clast sequence of Levels GG-HH-II, during or slightly predating the cold interval of HE4. The earliest Gravettian occurs among muddy small clasts and abundant small animal bones in Level X, during a warm interval shortly before HE3.

Geoarchaeological research at Lapa do Picareiro has been supported by grants from the U.S. National Science Foundation (BCS-2150625, BCS-2150662).

References: [1] Benedetti, M.M., Haws, J.A., Bicho, N.F., Friedl, L., Ellwood, B.B., 2019. Late Pleistocene site formation and paleoclimate at Lapa do Picareiro, Portugal. Geoarchaeology. 34, 698–726. [2] Haws, J.A., Benedetti, M.M., Talamo, S., Bicho, N., Cascalheira, J., Ellis, M.G., Carvalho, M.M., Friedl, L., Pereira, T., Zinsious, B.K., 2020. The early Aurignacian dispersal of modern humans into westernmost Eurasia. Proceedings of the National Academy of Sciences. 117, 25414–25422.

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

Re-evaluation of cephalopelvic fit across primates shows that humans are not the odd ones out

Lia Betti[1], Eishi Hirasaki[2], Todd C. Rae[3], Stefan Schlager[4], Nicole Torres-Tamayo[1,5]

1 - Department of Anthropology, University College London, London, United Kingdom · 2 - Center for the Evolutionary Origins of Human Behavior, Kyoto University, Inuyama, Japan · 3 - School of Life Sciences, University of Sussex, Brighton, United Kingdom · 4 - Department of Oral and Maxillofacial Surgery, University Medical Center, Freiburg, Germany · 5 - Institute of Evolutionary Medicine, University of Zurich, Zurich, Switzerland

Human childbirth is challenging because of the similar size of the head of the neonate and the mother's birth canal (tight cephalopelvic fit). Other large-bodied apes display a larger birth canal relative to the size of the fetus. Human cephalopelvic proportions are hypothesised to result from two opposing evolutionary trends: adaptation to bipedalism, requiring a more compact pelvic girdle, coupled with an increase in encephalization. This 'obstetric dilemma' narrative, ubiquitous in the literature of human evolution, anatomy, and even midwifery and obstetrics, is often supported by a graphic representation of the relationship between head and canal size by Adolf H. Schultz [1], showing the unique condition of humans among other large-bodied apes, but also relatively tight cephalopelvic fit in gibbons and some monkeys.

This visually effective (but relatively simple) graphic depiction of cephalopelvic fit, with the neonate head represented by a filled circle within the larger empty circle of the mother's canal, has some drawbacks, however. The birth canal dimensions used are based on human standard measurements, which do not always capture obstetrically-relevant dimensions of other primates due to differences in overall pelvic shape. Moreover, using only two linear dimensions (transverse and sagittal) does not account for the complex and variable shape of the canal in different species, nor does it accurately estimate the space available for the passage of a neonate.

To reevaluate the standard cephalopelvic fit model, 3D models of the female pelvis of 14 primate species (minimum three individuals per species), obtained from surface and CT scans of skeletal and full-body specimens, were used to characterise the size and shape of the birth canal in humans and other primates. Using landmarks and semi-landmarks on the pelvic girdle creates a more realistic depiction of the obstetrically-relevant aspects of the maternal birth canal and allows a more accurate comparison of its size and shape with neonatal head dimensions for each species. Using species-specific obstetric dimensions, instead of human standard linear measurements, returned significantly smaller estimated sizes of the canal in most non-human primates. Large-bodied apes stand out as having particularly low cephalopelvic proportions with ample space for the passage of the neonate. While humans show a substantially tighter cephalopelvic fit than other apes, they experience a more comfortable fit than many other primates. Squirrel monkeys (*Saimiri sciureus*) in particular, and small-bodies primates such as marmosets (*Callithrix jacchus*) and Senegal bushbabies (*Galago senegalensis*), suffer from a much higher cephalopelvic disproportion than humans. The estimation of cephalopelvic fit is affected by what head diameters are used, with a flexed or extended head positions providing a more comfortable passage in all species.

These results suggest that humans are far from unique in experiencing a tight cephalopelvic fit during birth, with some primates showing substantially higher disproportion. What appears to be unusual is the larger birth canal space available to the neonates of other large-bodied apes. Thus, the human condition can be interpreted as an autapomorphic trait within Hominidae, following human-specific adaptations in the pelvis and cranium; the evolutionary factors that led to the extremely tight fit experienced by some other primate species, and the evolution of an unusually ample birth canal in early hominids, are unclear at present.

For the access to specimens and CT scans, we wish to thank: California National Primate Research Center (University of California Davis), Duke Lemur Centre (Duke University, Durham), Natural History Museum (London), Powell-Cotton Museum (Birchington-on-Sea), Royal Belgian Institute of Natural Science (Brussels), Musée National d'Histoire Naturelle (Paris), Naturhistorisches Museum (Vienna), Museum fur Naturkunde (Berlin), American Museum of Natural History (New York), Smithsonian National Museum of Natural History (Washington), Field Museum (Chicago), Staatliches Museum für Naturkunde (Stuttgart), University Museum of Zoology (University of Cambridge), Oxford University Museum of Natural History (Oxford), University of Zurich (Zurich), Morphosource. Special thanks to Tim Smith and Valerie DeLeon (Slippery Rock University of Pennsylvania) for sharing scans of neonates of different primate species. The study was only possible thanks to funding from the Kyoto University Primate Research Institute Cooperative Research Programme (project title: Positional, dimorphic and obstetric influences on pelvic shape in primates), the Sasakawa Foundation Butterfield Awards for UK-Japan collaboration in medical research and public health practice (grant B130 - Positional, dimorphic and obstetric influences on human pelvic shape), Synthesys (grants BE-TAF-8273 and FR-TAF-8393) and the Leverhulme Trust (Project grant RPG-2021-130 - Solving the evolutionary puzzle of human childbirth).

References: [1] Schultz, A.H., 1949. Sex differences in the pelves of primates. American Journal of Physical Anthropology. 7, 401–424.

Poster Presentation Number 11, Session 1, Thursday 18:00 – 19:30

Did Neanderthals grip tools in the same way as humans? Potential insights from bone functional adaptation in the distal capitate

Emma E. Bird[1,2,3], Christopher J. Dunmore[3], Tracy L. Kivell[2]

1 - Centre for Human Evolution Research, Natural History Museum, London · 2 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology · 3 - School of Anthropology and Conservation, University of Kent

How and why human tool use differs from that of other animals is a key question in human evolution research. Although the human hand is highly dexterous, only a small number of grips are frequently used when modern humans make and use Lower Palaeolithic stone tools [1-2]. Pressure distribution studies during stone tool behaviours show that these postures result in distinct forces acting on the hand whereby loading is generally higher on the thumb, index and middle fingers relative to the other fingers [3]. It has therefore been hypothesised that Neandertals, which have more *Homo sapiens*-like hand morphology compared with earlier fossil hominins, and who habitually used stone tools, would have used similar grips and experienced similar loading [2]. However, due to differences in capitate-metacarpal articulations between Neandertals and recent *H. sapiens*, others have suggested that Neandertals may have gripped tools and loaded their hands differently [4]. Here, we analyse the functional signals within the internal bone structure of the distal capitate to help clarify potential differences in habitual manipulation between Neandertals and *H. sapiens*.

We tested whether Neandertals (n=4) have a mean relative total bone volume (trabecular and cortical) to total volume (rTBV/TV) distribution that differs from recent (n=28) and fossil (n=4) *H. sapiens* using canonical holistic morphometric analysis (cHMA) [5]. cHMA builds a canonical capitate model onto which each individual is deformed, allowing statistical comparisons of the rTBV/TV distribution between taxa. We conducted a Principal Component Analysis (PCA) on the rTBV/TV distribution within each distal capitate and compared group differences using permutational MANOVAs on PC scores of the first three components and report the Euclidian distances between group centroids.

The centroids of fossil *H. sapiens* and Neandertals both fell within the range of variation of recent *H. sapiens*, while there was no overlap between the Neandertal and fossil *H. sapiens* range of variation. The MANOVA result indicated the distribution of rTBV/TV was not statistically different ($p=0.082$). The Euclidian distance between the recent and fossil *H. sapiens* centroid (3.169) was smaller than between recent *H. sapiens* and Neandertals (8.764), with the distance between Neandertals and fossil *H. sapiens* falling in the middle (6.343). A qualitative assessment of the mean rTBV/TV distribution for each group suggests subtle loading differences between Neandertals and *H. sapiens*. Higher rTBV/TV at the radial and ulnar aspects of the distal capitate in Neandertals may suggest greater transverse loading through the wrist compared to more oblique loading arising from the second digit in *H. sapiens*, although rTBV/TV was not significantly different.

These results indicate areas for further investigation. The Neandertal centroid fell within recent *H. sapiens* variation but was separated from fossil *H. sapiens*. This potentially suggests that recent *H. sapiens* are employing greater grip diversity compared to the Neandertal or fossil *H. sapiens* individuals included here, while the latter two potentially use more limited or specialised grips, which are different from one another. Although no statistical differences were detected in this study, the inclusion of recent *H. sapiens* with known occupation would help to determine whether grip type was more restricted in Neandertals or fossil *H. sapiens*, or an artefact of small sample size.

This research was supported by a 50th Anniversary Research Scholarship, University of Kent and the Calleva Foundation (EEB), FP7 European Research Council Starting Grant #336301, European Union's Horizon 2020 research and innovation programme Grant #819960 and the Max Planck Society (MMS, TLK). For providing access to the specimens, we would like to acknowledge: G. Haszprunar, Bavarian State Collection of Zoology; F. Mayer and C. Funk, Berlin Museum für Naturkunde; T. Biers and M. Mirazon Lahr, the Duckworth Collection, University of Cambridge; V. Volpato and K. Krohmann, Frankfurt Senckenberg Museum; B. Groβkopf, Georg-August-University Goettingen, Anthropology Collection; A. Hildred, the Mary Rose Trust; C. Boesch, Max Planck Institute for Evolutionary Anthropology; A. Rosas, Paleoanthropology Group, Museo Nacional de Ciencias Naturales -Consejo Superior de Investigaciones Científicas (CSIC), Madrid, Spain; I. Livne, Powell-Cotton Museum; E. Gilissen and W. Wendelen, Royal Museum for Central Africa; I. Herskovitz, Tel Aviv University; J. Moggi-Cecchi and S. Bortoluzzi, University of Florence; M. Teschler-Nicola and R. Muehl, Vienna Natural History Museum. For technical support we thank S. Bachmann, TU Wien. For microCT scanning, we thank R. Freeney, P. Schoenfeld, A. Silvester, K. Smithson, N. Stephens, H. Temming, Z. Tsegai, and A. Winzer.

References: [1] Marzke, M.W., 1997. Precision grips, hand morphology, and tools. American Journal of Physical Anthropology. 102, 91–110. [2] Key, A., Merritt, S.R., Kivell, T.L., 2018. Hand grip diversity and frequency during the use of Lower Palaeolithic stone cutting-tools. Journal of Human Evolution. 125, 137–158. [3] Williams-Hatala, E.M., Hatala, K.G., Gordon, M., Key, A., Kasper, M., Kivell, T.L., 2018. The manual pressures of stone tool behaviors and their implications for the evolution of the human hand. Journal of Human Evolution. 119, 14–26. [4] Niewoehner, W.A., 2001. Behavioral inferences from the Skhul/Qafzeh early modern human hand remains. Proceedings of the National Academy of Sciences. 98, 2979–2984. [5] Bachmann, S., Dunmore, C.J., Skinner, M.M., Pahr, D.H., Synek, A., 2022. A computational framework for canonical holistic morphometric analysis of trabecular bone. Scientific Reports. 12, 5187.

Poster Presentation Number 12, Session 1, Thursday 18:00 – 19:30

First genome-wide aDNA data for Late Upper Palaeolithic individuals in southeastern Europe

Dušan Borić[1,2,3], Mateja Hajdinjak[4,5], Clive Bonsall[6], Adina Boroneant[7], Andrei Soficaru[8], Adisa Lepić[9], T. Douglas Price[10], Kevin Uno[11], Kristine Korzow Richter[11], Alana Masciana[12], Francesca Alhaique[13], Antonio Tagliacozzo[14], Cosimo Posth[15], Orhan Efe Yavuz[15], David Reich[11,16]

1 - Dept. of Environmental Biology, Sapienza U. of Rome, Rome, Italy · 2 - Dept. of Anthropology, New York University, New York, USA · 3 - The Italian Academy for Advanced Studies in America, Columbia U., New York, USA · 4 - Eva Dept. of Evolutionary Genetics, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 5 - Ancient Genomics Laboratory, The Francis Crick Institute, London, UK · 6 - School of History, Classics and Archaeology, U. of Edinburgh, UK · 7 - "Vasile Pârvan" Institute of Archaeology, Romanian Academy, Bucharest, Romania · 8 - Dept. of Paleoanthropology/Human Osteology, Institute of Anthropology, Bucharest, Romania · 9 - National Museum of Bosnia and Herzegovina, Zmaja od Bosne, Sarajevo, Bosnia and Herzegovina · 10 - Dept. of Anthropology, U. of Wisconsin-Madison, USA · 11 - Dept. of Human Evolutionary Biology, Harvard U., Cambridge, USA · 12 - Lamont-Doherty Earth Observatory of Columbia U., New York, USA · 13 - Museo delle Civiltà, Rome, Italy · 14 - Museo delle Civiltà, Rome, Italy · 15 - Archaeo- and Palaeogenetics group, Institute for Archaeological Sciences, Dept. of Geosciences & Senckenberg Centre for Human Evolution and Palaeoenvironment, U. of Tübingen, Tübingen, Germany · 16 - Dept. of Genetics, Harvard Medical School, Boston, USA

With the only exception of a lone Epigravettian burial from the site of Climente II in the Danube Gorges region of Romania, there are currently no other Gravettian- and/or Epigravettian-age articulated burials dating to the late Pleniglacial and the final phases of the Pleistocene in southeastern Europe. This lack of evidence stands in stark contrast to various other regions of southern, central, western, and eastern Europe. To rectify this gap in our understanding of the genetic history of the last Ice Age foragers in this region of Europe, apart from the articulated burial from Climente II, we have analyzed genome-wide data from another two individuals from the same site. One of these individuals was confirmed as human on the basis of collagen peptide-fingerprinting known as Zooarchaeology by Mass Spectrometry (ZooMS). ZooMS has also been applied in the recovery of human remains from the bone assemblages previously excavated at the Epigravettian sites of Badanj in Bosnia and Herzegovina and Grotta Romanelli in southern Italy. DNA was extracted from micro-samples of between 10.1 and 34.8 mg and converted into single-stranded DNA libraries. An aliquot of each library was subsequently enriched for mitochondrial DNA and sites across the genome were informative for the population relationships with other present-day and ancient modern humans, as well as Neandertals and Denisovans. We successfully extracted authentic ancient DNA (aDNA) from the Climente II, Badanj, and Grotta Romanelli individuals, and reconstructed their full mitochondrial (mtDNA) genomes to between 63 and 319-fold coverage. These reconstructed mtDNA sequences fall within the human haplogroups U5b and K1, respectively. The abovementioned samples have also been directly AMS-dated, falling into the period between c. 16,500 to 13,000 cal BP and analyzed for carbon and nitrogen stable isotope values. The mean δ13C value is –18.9±0.7 per mille (min δ13C=–18.2 per mille; max δ13C=–19.7 per mille) while the mean δ15N value is 14.7‰±3.1 (min δ15N=11.1; max δ15N=18.6 per mille). For the first time, these data provide us with information about the genomic ancestry and population affinities among different Late Upper Palaeolithic forager groups in southeastern Europe, and how these groups relate to other populations across Europe.

This research program and related results were made possible by the support of the NOMIS Foundation to D.B.

Poster Presentation Number 13, Session 1, Thursday 18:00 – 19:30

Recovering ancient DNA from sediments and skeletal remains to study the Neandertals from Teixoneres Cave

Alba Bossoms Mesa[1], Jordi Rosell[2,3], Ruth Blasco[2,3], Florent Rivals[2,3,4], Anna Rufà[5,6], Stefano Benazzi[7], Anna Schmidt[1], Yaniv Swiel[1], Stéphane Peyrégne[1], Janet Kelso[1], Matthias Meyer[1]

1 - Department of Evolutionary Genetics, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 2 - Departament d'Història i Història de l'Art, Universitat Rovira i Virgili (URV), Tarragona, Spain · 3 - Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Tarragona, Spain · 4 - Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain · 5 - Interdisciplinary Center for Archaeology and Evolution of Human Behaviour (ICArEHB), Universidade do Algarve, Faro, Portugal · 6 - Université de Bordeaux, CNRS, MCC, PACEA - UMR 5199, Pessac, France · 7 - Dipartimento di Beni Culturali, Università di Bologna, Ravenna, Italy

Archeological investigations at Teixoneres Cave (Spain) have revealed a pattern of repeated short-term human occupations of the site during the Middle and Late Pleistocene. In total, eight stratigraphic units have been identified: the uppermost unit has been dated with the uranium-thorium method to 16 - 14 ka, whereas the lower levels are older than 209 ka as determined by luminescence dating [1]. Even though Teixoneres has yielded a rich record of zooarchaeological and lithic remains, human skeletal remains are scarce. In this work, we aim to gain genetic insights about the past occupants of Teixoneres Cave using DNA extracted from both skeletal remains and sediments, taking advantage of the complementary strengths and weaknesses of both sources. On the one hand, while skeletal remains have the potential to generate high-resolution data, they are rare and only represent discrete points in time. In contrast, sediments can preserve human DNA from a succession of layers in a site [2-3], but in small quantities and with the inherent challenges of metagenomic samples.

We sampled a mandible fragment (TX-103, identified through ZooMS) and a clavicle fragment (identified based on its morphology), both unearthed from layer III-b3 (dated to >60 kya). After extracting their DNA and preparing single-stranded libraries, we performed hybridization capture to enrich for mitochondrial DNA (mtDNA), for 6.91 megabases of the Y chromosome, and for ~700,000 positions throughout the nuclear genome that are informative about Neandertal population history. For sediment DNA analysis, we collected 84 samples from levels II to VII (from 33 to >209 kya) [1], and used ~50 mg of each to generate single-stranded libraries. These were then enriched for human mtDNA and mammalian mtDNA.

While the clavicle fragment showed no evidence for the preservation of ancient human DNA, Neandertal DNA could be retrieved from TX-103. Because of the high levels of modern human DNA contamination in TX-103 (63% in the mtDNA and 30% in the nuclear genome), we restricted our analyses to sequences with ancient damage patterns, resulting in an average mtDNA coverage of 41-fold. In a tree with other Neandertal mtDNA sequences, the consensus mitochondrial genome of TX-103 falls into the Hohlenstein-Stadel (HST) mtDNA clade, which has previously been found only in few samples, all older than 100 kya [2,5]. Moreover, based on an average coverage of 0.27x, the Y chromosomal sequence of TX-103 falls basal to all other Neandertals Y chromosomes published to date [4]. Last, we also recovered ancient sequences from 225,000 positions in the nuclear genome. Comparing these data to the three high-quality Neandertal genomes available to date, we found that TX-103 is most closely related to Vindija 33.19, a ~50 ka-old Neandertal from Croatia, with an estimated population split time of ~128 kya between the two. These results are compatible with TX-103 belonging to a relatively old Neandertal population, who was possibly related to the HST population. However, more nuclear data and further analyses are needed to reconstruct the genetic history of TX-103 and its relationship with other Neandertals in detail.

Unfortunately, no ancient human DNA was retrieved from sediment samples from layer III-b, in which TX-103 was found. However, we identified HST-like mtDNA in one sediment sample from layer Vc. In addition, in layer IIb in the upper units of the stratigraphy, six samples yielded Neandertal mtDNA, all with high genetic affinity to the mtDNA of eastern Neandertals, including Mezmaiskaya-1 and Okladnikov-14. Although this tentatively suggests a Neandertal population replacement at Teixoneres Cave, nuclear DNA data would be needed from these sediment samples to draw firm conclusions.

In conclusion, our study demonstrates the potential of integrating DNA analysis from both bones and sediments for investigating the genetic history of the past occupants of a Palaeolithic site.

Data was produced by the Ancient DNA Core Unit of the Max Planck Institute for Evolutionary Anthropology, which is funded by the Max Planck Society.

References: [1] Zilio, L., Hammond, H., Karampaglidis, T., Sánchez-Romero, L., Blasco, R., Rivals, F., Rufà, A., Picin, A., Chacón, M.G., Demuro, M., Arnold, L.J., Rosell, J., 2021. Examining Neanderthal and carnivore occupations of Teixoneres Cave (Moià, Barcelona, Spain) using archaeostratigraphic and intra-site spatial analysis. Scientific Reports. 11, 4339. [2] Vernot, B., Zavala, E.I., Gómez-Olivencia, A., Jacobs, Z., Slon, V., Mafessoni, F., Romagné, F., Pearson, A., Petr, M., Sala, N., Pablos, A., Aranburu, A., de Castro, J.M.B., Carbonell, E., Li, B., Krajcarz, M.T., Krivoshapkin, A.I., Kolobova, K.A., Kozlikin, M.B., Shunkov, M.V., Derevianko, A.P., Viola, B., Grote, S., Essel, E., Herráez, D.L., Nagel, S., Nickel, B., Richter, J., Schmidt, A., Peter, B., Kelso, J., Roberts, R.G., Arsuaga, J.-L., Meyer, M., 2021. Unearthing Neanderthal population history using nuclear and mitochondrial DNA from cave sediments. Science. 372, eabf1667. [3] Zavala, E.I., Jacobs, Z., Vernot, B., Shunkov, M.V., Kozlikin, M.B., Derevianko, A.P., Essel, E., de Fillipo, C., Nagel, S., Richter, J., Romagné, F., Schmidt, A., Li, B., O'Gorman, K., Slon, V., Kelso, J., Pääbo, S., Roberts, R.G., Meyer, M., 2021. Pleistocene sediment DNA reveals hominin and faunal turnovers at Denisova Cave. Nature. 595, 399–403. [4] Petr, M., Hajdinjak, M., Fu, Q., Essel, E., Rougier, H., Crevecoeur, I., Semal, P., Golovanova, L.V., Doronichev, V.B., Lalueza-Fox, C., de la Rasilla, M., Rosas, A., Shunkov, M.V., Kozlikin, M.B., Derevianko, A.P., Vernot, B., Meyer, M., Kelso, J., 2020. The evolutionary history of

Neanderthal and Denisovan Y chromosomes. Science. 369, 1653–1656. [5] Posth, C., Wißing, C., Kitagawa, K., Pagani, L., van Holstein, L., Racimo, F., Wehrberger, K., Conard, N.J., Kind, C.J., Bocherens, H., Krause, J., 2017. Deeply divergent archaic mitochondrial genome provides lower time boundary for African gene flow into Neanderthals. Nature Communications. 8, 16046.

Poster Presentation Number 14, Session 1, Thursday 18:00 – 19:30

From fragments to a face: virtual reconstruction of Neanderthal cranial fragments from Vindija Cave

Marija Brdarić[1], Carolin Röding[1,2], Ivor Janković[3], Katerina Harvati[1,2,4]

1 - Paleoanthropology, Senckenberg Center for Human Evolution and Paleoenvironment, Eberhard Karls Universität Tübingen, Tübingen, Germany · 2 - Institute for Archaeological Sciences, Eberhard Karls University of Tübingen, Tübingen, Germany · 3 - Centre for Applied Bioanthropology, Institute for Anthropological Research, Zagreb, Croatia · 4 - DFG Centre of Advanced Studies 'Words, Bones, Genes, Tools', Eberhard Karls University of Tübingen, Tübingen, Germany

The paleoanthropological and archaeological site of Vindija Cave, Croatia, is known for its Pleistocene sediment sequence rich in Paleolithic artifacts and Neanderthal skeletal remains, which established Vindija among key Paleolithic sites for investigating late Neanderthal morphology. Among the skeletal remains, cranial elements are significantly overrepresented and include, but are not limited to, seven adult and three subadult frontal bones, eight young adult and adult mandibular, and two adult maxillary fragments. Since their discovery during an excavation led by Mirko Malez from 1974 to 1986, the Neanderthal cranial fragments have been extensively studied, including both from morphological and paleogenetic perspectives. However, a virtual reconstruction of these remains has yet to be attempted. This study aims to conduct the first virtual reconstruction of the Vindija Neanderthals using 3D surface scans to enhance our understanding of their morphology, to better determine the number of individuals represented in the assemblage, and to create composite representations of the cranial remains.

One of us (CR) obtained surface scans of Neanderthal remains from layer G, Vindija Cave, housed at the Institute for Paleontology and Geology in Zagreb, Croatia, with an Artec Space Spider scanner. For each fragment, a surface was extracted as triangular meshes. We conducted virtual alignment and mirror imaging in Avizo (2022.2). Previous work identified the supraorbital fragments Vi-11.1 and Vi-11.1a and the hemi-mandible fragments Vi-11.40 and Vi-11.40a as belonging to single individuals respectively. The former were already glued and scanned together, whereas the latter required a virtual alignment. All fragments preserving aspects of the midsagittal plane – five mandibular, two maxillary, and three supraorbital fragments - were mirror-imaged along this plane. This was repeated multiple times for each individual to obtain a set of biologically plausible reconstructions. La Ferrassie 1 was used as a reference for aligning mirrored mandibular fragments. A first comparative shape analysis of one of our supraorbital reconstructions [1] underlines the promise of our approach. Similar analyses will be conducted for the mandibular and maxillary reconstructions. In addition, five fragments of right frontal bones were mirror-imaged to assess shape similarities between all ten supraorbital fragments and to identify fragments from the right and left cranial sides that potentially belong together.

Preliminary observations of the supraorbital fragments revealed three clusters: (I) Vi-11.1+ Vi-11.1a closely resemble Vi-11.3 in shape; (II) Vi-11.4, Vi-11.5, Vi-11.10 and Vi-11.11 exhibit similarities with each other while differing from the first cluster; and (III) the remaining three fragments Vi-11.2, Vi-11.8 and Vi-11.9 differ from all other. The most substantial shape similarities were observed between the right supraorbital fragment Vi-11.5 and the left fragment Vi-11.4. These have been described as late juvenile to young adult and juvenile, respectively. However, their degree of similarity suggests that they may belong to the same individual, warranting further analysis. The preliminary exploratory analysis of morphological variation in the supraorbital torus indicated seven as minimum number of individuals represented.

Composite reconstructions from the Vindija fragments include mirror-imaged reconstructions of mandibles, maxillae, and supraorbital tori in combination with the zygomatic bone Vi-11.6 in approximate anatomical position. Such composite reconstructions will be informed by exploratory analysis of morphological variation as described above, provide a more intuitive understanding of the specimens' morphology and variation, and a striking visualization for possible use in scientific communication and outreach.

This research was supported by the ERC AdG FIRSTSTEPS (101019659) and COST Action CA19141 - Integrating Neandertal Legacy: From Past to Present (iNEAL). We thank the Institute for Paleontology and Geology in Zagreb, Croatia, for access to the original Vindija specimens.

References: [1] Röding, C., Janković, I., Harvati, K., (submitted abstract). Vindija: a new look at the frontal bone morphology.

Poster Presentation Number 15, Session 1, Thursday 18:00 – 19:30

A collective investigation of the non-adult specimens from the Rising Star Cave System, South Africa

Juliet K. Brophy[1,2], Debra R. Bolter[2,3,4], Marina Elliott[2,4], John Hawks[2,5]

1 - Department of Geography and Anthropology, Louisiana State University, LA, USA · 2 - The Centre for the Exploration of the Deep Human Journey, University of the Witwatersrand, South Africa · 3 - Department of Anthropology, Modesto Junior College, Modesto, CA, USA · 4 - Department of Anthropology, California State University Stanislaus, Turlock, CA, USA · 4 - Department of Archaeology, Simon Fraser University, Burnaby, British Columbia, Canada · 5 - Department of Anthropology, University of Wisconsin-Madison, Madison, WI, USA

This research is part of an on-going project featuring the non-adult *Homo naledi* specimens from the Rising Star Cave system, South Africa. The number of individuals represented in the cave system is currently at 29, 18 of which are non-adult. These individuals have been recovered from four regions inside the cave: Dinaledi Chamber, Lesedi Chamber, Hill Antechamber and U.W. 110. Previous research focused on the craniodental material from six early-aged juveniles [1-2]. This current study broadens the focus to investigate additional non-adult specimens and a larger age range. The infant category is broadly defined by a lack of permanently erupted teeth, which we estimate represents individuals younger than 5.0-6.6 years old based on human standards. The juvenile life stage is divided into two categories. The early juvenile life stage includes individuals whose first molar has erupted. We estimate this life stage to include individuals at least 5.0-6.6 years old. The late juvenile life stage is defined by the second molar eruption, which we estimate includes individuals at least 9.9-14.5 years. The sub-adult category is defined by erupted but unworn third molars, which we approximate includes individuals at least 16.1-19.6 years old. We analyzed the non-adult remains using dental use wear, interproximal and occlusal facets, developmental stages and size and spatial proximity of 108 teeth, and analyses of developmental stages, spatial locations, and distribution of refits of 228 skeletal elements. We identified partial materials for four infants, six early juveniles, five late juveniles, one sub-adult and two individuals either in the late juvenile or sub-adult age class. In the Dinaledi Chamber, the immatures are spatially distributed, which aids in making associations. The data reveal a cluster of 4 individuals including three early juveniles and one infant on the surface in Area 4. These specimens are considered to be 14.5 years or younger. Nearby on the chamber floor's surface, one sub-adult has been identified. From slightly farther away in Areas 2, 3 and 9 and under the soil, two infants and one early juvenile were found. In addition, all three late juveniles were recovered at least 4 cm below sediment from this region of the Chamber. In other regions of the cave system, U.W. 110 and Lesedi Chamber contained two early juvenile craniodental fragments that were found as surface finds. For the Lesedi early juvenile, the majority of craniodental material was recovered from a ledge in the cave wall while postcranial material was recovered in an adjacent passage around the corner. In the Hill Antechamber a cluster of mixed immatures from at least four individuals were recovered near the bottom of the "chute" which is the vertical entrance into the Hill Antechamber and adjacent Dinaledi Chamber. The increasing number of non-adult specimens excavated throughout the Rising Star cave system provides a robust paleodemographic profile of 18 non-adult *Homo naledi*, along with an additional 11 adults, ranging in representation from a single tooth to partial skeletons. The homogeneity of the paleodeme in their metric and non-metric dental traits offers a solid foundation to approach this assemblage as a localized hominin population, of which we now have identified multiple individuals across maturity stages.

References: [1] Brophy, J.K., Elliott, M.C., De Ruiter, D.J., Bolter, D.R., Churchill, S.E., Walker, C.S., Hawks, J., Berger, L.R., 2021. Immature hominin craniodental remains from a new locality in the Rising Star Cave System, South Africa. PaleoAnthropology. 2021. [2] Brophy, J.K., Bolter, D.R., Elliott, M., Hawks, J., Berger, L.R., 2024. An examination of *Homo naledi* early juveniles recovered from the Rising Star cave system, South Africa. Annals of Human Biology. 51, 1-11.

Poster Presentation Number 16, Session 1, Thursday 18:00 – 19:30

The search for the perfect proxy? A comparison of the effect of hybridisation in two non-human primate models for hominin evolution

Laura T. Buck[1,2], Rebecca Rogers Ackermann[3,4], Talha Ebrahim[1], Eishi Hirasaki[5], Tsuyoshi Ito[6], Sree Kanthaswamy[7], David C. Katz[8], Yoshi Kawamoto[9], Aurélien Mounier[10,11,12], Takeshi Nishimura[13], Chris B. Stringer[14], Timothy D. Weaver[2]

1 - Research Centre for Evolutionary Anthropology and Palaeoecology, Liverpool John Moores University, UK · 2 - Department of Anthropology, University of California Davis, USA · 3 - Department of Archaeology, University of Cape Town, South Africa · 4 - Human Evolution Research Institute, University of Cape Town, South Africa · 5 - Centre for the Evolutionary Origins of Human Behaviour, University of Kyoto, Japan · 6 - The Kyoto University Museum, Kyoto University Japan · 7 - School of Mathematics and Natural History, Arizona University, USA · 8 - Cell Biology and Anatomy, University of Calgary Cumming School of Medicine, Canada · 9 - Nippon Veterinary and Life Sciences University, Toyko, Japan · 10 - UMR 7194 HNHP, Musée de l'Homme, Paris, France · 11 - Turkana Basin Institute, Nairobi, Kenya · 12 - CNRS, UAR 3129 – UMIFRE 11 3, Maison Française d'Oxford, Oxford, UK · 13 - The Graduate School of Human Sciences, Osaka University, Japan · 14 - The Natural History Museum, London, UK

Research shows multiple interbreeding events with extinct taxa in the *Homo sapiens* lineage [1]. The effect this had on skeletal phenotype is uncertain, hindering our ability to identify hybrids in the fossil record and our understanding of the adaptive potential of hybridisation during human evolution. Since the confirmed hominin fossil sample is extremely limited and fragmentary, using non-human primate models can facilitate this investigation [2]. We require non-human primate comparisons that are a good fit for hybridising hominins (e.g., *H. sapiens* x Neanderthals) and the circumstances of their hybridisation, and various non-human primates may make good candidates.

Here we compare the effects of hybridisation on the pelvic morphology of two potential hominin hybrid proxies: Chinese x Indian rhesus macaques, and Japanese x Taiwanese macaques. The rhesus macaques have a similar divergence time to humans / Neanderthals but are captive-bred and the parental taxa are phenotypically more similar than the hominin pair [3]. In contrast, the Japanese / Taiwanese macaques were wild [4] and show greater phylogenetic and phenotypic divergence than the rhesus macaques. The relationship between pelvic morphology and hybridisation is important because of the requirement for congruence between the maternal birth canal and foetal cranium for successful parturition. We use 3D landmark-based GMM to capture the relationship between shape and admixture in two large samples of CT and surface scan data from macaque hybrids with a wide range of admixture and multiple generations of interbreeding.

In the rhesus macaques, we have shown a subtle, linear relationship between admixture and pelvic shape, with no transgressive individuals. We now analyse the Japanese / Taiwanese macaque hybrids for comparison. Initial results suggest these hybrids show greater pelvic shape similarity with Japanese full-breds than expected based on their admixture percentage. This supports previous work on cranial shape in these hybrids [5].

Potential explanations for this pattern include selection for the phenotype better adapted to local conditions (Japanese), or purifying selection of input from a more inbred, historically captive population (Taiwanese). As with the rhesus macaques, no hybrid shapes appear transgressive despite the greater disparity between these parental taxa. Our work highlights the complexity of factors that must be considered to model hybridisation in hominins and the importance of proxy choice.

Rhesus macaque research: Funding was provided by NSF grants #1623366 and #1720128 and The Leakey Foundation. RRA is supported by the National Research Foundation of South Africa (Grant No. 136512). We thank the CNPRC for data collection and acknowledge the NIH funding to the center (P51 0D011107). We thank Leslea Hlusko for her involvement with this project, and Sara Jhanjar and Amber Parks for their help with CT scan segmentation. Japanese / Taiwanese macaque research: Funding was provided by The Daiwa Foundation (Small Grant 13906/14740); The Great Britain Sasgawa Foundation (Ref: 6251); an Erasmus+ Training Mobility grant to LTB; and funding from School of Biological and Environmental Sciences, Liverpool John Moores University supporting TE. The research of CS is supported by the Calleva Foundation (Grant Number SDV17014) and the Human Origins Research Fund. We are very grateful to the Working Group of Wakayama Taiwanese Macaques, The Centre for the Evolutionary Origins of Human Behaviour, and the Japan Monkey Centre for their permission to work with the Japanese / Taiwanese macaque skeletal material and facilitation of data collection..

References: [1] Gokcumen, O., 2019. Archaic hominin introgression into modern human genomes. American Journal of Physical Anthropology. 171, 60–73. [2] Ackermann, R.R., Rogers, J., Cheverud, J.M., 2006. Identifying the morphological signatures of hybridization in primate and human evolution. Journal of Human Evolution. 51, 632–645. [3] Buck, L.T., Katz, D.C., Ackermann, R.R., Hlusko, L.J., Kanthaswamy, S., Weaver, T.D., 2021. Effects of hybridization on pelvic morphology: A macaque model. Journal of Human Evolution. 159, 103049. [4] Hamada, Y., Yamamoto, A., Kunimatsu, Y., Tojima, S., Mouri, T., Kawamoto, Y., 2012. Variability of tail length in hybrids of the Japanese macaque (*Macaca fuscata*) and the Taiwanese macaque (*Macaca cyclopis*). Primates. 53, 397–411. [5] Boel, C., Curnoe, D., Hamada, Y., 2019. Craniofacial Shape and Nonmetric Trait Variation in Hybrids of the Japanese Macaque (*Macaca fuscata*) and the Taiwanese Macaque (*Macaca cyclopis*). International Journal of Primatology. 40, 214–243.

Poster Presentation Number 17, Session 1, Thursday 18:00 – 19:30

The identification of fire traces in low visibility contexts. A methodological proposal applied to the Iberian Middle Pleistocene sites of Sima del Elefante and La Cansaladeta

Aitor Burguet-Coca[1,2,3], Asier Vallejo[4], Rosa Huguet[2,3], Xosé-Pedro Rodríguez-Álvarez[2,3], Andreu Ollé[2,3], Josep Maria Vergès[2,3], Amanda G. Henry[1]

1 - Leiden University, Faculty of Archaeology, Department of Archaeological Sciences, Leiden, The Netherlands · 2 - Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Tarragona, Spain · 3 - Universitat Rovira i Virgili (URV), Departament d'Història i Història de l'Art, Tarragona, Spain · 4 - Department of Analytical Chemistry, University of the Basque Country (UPV/EHU), Faculty of Pharmacy, Vitoria-Gasteiz, Spain

The use of fire is one of the most relevant milestones in human evolution, with a profound impact on human subsistence and adaptation strategies. In recent years, the state of research on the fire record, commonly referred to as pyroarchaeological record, has been advancing from diverse theoretical, analytical, and methodological perspectives, generating an intense debate regarding the significance of each type of fire evidence and its relevance for informing about the process of fire acquisition. The early evidence of the use of fire is one of the most challenging phases to examine due to the low recurrence of the fire record, its vulnerability to alteration by taphonomic processes, and the low visibility during fieldwork. Roebroeks and Villa [1] present one of the first chronological proposals on the use of fire in Europe between 400 and 300 ka, and their proposal has articulated the main debates on the use of fire during the Pleistocene [2-3].

Through our study of two Iberian sequences assigned to the late Middle Pleistocene, we aimed to (I) make a methodological proposal on how to comprehensively address the fire record in these chronologies, (II) investigate and reevaluate the indirect evidence of fire previously described at the sites of Sima del Elefante (TE19) and La Cansaladeta, and (III) evaluate the relevance of the results obtained in the context of the Iberian Peninsula.

To investigate the possible presence of fires in the archaeological record, we propose the integration of biochemical analyses (PAHs and n-alkanes) with mineralogical (FTIR) and archaeobotanical (phytolith) analyses. These techniques allow the identification of combustion residues of fire through the study of PAHs, phytoliths and the presence of pyrogenic calcite by FTIR; the thermal impact of fire through the analysis of thermally altered clays by FTIR; and the palaeoecological and depositional context through n-alkanes and phytoliths. In essence, it enables us to gain a comprehensive understanding of the pyroarchaeological record, encompassing all its parts, derived from diverse approaches, and integrating the palaeoecological and depositional context.

We present the results of phytoliths, FTIR, PAHs and n-alkanes from two relevant sequences in the Iberian Peninsula with a low visibility pyroarchaeological record, only documented partially through indirect evidence. The Cansaladeta sequence has been dated by TL, TT-OSL, and ESR/U-series methods, with internally consistent dates between 370-400 ka (MIS11) [4]. Throughout the sequence, the presence of abundant burnt lithic, burnt bones, and high concentrations of microcharcoals have been identified. Level TE19 of Sima del Elefante corresponds to the top three meters of the sequence, with a date of 266-237 ka (MIS7) obtained by the luminescence method [5]. In this unit, the unique charcoal of the sequence has been identified, together with the presence of microcharcoal peaks, and a possible thermal impact spot on the sediment.

Our results will provide new data on a series of fire evidence that has been handled throughout time without a specific study of the origin of this record, generating reliable data linked to the possible use of fire. It will also be a concrete application of a series of techniques, previously applied isolated to the study of fire in more recent contexts, providing a methodological improvement that considers the complexity of the pyroarchaeological record and its ecological and depositional environment. In the context of the Iberian Peninsula, where some of the earliest evidence has been identified, these data will be relevant to unravelling one of the longest and most complex processes in human evolution and filling the gap in the study of the Middle Pleistocene pyroarchaeological record.

This work is part of the I+D+i project PID2021-122355NB-C32, funded by MCIN/AEI/10.13039/501100011033 and by FEDER A way to make Europe, funded by Generalitat de Catalunya research projects 2021 SGR 1237 and 2021- SGR 01239 and supported by the Spanish Ministry of Science and Innovation through the María de Maeztu excellence accreditation (CEX 2019-000945-M). These results are part of A. Burguet-Coca's Fire Tools project (Marie Sklodowska-Curie Actions, HORIZON-MSCA–2021–PF-01 ID: 101063904). A. Burguet-Coca and A. Vallejo are grateful to the Palarq Foundation for funding the analysis of these two archaeological sequences..

References: [1] Roebroeks, W., Villa, P., 2011. On the earliest evidence for habitual use of fire in Europe. Proceedings of the National Academy of Sciences. 108, 5209–5214. [2] Sandgathe, D.M., Dibble, H.L., Goldberg, P., McPherron, S.P., Turq, A., Niven, L., Hodgkins, J., 2011. Timing of the appearance of habitual fire use. Proceedings of the National Academy of Sciences. 108, E298. [3] Sorensen, A.C., Claud, E., Soressi, M., 2018. Neandertal fire-making technology inferred from microwear analysis. Scientific Reports. 8, 10065. [4] Demuro, M., Arnold, L.J., Parés, J.-M., Aranburu, A., Huguet, R., Vallverdú, J., Arsuaga, J.-L., Bermúdez de Castro, J.-M., Carbonell, E., 2022. Extended-range luminescence chronologies for the Middle Pleistocene units at the Sima del Elefante archaeological site (Sierra de Atapuerca, Burgos, Spain). Quaternary Geochronology. 71, 101318. [5] Ollé, A., Vergès, J.M., Rodríguez-Álvarez, X.P., Cáceres, I., Angelucci, D.E., Vallverdú, J., Demuro, M., Arnold, L.J., Falguères, C., Bennàsar, M., López-García, J.M., Blain, H.-A., Bañuls-Cardona, S., Burjachs, F., Expósito, I., López-Polín, L., López-Ortega, E., 2016. The Middle Pleistocene site of La Cansaladeta (Tarragona, Spain): Stratigraphic and archaeological succession. Quaternary International. 393, 137–157.

Podium Presentation, Session 10, Saturday 11:00 – 12:40

Expression of the MIS 12 glacial stage in the eastern Mediterranean and its impact over the middle Pleistocene hominins in Megalopolis Basin (Greece)

Geanina A. Butiseacă[1], Iuliana Vasiliev[2], Marcel T.J. van der Meer[3], Ines J.E. Bludau[4,5], Panagiotis Karkanas[6], Vangelis Tourloukis[1,7], Annett Junginger[4,5], Andreas Mulch[2,8], Eleni Panagopoulou[9], Katerina Harvati[1,4,10]

1 - Palaeoanthropology, Institute of Archaeological Sciences, Department of Geosciences, Eberhard Karls Universität Tübingen, Tübingen, Germany · 2 - Senckenberg Biodiversity and Climate Research Centre (BiK-F), Frankfurt am Main, Germany · 3 - NIOZ Royal Netherlands Institute for Sea Research, Department of Marine Microbiology and Biogeochemistry, Den Burg, Texel, The Netherlands · 4 - Senckenberg Centre for Human Evolution and Palaeoenvironment, Tübingen, Germany · 5 - Micropaleontology, Department of Geosciences, Eberhard Karls Universität Tübingen, Tübingen, Germany · 6 - M. H. Wiener Laboratory for Archaeological Science, American School of Classical Studies at Athens, Athens, Greece · 7 - Department of History and Archaeology, University of Ioannina, Ioannina, Greece · 8 - Goethe University, Institute of Geosciences, Frankfurt am Main, Germany · 9 - Ephorate of Palaeoanthropology-Speleology, Hellenic Ministry of Culture, Athens, Greece · 10 - DFG Centre for Advanced Studies 'Words, Bones, Genes, Tools: Tracking linguistic, cultural and biological trajectories of the human past, Tübingen, Germany

Southern Europe is hypothesized to have acted as a glacial refugium for hominin populations during the Pleistocene [1]. Of particular importance is South-East Europe, which most likely played a dual role both as refugium and dispersal corridor, especially during the Middle Pleistocene glaciations, when drastic climatic conditions led to major sea level drops in the Aegean [2]. However, little is known about the paleoenvironmental conditions at the time of hominin presence in the region, making these hypotheses difficult to test. Here we analyze biomarker data of the MIS 12 Lower Paleolithic site Marathousa 1 (Megalopolis basin, Greece; [3-4]) to track changes in the environment, such as: mean air annual temperature (MAAT) and mean temperature above freezing (MAF). Additionally, we use leaf waxes (*n*-alkanes) ratios and carbon ($\delta^{13}C$) and hydrogen ($\delta^{2}H$) stable isotopic compositions to assess the climatic conditions around the time of hominin presence in the area and monitor the vegetation response to climatic changes in the basin catchment. To this extent thirty-six sedimentary rock samples were collected from the Area B profile (units UB10-UB1) and underwent standard biomarkers extraction and purification procedure. The integrated biomarker and stable isotope on leaf waxes data from Marathousa 1 (Peloponnese, Greece) cover the interval between ~485-412 ka, confirming glacial conditions in southern Greece and the Eastern Mediterranean during MIS 12 stage. Biomarker based reconstructed mean annual temperatures show a general cooling trend in the section, that culminates between ~440-432 ka, when the minimum is registered (i.e., during peak glacial conditions). The cooling trend is associated with important changes in vegetation, from more forested to more open landscape (increase in C_4 plants), as well as in water and moisture availability (i.e., lake shrinkage, dryer). Hydrogen isotope data measured on leaf waxes indicate two episodes with drier conditions in the Megalopolis basin, one peaking at ~436.8 ka and the other at ~433.2 ka. The first is associated with a warming interval during the general cold conditions, while the second with the end of the glacial maximum. Hominin presence at the end of this interval suggests that the Megalopolis basin served as a refugium for hunter-gatherer groups during periods of harsh climatic conditions. This evidence is in agreement with and complementary to other studies, showing that within the broader refugium of the Balkan peninsula, parts of the Greek mainland hosted glacial refugia for floral and faunal populations. Importantly, our data help contextualize and test previous models that have stressed the importance of the wider Aegean region as a refugial area and integral part of hominin dispersal routes within Eurasia [5].

This research was supported by DFG - 2021 Gottfried Wilhelm Leibniz Prize awarded to K. Harvati. The excavation of Marathousa 1 was conducted under the auspices of the Ephorate of Paleoanthropology and Speleology, Greek Ministry of Culture and Sports and was financed by the European Research Council (ERC-StG-283503 'PaGE' and ERC-CoG-724703 'CROSSROADS', awarded to K. Harvati). KH is additionally supported by the ERC-AdG-101019659. We thank U. Treffert for laboratory technical support.

References: [1] Harvati, K., Konidaris, G., Tourloukis, V., (Eds), 2018. Special issue: Human evolution at the gates of Europe. Quaternary International. 497. [2] Rohling, E. J., Marino, G., Grant, K. M., 2015. Mediterranean climate and oceanography, and the periodic development of anoxic events (sapropels). Earth-Science Reviews, 143, 62–97. [3] Panagopoulou, E., Tourloukis, V., Thompson, N., Konidaris, G., Athanassiou, A., Giusti, D., Tsartsidou, G., Karkanas, P., Harvati, K., 2018b. The Lower Palaeolithic site of Marathousa 1, Megalopolis, Greece: Overview of the evidence. Quaternary International. 497, 33–46. [4] Tourloukis, V., Muttoni, G., Karkanas, P., Monesi, E., Scardia, G., Panagopoulou, E., Harvati, K., 2018. Magnetostratigraphic and chronostratigraphic constraints on the Marathousa 1 Lower Palaeolithic site and the Middle Pleistocene deposits of the Megalopolis basin, Greece. Quaternary International. 497, 154–169. [5] Tourloukis, V., Karkanas, P., 2012. The Middle Pleistocene archaeological record of Greece and the role of the Aegean in hominin dispersals: new data and interpretations. Quaternary Science Reviews. 43, 1–15.

Poster Presentation Number 18, Session 1, Thursday 18:00 – 19:30

The complex geometry of the cerebellar fossae studied with EVAN Toolbox: comparison of two methods to place semilandmarks and polylines

María Asunción Cabestrero-Rincón[1]

1 - Human Cognition and Evolution, University of the Balearic Islands, Palma, Spain

The cerebellum has received growing attention in recent decades, particularly for its empirically demonstrated role in cognition [1]. Increasingly refined imaging techniques such as fMRI (functional Magnetic Resonance Imaging) or μCT-nCT (Computed Micro- and Nanotomograghy) identify areas of interest, whose detailed knowledge could be crucial to point out differences or similarities between the behavioral capabilities of extant Homo sapiens and other extinct species. EVAN Toolbox (ET), a software package developed by the European Virtual Anthropology Network – EVAN and the EVAN-Society (https://evan- society.org), is a useful tool for performing fossil shape and form analysis [2, 3]. The present study will use ET to compare two designs for placing semi-landmarks and polylines in the cerebellar areas, and it will determine which of them best discriminates the different groups of extant and fossil H. sapiens and Neanderthals, or where there is no significant difference between both methods.

We placed six landmarks on the internal occipital table of the cerebellar fossae: left and right endasterion, endinion, opisthion, and left and right cerebellar depth [4], and up to 324 semilandmarks, depending on the method. We distributed these semilandmarks along previously created polylines and on the surface of the bone, to map every small feature of these complex geometry parts. In the first method (a), polylines are drawn joining landmarks and bone structures, whereas in the second (b) the polylines closely follow the specific shape of the bone structures, leaving landmarks at outer positions. Polylines, which largely overlap in both methods, were generated in the cerebellar fossae as follows:

a) The inferior branch of the transverse sinus sulcus was followed, from the endinion to the right endasterion, to obtain Curve_Endi-EndAstR; the posterior meningeal sulcus, from the right endasterion to the opisthion, following part of the edge of the occipital bone, to obtain Curve_EndAstR-O, and the occipital crest, for Curve_O-Endi.

b) An oval was formed on each side of the bone, starting from the small curve immediately below the internal occipital protuberance, following the internal occipital crest, the sulcus for the posterior meningeal vessels and finally, the edge of the occipital bone. Each oval shape was called CurveR or CurveL, depending on the side of the occipital to which it corresponded.

The semilandmarks were evenly distributed on the polylines and on the surfaces enclosed in them. GPA (General Procustes) and PCA (Principal Components) analysis use 3D data of voxel locations.

Although both methods highlight the particularities of the cerebellar area, as was our objective, our conclusion is that the second method better discriminates between the different groups (fossil, Holocene and extant H. sapiens, and Neanderthals). PCA performed after GPA shows in the first method the greatest distance between fossil H. sapiens on the one hand and the rest of the groups on the other, but the second method shows a closer clustering of the individuals of each group and greater distances between groups. Both methods show asymmetries in some species; Specifically, the left occipital petalias are the most accentuated in fossil H. sapiens.

These results are preliminary. We are currently testing more informative ways of placing polylines and semilandmarks. This is part of an investigation into certain areas of the cerebellum that will be measured more specifically in a larger sample. We believe that the information obtained here could be complemented with other quantitative approaches such as that of Zang & Wu [5], or others that we previously tested [4]. ET provides other algorithms such as PLS (Partial Least Squares) or Regressions [2, 3] that are also important to deepen the knowledge of the cerebellar areas.

I would like to thank PhD directors Dr. F.L. Coolidge and Dr. C. Boeckx for their comments and support; Dr. A. Balzeau for CT files and comments; Dr. C. Fornai and Dr. G. Weber for helpful comments about ET.

References: [1] Coolidge, F. L. 2021. The role of the cerebellum in creativity and expert stone knapping. Adaptive Behavior, 29(2), 217-229. [2] O'Higgins, P., Weber, G.W., Baverstock, H., Prôa, M., Dunn, J., Fornai, C., 2012. Manuals for the EVAN toolbox. [3] Bastir, M., García- Martínez, D., Torres-Tamayo, N., Palancar, C.A., Fernández-Pérez, F.J., Riesco-López, A., Osborne-Márquez, P., Ávila, M., López-Gallo, P., 2019. Workflows in a Virtual Morphology Lab: 3D scanning, measuring, and printing. Journal of Anthropological Sciences. 96, 107– 134. [4] Cabestrero-Rincón, M.A., Balzeau, A., Lorenzo, C., 2018. Differential evolution of cerebral and cerebellar fossae in recent Homo: A new methodological approach. Homo. 69, 289–303. [5] Zhang, Y., Wu, X., 2021. Asymmetries of cerebellar lobe in the Genus Homo. Symmetry. 13, 988.

Poster Presentation Number 19, Session 1, Thursday 18:00 – 19:30

Human diet in central Portugal during the Middle to Upper Paleolithic Transition: the case from Lapa do Picareiro

Milena Carvalho[1], Michael Benedetti[1,2], Lukas Friedl[1,3], João Cascalheira[1], Nuno Bicho[1], Jonathan Haws[1,4]

1 - ICArEHB – Universidade do Algarve · 2 - University of North Carolina Wilmington · 3 - University of West Bohemia · 4 - University of Louisville

It used to be that differences in diet between Neanderthals and modern humans were hypothesized as a contributing factor to the disappearance of Neanderthals and success of colonizing modern humans during the Middle to Upper Paleolithic transition in Eurasia. In the last several decades, however, research has shown that diets that included small game such as rabbits, birds and tortoises were in fact a behavior observed in the *Homo* lineage as early as 400,000 ago [1], and not a behavior typical of modern humans only. One region with a limited Paleolithic archaeological record that does contain evidence of wider diet breadth (small game consumption) among Neanderthals is in central Portugal, where zooarchaeological evidence from a handful of sites dating from MIS 5 - MIS 3 suggest that Neanderthals were highly mobile, exploited coastal, estuarine, and mountainous environments, and consumed a variety of prey including marine resources (fish, crab, mollusks) tortoises, and rabbits in addition to large game [2-4]. For example, at Figueira Brava, evidence of fishing and exploitation of marine resources such as crab by Neanderthals had been observed [2]. At Gruta Nova da Columbeira, Neanderthals not only ate rabbits, but consumed marrow from long bones, particularly tibiae [3]. Though the record is fragmented and limited, this points to an ecologically plastic population of Neanderthals in central Portugal during MIS 5-3 who may have been experts at exploiting their environments. Little is known, however, about the first Upper Paleolithic human diets in central Portugal, where an early Aurignacian presence has recently been identified at Lapa do Picareiro [5]. In this poster, we present new data on human diets from late Mousterian and early Aurignacian deposits from Lapa do Picareiro, a cave site located in Portuguese Estremadura. Lapa do Picareiro has large zooarchaeological assemblages, stratigraphic integrity, chronological control, and several paleoenvironmental reconstructions making rendering it an ideal site to assess diets and human behavior during the Middle to Upper Paleolithic transition. Through taphonomic and zooarchaeological analyses, we tease out the taphonomic agents responsible for depositing the bones that formed the assemblages in levels JJ (Mousterian) and GG-II (early Aurignacian). We then assess whether: Neanderthals and modern humans consumed small game at this site? Are there differences or continuity in the way that Neanderthals and modern humans exploited the surrounding landscape? Does the pattern observed in Neanderthal behavior in Central Portugal hold at Lapa do Picareiro? This research will build upon the understanding of a regional picture of the Middle to Upper Paleolithic transition in westernmost Iberia, and by extension, the Iberian Peninsula.

This project is funded by NSF grant #BCS-1724997 (Haws), and NSF GRF ID# 2016223837 (Carvalho). We would like to thank our collaborators and Emily Lena Jones at the University of New Mexico for guidance on this research design.

References: [1] Morin, E., Meier, J., El Guennouni, K., Moigne, A-M., Lebreton, L., Rusch, L., Valensi, P., Conolly, J., Cochard, D., 2019. New evidence of broader diets of archaic *Homo* populations in the northwestern Mediterranean. Science Advances 5: eaav9106. [2] Zilhão, J., Angelucci, D.E., Igreja, M.A., Arnold, L., Badal, E., Callapez, P., Cardoso, J.L., D'errico, F., Daura, J., Demuro, M., Deschamps, M., Dupont, C., Gabriel, S., Hoffmann, D.L., Legoinha, P., Matias, H., Soares, A.M., Nabais, M., Portela, P., Queffelec, A., Rodrigues, F., Souto, P., 2020. Last Interglacial Iberian Neandertals as fisher-hunter-gatherers. Science. 367, eaaz7943. [3] Carvalho, M., Pereira, T., Manso, C., 2018. Rabbit exploitation in the Middle Paleolithic at Gruta Nova da Columbeira, Portugal. Journal of Archaeological Science: Reports. 21, 821-832. [4] Nabais, M., Zilhão, J., 2019. The consumption of tortoise among last interglacial Iberian Neanderthals. Quaternary Science Reviews. 217, 225-246. [5] Haws, J.A., Benedetti, M.M., Talamo, S., Bicho, N., Cascalheira, J., Ellis, M.G., Carvalho, M.M., Friedl, L., Pereira, T., Zinsious, B.K., 2020. The early Aurignacian dispersal of modern humans into westernmost Eurasia. Proceedings of the National Academy of Sciences of the United States of America. 117, 25414–25422.

Podium Presentation, Session 6, Friday 10:30 – 12:10

Early hominins (and other apes) under the canopy

Susana Carvalho[1], João d'Oliveira Coelho[1], René Bobe[1]

1 - Department of Science, Gorongosa National Park, Sofala, Mozambique

The questions of when and where hominins originated, and under what circumstances, are of deep interest to Palaeoanthropology. We know from extensive research that the hominin lineage originated in Africa probably around 8 to 10 million years ago, that is, during the late Miocene, but there is considerable uncertainty about the precise timing of this evolutionary event. Furthermore, Africa is a huge landmass, and the place of our origins within the continent remains unknown. There are also hypotheses that posit a European origin for the African apes. Given these chronological and geographical uncertainties, the ecological circumstances that may have led to our divergence from the African apes remain obscure. It is thus imperative to consider new sources of data about our origins. It is also important to 1) evaluate on a continental scale the sources of data that already exist, 2) to use the full potential of the data to answer questions about our origins, 3) and to expand the geographical scope of fieldwork into new regions of Africa with potential Miocene fossils. The middle and late Miocene was a time of significant climatic and environmental changes in Africa as well as globally. After the Miocene Climatic Optimum (a warm interval from 17 Ma to 15 Ma), global temperatures began to decline and C4 grasslands began to spread in tropical latitudes after 10 million years ago. These processes alongside the continuing evolution of the East African Rift System contributed to an expanding biogeographic arid corridor that may have isolated coastal forest communities from those in central Africa, resulting in allopatric speciation among various groups of mammals. As coastal forests separated from the main forest regions of central Africa, they extended their influence on the fauna and flora of the East African Rift through networks of fluvial corridors. It was in this context that the clade of African hominids (humans, chimpanzees, and gorillas) originated. Here we present analyses of African paleoecology with a new database including 87 palaeontological sites from the Neogene. This analysis emphasizes the heterogeneity of Africa in the Miocene and the major temporal and geographic gaps remaining.

We thank the Carr Foundation and the staff of Gorongosa National Park for supporting this research.

Podium Presentation, Session 5, Friday 8:30 – 10:10

New functional evidence from the internal structure of the *Danuvius guggenmosi* lower limb

Marine Cazenave[1,2,3], Annalisa Pietrobelli[1], Marta Pina[4], Sebastian Bachmann[5], David R. Begun[6], Jeremy DeSilva[7], Nikolai Spassov[8], Alexander Synek[5], Zewdi J. Tsegai[9], Madelaine Böhme[10,11], Tracy L. Kivell[1]

1 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 2 - Division of Anthropology, American Museum of Natural History, New York, USA · 3 - Department of Anatomy, Faculty of Health Sciences, University of Pretoria, South Africa · 4 - Institut Català de Paleontologia Miquel Crusafont, Universitat Autònoma de Barcelona, Barcelona, Spain · 5 - Institute of Lightweight Design and Structural Biomechanics, TU Wien, Vienna, Austria · 6 - Department of Anthropology, University of Toronto, Toronto, Canada · 7 - Department of Anthropology, Dartmouth College, Hanover, USA · 8 - Department of Paleontology and Mineralogy, National Museum of Natural History, Bulgarian Academy of Sciences, Sofia, Bulgaria · 9 - Department of Organismal Biology and Anatomy, The University of Chicago, Chicago, USA · 10 - Eberhard Karls University of Tübingen, Department of Geoscience, Tübingen, Germany · 11 - Senckenberg Centre for Human Evolution and Paleoenvironment, Tübingen, Germany

Danuvius guggenmosi is an 11.62-million-year-old fossil great ape originally described as dentally most similar to dryopithecins, while the external morphology of the postcrania suggested adaptations to both suspensory locomotion and bipedalism [1]. The authors proposed a new positional behaviour — extended-limb clambering — that provides a model for the common ancestor of great apes and humans [1]. However, the bipedal component of the locomotor repertoire of *Danuvius* has been questioned [2].

The assessment of the structural variation in lower limb of the plastic ecophenotypic cortical and trabecular bone has the potential to provide functional information about the mechanical loading of the hip, knee, and ankle joints of *Danuvius* [3]. Here we investigate for the first time the internal bone structure of *Danuvius*, focusing on the femoral head, patella and distal tibia of male (GPIT/MA/10000) and female (GPIT/MA/10003) individuals. We compare its endostructure to Miocene apes *Rudapithecus* and *Oreopithecus* (patella only), australopiths (SKW 19, StW 311, StW 358, StW 389, StW 522, SWT1/B-2) and to a minimum (depending on the skeletal element) sample size of 9 humans, 10 *Pan*, and 5 each of *Gorilla*, *Pongo*, *Papio* and *Macaca*. We also include Sansuke, a bipedally-trained *Macaca fuscata* individual.

All specimens were microCT scanned with a spatial voxel size <90 microns. Bone tissues were segmented using medical image analysis clustering segmentation and the trainable Weka segmentation algorithm in ImageJ. A holistic morphometric analysis in medtool® was used to quantify trabecular bone volume fraction (BV/TV) throughout the entire preserved epiphyseal region (femoral head, distal tibia) or bone (patella). To statistically compare variation between groups, we applied canonical holistic morphometric analysis, that maps the trabecular values to a volumetric mesh of a canonical bone created by a statistical free-form deformation model [4]. We further compare variation in trabecular structure via principal component analyses (PCA).

Results of PCA reveal good separation among extant taxa for each skeletal element. Trabecular bone of the *Danuvius* femoral head shows a high BV/TV in the region of the fovea capitis that is also observed in the bipedally-trained macaque; both individuals found together in PC1-PC5 [5]. Such reinforcement might relate to the function of the ligamentum teres. The *Danuvius* patella shows high BV/TV and thick cortex mediosuperiorly; a pattern that is most similar to the terrestrial quadrupedal *Papio* and may reflect the action of the vastus medialis that plays an important role in the stabilisation of the patella during knee extension. *Danuvius* differs from the patterns observed in *Rudapithecus* and *Oreopithecus* patellae. The *Danuvius* distal tibia shows high BV/TV throughout the epiphysis. The BV/TV pattern suggests trabecular reinforcement at the anterior and posterior margins of the trochlear articulation, akin to non-human great apes, reflecting high loading in dorsiflexion and plantarflexion. However, unlike apes, these reinforcements are more centrally located on the articulation, possibly indicating lesser loading in dorsiflexion. The distal tibia also shows human-like reinforcement at the centre of the articulation, suggesting loadings of the tibiotalar joint related to weight bearing in a neutral axis.

The internal structure of the *Danuvius* femur, patella and tibia reveals novel information about the posture and loading of its lower limb. *Danuvius* shows a unique pattern that differs from the preserved elements of the suspensory apes *Rudapithecus* and *Oreopithecus*. Similarities to humans (distal tibia) and the bipedally-trained Sansuke (femoral head) are consistent with the use of more extended lower limb postures than in extant great apes.

We thank C. Dunmore (Univ. Kent) and A. Hammond (AMNH) for helpful discussions; S. Steinbrenner (MPI-EVA) for assisting in the analyses and B. Zipfel (Wits. Univ.) for curation of the hominin fossil material. We acknowledge E. L'Abbé and A.C. Oettlé to the human sample of the Pretoria Bone Collection of the University of Pretoria, Pretoria; J. Chupasko for the *Gorilla* and *Pongo* patellae of the Museum of Comparative Zoology at Harvard University; C. Crockford and R. Wittig of the Tai Chimpanzee Project and P. Gunz of the Department of Human Origins for access to the *Pan* sample at the Max Planck Institute for Evolutionary Anthropology, Leipzig; B. Grosskopf to the human sample of the Historische Anthropologie und Humanökologie , Johann-Friedrich-Blumenbach-Institut für Zoologie und Anthropologie der Georg-August-Universität Göttingen; L. Hutten to the baboon sample from the University of Cape Town; I. Livne to the *Gorilla* sample of the Powell-Cotton Museum; A. van Heteren to the Pongo sample of the Zoologische Staatssammlung München, L. Costeur to the *Oreopithecus* patellae of the Natural History Museum Basel. For the extant human comparative sample, ethical clearance was obtained from the Faculty of Health Sciences Research Ethics committee of the University of Pretoria (ref. no. 39/2016). We thank G. Ferreira (Senckenberg Center) for scanning of *Danuvius* bones at the 3-D imaging lab at Tübingen University. We thank R. Macchiarelli (Univ. of Poitiers and MNHN, Paris), A. Mazurier (Univ. of Poitiers) and C. Zanolli (PACEA, Bordeaux) for sharing the scans of *Oreopithecus*. We thank M. Bellato for scanning the *Pan* sample at the AST-RX Plateau d'Accès Scientifique à la Tomographie à Rayons X of the UMS 2700 2AD CNRS-MNHN, Paris (data kindly shared by R. Macchiarelli). We thank F. de Beer (Pelindaba), J. Hoffman (Pelindaba), L. Bam (Pelindaba), K. Jakata (Johannesburg), K. Smithson (University of

Cambridge), G. Schulz (Basel) and D. Plotzki (MPI) for CT scanning at Necsa, Wits, Cambridge, Univ. Basel and MPIEVA, respectively. We thank V. Volpato (Univ. of Poitiers), R. Macchiarelli (Univ. of Poitiers and MNHN, Paris), N. Morimoto (Kyoto Univ.) and M. Nakatsukasa (Kyoto Univ.) for sharing the scans of *Macaca* and Sansuke's femora.

References: [1] Böhme, M., Spassov, N., Fuss, J., Tröscher, A., Deane, A.S., Prieto, J., Kirscher, U., Lechner, T., Begun, D.R., 2019. A new Miocene ape and locomotion in the ancestor of great apes and humans. Nature. 575, 489–493. [2] Williams, S.A., Prang, T.C., Meyer, M.R., Russo, G.A., Shapiro, L.J., 2020. Reevaluating bipedalism in Danuvius. Nature. 586, E1–E3. [3] Cazenave, M., Kivell, T.L., 2023. Challenges and perspectives on functional interpretations of australopith postcrania and the reconstruction of hominin locomotion. Journal of Human Evolution. 175, 103304. [4] Bachmann, S., Dunmore, C.J., Skinner, M.M., Pahr, D.H., Synek, A., 2022. A computational framework for canonical holistic morphometric analysis of trabecular bone. Scientific Reports. 12, 5187. [5] Cazenave, M., Nakatsukasa, M., Mazurier, A., M. Skinner, 2024. Identification of functionally related adaptations in the trabecular network of the proximal femur and tibia of a bipedally trained Japanese macaque. Anthropological Science. 132, 13–26.

Poster Presentation Number 20, Session 1, Thursday 18:00 – 19:30

The humero-tibial proportions of an immature *H. naledi*

Tara J. Chapman[1,2,3], Eloïse Breyne[4], Samuel Stapleton[2], Caroline Polet[2]

1 - Scientific Service Heritage, Royal Belgian Institute of Natural Sciences (RBINS), Brussels, Belgium · 2 - Operational Direction Earth and History of Life, Royal Belgian Institute of Natural Sciences (RBINS), Brussels, Belgium · 3 - Laboratory of Anatomy, Biomechanics and Organogenesis (LABO), Faculty of Medicine, Université Libre de Bruxelles (ULB), Brussels, Belgium · 4 - Faculté de Philosophie et Sciences Sociales, Université Libre de Bruxelles (ULB), Brussels, Belgium

Long bone lengths in palaeoanthropology are often used for sex determination and to estimate stature. Proportions of the upper and lower limbs have also long been used to derive evolutionary hypotheses on ancient hominids. Modern humans have lower limb dominant proportions, whereas some *Australopithecus* and early *Homo* have more ape-like forelimb dominant proportions, which could be linked to more arboreal behavior. The *H. naledi* skeleton recently found in South Africa [1], has a mosaic of primitive and derived features. The shoulder girdle is primitive and features, such as the elevated shoulder and low torsion in the humerus, indicate that *H. naledi* was likely still engaging in arboreal behaviour or rock climbing. Despite several primitive and unique features, previous studies have found that the foot and lower limbs are human-like and capable of striding bipedalism.

The *H. naledi* material recovered thus far is fragmented, complicating the analysis of intralimb proportions. However, the juvenile *Homo naledi* skeleton (DH7) possesses a complete left tibia (U.W. 101-1070) and an almost complete right humerus (U.W. 101-948) [2].

To estimate the length of the humerus, measurements were taken on a sample of complete humerii from a collection of an identified modern human skeletal collection from the 19-20th century (Schoten, N = 51). Maximum length (M1) was estimated from a new measurement (M OLE-NEC) using the maximum bone available (the centre of the top of the olecranon fossa and the intersection between the top of the surgical neck and the head of the humerus). Regression of M1 and M OLE-NEC in the modern human sample was highly statistically significant, allowing for maximum length to be estimated and a humero-tibial index to be taken on the *H. naledi* skeleton.

The humero-tibial index was lower than the Schoten modern human population and this may be due to the length of the tibia (U.W. 101-1070), which was long when compared to femoral head size [3]. Results were further compared to a database of over 1500 different human populations from throughout the Holocene, including short stature populations [4] and was found to be within the standard deviation of modern humans, although at the lower end.

Earlier studies examining relative limb proportions in *H. naledi* found that they were within human variability or had a statistically non-significant slightly greater relative upper limb size. However, limb bones were either not associated or lengths were not taken. A limitation of our study is the estimation of bone dimensions and in the association, although both DH7 associated specimens were found in the same location and are developmentally the same in indicators of maturity [2]. Given the primitive *Australopithecus*-like morphology of the upper body of *H. naledi*, results are surprising as a higher humero-tibial index was expected in line with the A.L. 288-1 (Lucy) *Australopithecus afarensis* specimen, which has an intermediate humero-tibial index between modern humans and chimpanzees. The results of intralimb indices alone imply that *H. naledi* were similar to modern humans and therefore bipedality was probably the most significant mode of locomotion. However, other factors should be taken into account such as the mechanical loading of the joints.

References:
[1] Berger, L.R., Hawks, J., de Ruiter, D.J., Churchill, S.E., Schmid, P., Delezene, L.K., Kivell, T.L., Garvin, H.M., Williams, S.A., DeSilva, J.M., Skinner, M.M., Musiba, C.M., Cameron, N., Holliday, T.W., Harcourt-Smith, W., Ackermann, R.R., Bastir, M., Bogin, B., Bolter, D., Brophy, J., Cofran, Z.D., Congdon, K.A., Deane, A.S., Dembo, M., Drapeau, M., Elliott, M.C., Feuerriegel, E.M., Garcia-Martinez, D., Green, D.J., Gurtov, A., Irish, J.D., Kruger, A., Laird, M.F., Marchi, D., Meyer, M.R., Nalla, S., Negash, E.W., Orr, C.M., Radovcic, D., Schroeder, L., Scott, J.E., Throckmorton, Z., Tocheri, M.W., VanSickle, C., Walker, C.S., Wei, P., Zipfel, B., 2015. *Homo naledi*, a new species of the genus *Homo* from the Dinaledi Chamber, South Africa. eLife. 4, e09560. [2] Bolter, D.R., Elliott, M.C., Hawks, J., Berger, L.R., 2020. Immature remains and the first partial skeleton of a juvenile *Homo naledi*, a late Middle Pleistocene hominin from South Africa. PLOS ONE. 15, e0230440. [4] Marchi, D., Walker, C.S., Wei, P., Holliday, T.W., Churchill, S.E., Berger, L.R., DeSilva, J.M., 2017. The thigh and leg of *Homo naledi*. Journal of Human Evolution. 104, 174–204. [3] Marchi, D., Walker, C.S., Wei, P., Holliday, T.W., Churchill, S.E., Berger, L.R., DeSilva, J.M., 2017. The thigh and leg of Homo naledi. Journal of Human Evolution. 104, 174–204. [4] Auerbach, B.M., Sylvester, A.D., 2010. Allometry and apparent paradoxes in human limb proportions: Implications for scaling factors. American Journal of Physical Anthropology. 144, 382–391.

Poster Presentation Number 21, Session 1, Thursday 18:00 – 19:30

HOME

Wei Chu[1]

1 - Leiden University

While caves have traditionally been seen as prime habitats for early hominins, the predominance of Late Pleistocene open-air sites across Europe has long prompted a broader investigation into the spatial preferences and adaptive strategies of prehistoric societies in regions devoid of karstic deposits. Beginning with the earliest unambiguous evidence of anthropogenic shelter construction c. 20 ka ago, the project HOME aims to unravel the multifunctional roles of these structures beyond extrasomatic protective barriers from the harsh environmental conditions. Despite their potential significance, the archaeological record pertaining to such shelters remains fragmentary and incompletely understood, eliciting a paradigm shift in systematic methodologies for targeted discovery and investigation.

Central to this is a cross-disciplinary framework comprising systematic surveys, stratigraphically controlled excavations, and state-of-the-art analytical techniques. Four interconnected work packages form the backbone of this research project, each addressing distinct aspects of Paleolithic shelter archaeology. Leveraging digital ethnographic datasets, geophysical prospection methods, and detailed stratigraphic investigations, the goal is to elucidate the typological diversity of ancient shelters, refine predictive models for targeted field surveys, and evaluate the extent/nature of human habitation within karstic regions.

Beyond the documentation of shelters, the overarching objective is to reconstruct the socio-economic dynamics underpinning Paleolithic settlement patterns and the adaptive strategies employed by hominins to navigate and engineer their physical environments. An expected outcome is to illuminate the technological innovations and social practices that shaped human existence during this pivotal period.

By embracing methodological innovation and challenging entrenched paradigms, an improved understanding of past sheltering solutions will augment our understanding of human evolution and the adaptive strategies employed by hominins in response to environmental challenges. By revealing the origins of hominin habitation and the socio-economic dynamics underpinning Paleolithic lifeways, HOME aspires to forge a deeper appreciation for the resilience and ingenuity of our ancient predecessors.

ERC-2023-COG Project 101124398- HOME.

Podium Presentation, Session 10, Saturday 11:00 – 12:40

Why did the Acheulean happen? Experimental and archaeological insights into the emergence of bifaces

James Clark[1]

1 - Department of Archaeology, University of Cambridge

The sheer geographic and temporal breadth of biface presence in the archaeological record of the Acheulean has made them a topic of intense research, especially because this technocomplex oversees important biological and cognitive changes within the hominin lineage. At the same time, there is substantial variation in biface representation within individual assemblages both within and between regions. The basis of this variability remains strongly debated, including for the very earliest Acheulean assemblages in East Africa. These debates focus on whether their presence or absence at individual sites is reflective of random processes, different biological and/or cultural groupings, raw material constraints, and/or differences in activity that may be patterned by ecological context. With regards to the latter, function is key to understanding the potential of differential biface deployment, and yet is particularly poorly understood in the Early Acheulean. While experimental studies attest to the utility of bifaces in heavy-duty cutting tasks, something that is reflected in use analyses from the Middle Pleistocene [1], this may not explain the origins of the technology. Indeed, use-wear data provides at-best inconsistent evidence of use in different tasks (including butchery at Konso Gardula, woodworking at Peninj, and pounding at Olduvai [2]), and often suggest they were not used at all [3]. Alternate explanations suggest that bifaces evolved for deployment as specialised cores [4], but why these would be more useful in some contexts had not, until now, been explored.

This presentation puts forward the results of multidisciplinary research over the last four years, examining the potential ecological bases for the varied incorporation of bifaces into archaeological assemblages in the Early Pleistocene. Firstly, an experimental replication of Oldowan and Early Acheulean artefacts is described, alongside the application of cutting-edge tools for lithic analysis [5]. These data demonstrate the efficiency of bifaces as a source of small flakes when compared to traditional core forms. Secondly, a database of technological information from Early Acheulean sites across 1.8-1.2 Ma is presented, collating data from already-published studies. Finally, these results are analysed through a number of multivariate statistical approaches. My results suggest that biface representation and morphology is part of a broader system of technological tradeoffs that give structure to the archaeological record across the Oldowan-Acheulean transition. The varying proportion of bifaces in archaeological assemblages also seems to reflect changing patterns of sharp-edged flake production over time within individual landscapes. Consequently, I argue that bifaces evolved for use as specialised core forms in the context of increasingly structured landscape exploitation after 1.8 Ma, and that the deployment of these cores was related to intra-annual periods of increased mobility within the landscape. The implications of these findings for technological evolution in the Pleistocene are discussed.

I wish to thank my supervisor, Marta Mirazón Lahr, for her supervision of my PhD project, as well as my frequent collaborator, Gonzalo Linares-Matás. I also thank the National Museums of Kenya for access to material.

References: [1] Toth, N., Schick, K., 2019. Why did the Acheulean happen? Experimental studies into the manufacture and function of Acheulean artifacts. L'Anthropologie. 123, 724–768. [2] Bello-Alonso, P., Rios-Garaizar, J., Panera, J., Rubio-Jara, S., Pérez-González, A., Rojas, R., Baquedano, E., Mabulla, A., Domínguez-Rodrigo, M., Santonja, M., 2021. The first comprehensive micro use-wear analysis of an early Acheulean assemblage (Thiongo Korongo, Olduvai Gorge, Tanzania). Quaternary Science Reviews. 263, 106980. [3] Diez-Martín, F., Wynn, T., Sánchez-Yustos, P., Duque, J., Fraile, C., de Francisco, S., Uribelarrea, D., Mabulla, A., Baquedano, E., Domínguez-Rodrigo, M., 2019. A faltering origin for the Acheulean? Technological and cognitive implications from FLK West (Olduvai Gorge, Tanzania). Quaternary International. 526, 49–66. [4] Shea, J.J., 2010. Stone Age visiting cards revisited: A strategic perspective on the lithic technology of early hominin dispersal. In: Fleagle, J.G., Shea, J.J., Grine, F.E., Baden, A.L., Leakey, R.E. (Eds.), Out of Africa I: The First Hominin Colonization of Eurasia. Springer, Dordrecht, pp. 47–64. [5] Gellis, J., Smith, C., Foley, R., 2022. PyLithics: A Python package for stone tool analysis. Journal of Open Source Software. 7, 3738.

Poster Presentation Number 22, Session 1, Thursday 18:00 – 19:30

What makes Sibhudu a site of outstanding universal value?

Nicholas J. Conard[1,2]

1 - Department of Early Prehistory and Quaternary Ecology, University of Tübingen, Tübingen, Germany · 2 - Senckenberg Centre for Human Evolution and Palaeoenvironment at the University of Tübingen, Tübingen, Germany

Following an earlier excavation by Aron Mazel from the KwaZulu-Natal Museum in the 1983, Lyn Wadley from the University of the Witwatersrand led major excavations focused on the long Middle Stone Age (MSA) sequence at Sibhudu Cave between 1998 and 2011. This research led to numerous high-profile publications and made important contributions to the recognition of the MSA as a period characterized by many innovations by early modern humans. Following Wadley's invitation to continue field work at Sibhudu, the author has headed excavations at the site since 2011.

This year the UNESCO World Heritage Committee will decide on a serial nomination of Sibhudu Cave, Diepkloof Rock Shelter and the Pinnacle Point sites. The main criterion for a site obtaining UNESCO World Heritage is "Outstanding Universal Value" or OUV. This paper explains what makes Sibhudu a uniquely important site documenting the cultural innovations of modern humans in southern Africa and why Sibhudu fulfills the requirements for OUV.

Sibhudu Cave is the only rock shelter where faunal and rich botanical remains are preserved in association with Late Pleistocene archaeological material within the sub-tropical biome of the Indian Ocean Coastal Belt. Sibhudu contains a five-meter-thick stratigraphy that provides a rich record of the lifeways of early modern humans in what is today KwaZulu-Natal. The deposits span the period from ca. 100 – 38 ka BP and contain 71 major stratigraphic layers, each with numerous subdivisions and countless anthropogenic features that formed during the history of intense occupation of the site. Decades of research at the site have documented numerous lithic, osseous and botanical innovations, many of which have important implications for understanding the patterns of cultural change during the MSA. Work at the site has also documented a valuable archive for past environmental conditions in this part of southern Africa. The rich artifact assemblages do much to help untangle the complex relationships between environmental dynamics, demographic change and patterns of technological variation. Sibhudu preserves a rich record of the behavioral repertoire of modern humans before they spread deep into Eurasia and ultimately replaced all archaic hominins. The record from Sibhudu also provides a highly informative record of how technology and social-economic behavior evolved from the last interglacial complex until the Final MSA. Sibhudu serves as a keystone for studying cultural change in KwaZulu-Natal and for facilitating reliable interregional comparisons of past behavioral adaptations that reflect the capacities of early modern humans in southern Africa. This paper also discusses how the management plan for Sibhudu contributes to education and empowerment of the residents of the region surrounding the site and the global community as a whole.

My warmest thanks go to Lyn Wadley for her ongoing support of the excavations at Sibhudu. Her brilliant and innovative research put Sibhudu on the map. The research at Sibhudu between 2011 and today has been funded by the Deutsche Forschungsgemeinschaft, the Heidelberg Academy of Sciences and Humanities project: the Role of Culture in the Early Expansions of Humans, the Ministry of Science of Baden-Württemberg, the Senckenberg Centre for Human Evolution and Palaeoenvironment, and the University of Tübingen. Particularly thanks go to all of the members of the excavation teams and the many scientists who have contributed to the research at Sibhudu.

Poster Presentation Number 23, Session 1, Thursday 18:00 – 19:30

Stone balls as vehicles of agency and causality

Frederick L. Coolidge[1]

1 - University of Colorado, Colorado Springs

Stone balls (aka spheroids) began their appearance in the archaeological record about 2 million years ago. Some stone balls had been intentionally knapped (shaped stone balls [SBBs]) while others were simply chosen for their shape. Regardless, their functions may have been similar: throwing affordances to kill game, self-defense, extracting marrow, and perhaps a symbolic and/or cosmological value. The present paper argues for a fourth, heretofore, unheralded function of stone balls: as a sense of agency and causality in children. The Leakeys, among others, noted stone balls' uniqueness among stone tools, their intentionally knapped nature, or their choice for being naturally rounded. Others viewed them as "throwing-affordances," like for killing small animals or self-defense. Walker [1] emphasized their symbolic value in a belief system that he claimed resembled "modern-like behaviour." Recently Assaf [2] has proposed that stone balls may have a cosmological value, in that they have been found prominently among horse fossils, especially in the Middle and Lower Paleolithic. She found that stone balls had often been used in extracting marrow from horse bones, especially from horse mandibles. Her contention was that stone balls "play an important role in the human-horse alignment, embodying within them the world of perceptions and relationships of ancient humans with this non-human animal who shared their habitat" (p. 1).

My present argument for stone balls as vehicles for instantiating agency and causality is based on Malafouris' [3] notion of embodied cognition. Malafouris viewed material items as cognitive scaffolds and proposed that hominins have been interacting with materials and the processes associated with them for millennia. In this light, Assaf's contention receives theoretical support from Malafouris that early minds were embodying their cognitive processes in spheroidal materials and their manufacturing processes.

Further, my hypothesis for a critical fourth purpose of stone balls is also based on the notion of an exaptation and a spandrel, where a phenotypic trait is a byproduct of the evolution of some other characteristic, rather than a direct result of natural selection. It is known that children did play a role in the Paleolithic, perhaps constituting up to 40% of the members of those communities. My stone balls as vehicles of agency and causality hypothesis is also based on the concepts of developmental psychologist Jean Piaget [4-5] about how children learn causality. Piaget proposed that causality was elicited by a child's experience with objects in their environment, specifically things that a child could move easily and perceive that the child's movement, like hands or fingers, 'caused' a thing to move. Modern empirical evidence supports Piaget's concept in that the intention to perform a motor act first forms a perceptual representation (model) of that motor act and a model for subsequent action. A child's learning of the link, between its actions and the action of something the child moves, helps the child gain a sense of agency and an awareness of how causality operates experientially. The stone balls are therefore an example of embodied cognition, and they are also an evolutionary spandrel. Stone balls may well have been throwing-affordances, tools for marrow extraction, and possess a symbolic and/or cosmological function. However, that does not exclude the possibility may have also been rolling-affordances and that children would have perceived their affordant nature as toys or things that could be rolled, as opposed to nearly everything else in their environment that could not be rolled, like most non-spherical objects. By claiming that stone balls are examples of embodied cognition does tie together explanations as diverse as throwing-affordances, missiles, self-defense weapons, food processes, rituals, and toys.

References: [1] Walker, N., 2008. Through the crystal ball: making sense of spheroids in the Middle Stone Age. The South African Archaeological Bulletin, 63, 12-17. [2] Assaf, E., 2024. Set in stone: Human–horse relations as embodied in shaped stone balls. Archaeologies, 20, 64-105. [3] Malafouris, L., 2016. How things shape the mind: A Theory of Material Engagement. MIT Press. [4] Piaget, J., 1930. The child's conception of causality. Harcourt Brace. [5] Piaget, J., 1954. The construction of reality in the child. Basic Books.

Poster Presentation Number 24, Session 1, Thursday 18:00 – 19:30

The evolutionary insights we gain from studying energy requirements during singleton and twin pregnancies

Cédric Cordey[1], Nicole M. Webb[1,2], Martin Haeusler[1]

1 - Institute of Evolutionary Medicine, University of Zürich, Zürich, Switzerland · 2 - Department of Palaeoanthropology, Senckenberg Gesellschaft für Naturforschung, Frankfurt am Main, Germany

The "Energetics of Gestation and Growth" (EGG) hypothesis suggests that the neurological immaturity of human newborns stems primarily from limitations in maternal energetic capacity during pregnancy, particularly due to inefficient transfer of essential fatty acids across the placenta to the fetus [1-2]. Under the EGG hypothesis, fetal energy requirements increase exponentially during pregnancy, and labour begins when these demands surpass the mother's sustainable metabolic capacity, which is between 2.0 and 2.1×BMR (basal metabolic rate) [2]. This hypothesis has been a popular contender to the obstetrical dilemma hypothesis, which attributes our secondarily altricial infants to a spatial limitation of the pelvis rather than to maternal energetics. However, our previous research has demonstrated substantial variability in maternal metabolic capacity during pregnancy, which does not correspond to comparable variation observed in birth timing [3]. Furthermore, additional studies suggest that a multitude of other factors, beyond those derived from metabolic explanations, likely influence birth timing in modern humans [3].

Here, we use twin pregnancies to further explore the actual limits of maternal energetic capacity and elucidate the plausibility of a metabolic threshold dictating birth timing as argued under the EGG hypothesis. Based on a literature review on energy expenditure we performed a meta-analysis comparing the metabolic scopes of mothers expecting singletons versus twins. Women usually experience higher gestational weight gain during twin pregnancies compared to singleton pregnancies [4]. Accordingly, we quantified whether the higher gestational weight gain of twin pregnancies equates to higher metabolic scopes during pregnancy, and whether these higher metabolic scopes are compensated by the generally shorter duration of twin pregnancies and lower birth weights. We found that the metabolic scope of a mother expecting twins reaches approximately 2.2×BMR at the onset of the third trimester, and this high metabolic scope is sustained until birth. This drastically differs to the average values previously observed in singleton pregnancies, where the metabolic scope, on average, steadily increases to 2.0×BMR (range 1.83-2.39) [3]. Additionally, the metabolic scope of 2.2×BMR during twin pregnancies contradicts the EGG hypothesis' main assumption that birth is triggered by a metabolic threshold situated at around 2.1×BMR. Further, we found that fetal energy requirements increase rapidly until around pregnancy week 35, after which fetal growth slows down and plateaus, suggesting a decline in fetal energy requirements toward the end of gestation. These findings stand in contrast to the EGG hypothesis' assumptions of exponential growth of fetal energy requirements during pregnancy.

The fetal energy requirements in twin pregnancies are usually higher compared to singleton pregnancies. Assuming similar fetal growth patterns in twins as in singletons, two twins weighing 2.6kg each in pregnancy week 36 expend above 600 kcal/d. By comparison, a singleton weighing 4.0kg during pregnancy week 36, which at this timepoint represents the highest fetal weight in our sample, expends 450 kcal/d (50th percentile: 2.8kg, 350 kcal/d). However, given that twins are regularly born earlier than their singleton counterparts [4], the higher energetic costs they require may in fact directly influence birth timing. Yet, there are additional reasons (beyond metabolic factors) for a shorter gestation length of twin pregnancies, like premature rupture of membranes, placental abruption, or fetal growth restrictions [5]. This implies that metabolic factors alone remain insufficient for explaining birth timing [3]. It also reiterates that the female metabolism has evolved to be quite adaptable as demonstrated by the mere ability to sustain pregnancies with multiples despite their much higher energetic costs.

Financial support comes from the Swiss National Science Foundation Grant Nos. 31003A_176319 and 310030_212984. This work is also part of the Leibniz-Kooperative Exzellenz project K438/2022.

References: [1] Haeusler, M., Grunstra, N.D.S., Martin, R.D., Krenn, V.A., Fornai, C., Webb, N.M., 2021. The obstetrical dilemma hypothesis: there's life in the old dog yet. Biological Reviews/Biological Reviews of the Cambridge Philosophical Society. 96, 2031–2057. [2] Dunsworth, H.M., Warrener, A.G., Deacon, T., Ellison, P.T., Pontzer, H., 2012. Metabolic hypothesis for human altriciality. Proceedings of the National Academy of Sciences of the United States of America. 109, 15212–15216. [3] Cordey, C., Webb, N.M., Haeusler, M., 2023. Take it to the limit. Evolution, Medicine and Public Health. 11, 415–428. [4] Gandhi, M., Gandhi, R., Mack, L.M., Shypailo, R., Adolph, A.L., Puyau, M.R., Wong, W.W., Deter, R.L., Sangi-Haghpeykar, H., Lee, W., Butte, N.F., 2018. Estimated energy requirements increase across pregnancy in healthy women with dichorionic twins. The American Journal of Clinical Nutrition. 108, 775–783. [5] Gardner, M.O., Goldenberg, R.L., Cliver, S.P., Tucker, J.M., Nelson, K.G., Copper, R.L., 1995. The origin and outcome of preterm twin pregnancies. Obstetrics and Gynecology. 85, 553–557.

Poster Presentation Number 25, Session 1, Thursday 18:00 – 19:30

Diachronic and geographic diversity of the femoral structure in Neanderthals

Quentin Cosnefroy[1,2], Isabelle Crevecoeur[1], Patrick Semal[3], Gilles Berillon[4], François Marchal[2], Thibaut Devièse[5], Hélène Rougier[6]

1 - UMR 5199 PACEA, CNRS - Université de Bordeaux - Ministère de la Culture, Pessac, France · 2 - UMR 7268 ADES, Aix-Marseille Univ - CNRS, EFS, Marseille, France · 3 - Scientific Service Heritage, Royal Belgian Institute of Natural Sciences, Brussels, Belgium · 4 - UMR 7194 HNHP, CNRS - MNHN - UPVD, Paris, France · 5 - CEREGE, Aix-Marseille Univ - CNRS - IRD - INRAE - Collège de France, Aix-en-Provence, France · 6 - Department of Anthropology, California State University Northridge, Northridge, CA, USA

Neanderthal femora exhibit documented morphological differences compared to those of other *Homo* [1-2], including *Homo sapiens*, particularly in the internal structure of their diaphysis. However, comprehending the intra-specific diversity of femoral structure among Neanderthals is crucial for elucidating the broader diversity within the *Homo* genus throughout the Middle and Late Pleistocene. This study aims to comprehensively document the diversity of femoral structure among Neanderthals, both chronologically and geographically.

We conducted an analysis of the internal structure of femoral diaphyses of Neanderthal individuals from the Levant and Northern, Central, and Western Europe. The study incorporates both previously published and newly acquired micro-CT data spanning from MIS 7 to MIS 3, as well as one Middle Pleistocene *Homo* specimen. Using the morphomap R routine [3], we evaluated the diaphyseal structure by using traditional cross-sectional properties and applied a 2D landmark-based geometric morphometric approach to delve into the endosteal, periosteal, and cross-sectional shape characteristics. These analyses were conducted at three distinct locations along the femoral diaphysis—subtrochanteric (80% of biomechanical length from the distal end), midshaft (50%), and mid-distal (35%).

While conventional measurements of cross-sectional properties did not reveal clear trends among chronological and geographical groupings, multivariate analysis from the morphometric approach to cross-sectional shape allows us to define distinct clusters. Late Neanderthals of MIS 4 to 3 from Western and Northern Europe appear to differentiate from earlier specimens of Middle Pleistocene *Homo* and MIS 7 to 5 Neandertals. These differences result in Late Neandertals having more circular cross-sections in the proximal diaphysis and a medial buttress that is both more developed at midshaft and emerges from the mid-distal diaphysis.

The present study therefore reveals clear chronological diversity in the structural patterns of Neanderthal femora. Few specimens from Northern Europe also exhibit deviations from the seemingly homogeneous pattern observed among Late Neanderthals, raising the possibility that these are idiosyncratic variations or regional differences.

This research was realized thanks to financial support of the Aix-Marseille University Doctoral School ED251, the French National Agency ANR-22-CE27-0016 NeHos (dir. T. Devièse) and ANR-18-CE27-0010-01 HoBiS (dir. G. Berillon), the CNRS-INEE International Research Network GDRI0870 Bipedal Equilibrium. This research also benefited from the scientific framework of the University of Bordeaux's IdEx Investments for the Future Programme/GPR Human Past. The authors thank the tomography data providers: the Royal Belgian Institute for Natural Sciences, the Ulmer Museum, the Museum für Ur-and Frühgeschichte Thüringens from Weimar, the Muséum national d'histoire Naturelle from Paris, the Tel-Aviv University and the Neandertal Museum digital archive.

References: [1] Trinkaus, E., Ruff, C.B., 2012. Femoral and tibial diaphyseal cross-sectional geometry in Pleistocene *Homo*. PaleoAnthropology 2012, 13–62. [2] Puymerail, L., Condemi, S., Debénath, A., 2013. Comparative structural analysis of the Neanderthal femoral shafts BD 5 (MIS 5e) and CDV-Tour 1 (MIS 3) from La Chaise-de-Vouthon, Charente, France. Paléo 24, 257–270. [3] Profico, A., Bondioli, L., Raia, P., O'Higgins, P., Marchi, D., 2020. Morphomap: An R package for long bone landmarking, cortical thickness, and cross-sectional geometry mapping. American Journal of Physical Anthropology. 174, 129–139.

Poster Presentation Number 26, Session 1, Thursday 18:00 – 19:30

Cut-marks on teeth: taphonomic insights into Palaeolithic animal carcass processing

Lucile Créte[1], Simon A. Parfitt[1,2], Silvia M. Bello[1]

1 - Centre of Human Evolution Research, Natural History Museum, UK · 2 - Institute of Archaeology, University College London, London, UK

Surface modifications, particularly cut-marks, are the primary direct evidence of butchery activities conducted by hominins. Such marks have been recurrently described and studied on bones, but they are rarely observed on dental remains. The scarcity of reported cut-marks on animal teeth could reflect the rare occurrence of such marks in relation to butchering processes, but, alternatively, it could also be due to the difficulty in observing and identifying this type of surface alteration on highly reflective material such as enamel.

In this study, we describe cut-marks identified on deer teeth from the Boxgrove Q1/B site (West Sussex, England), a key locality for the study of Middle Pleistocene human behaviour, with deposits assigned to the MIS 13 interglacial (~480 ka) that yielded numerous faunal remains and lithic artefacts, as well as a hominin partial tibia and two cut-marked lower incisors. The cut-marks on the deer teeth were analysed using microscopic analytical techniques (i.e., focus-variation microscopy) to record and assess their micro-morphometric characteristics, and comparisons were made with cut-marks on deer bones from the same site.

Results show that the cut-marks on the deer teeth exhibit micro-morphometric characteristics similar to those on bones, although differences in the depth of the incisions were observed, likely due to the differing structural properties of bone and enamel. This suggests that the dental surface modifications recorded on the Boxgrove deer teeth likely resulted from hominin butchering activities, possibly in relation to the disarticulation of the mandible, and/or the cutting of the tongue and lips of the carcasses.

These results provide an encouraging new avenue for future studies of human butchery practices, showing that teeth, which are rarely considered when studying ancient carcass processing techniques, can provide useful additional insights into ancient human behaviours. In addition, in-depth analyses of cut-marks on animal teeth could be used as comparative sample for future studies aimed to understand the aetiology of the striations observed on hominin teeth (e.g., Boxgrove, Atapuerca). These analyses may help assess whether the dental striations observed on human teeth were produced during the life of the individual through the use of the mouth as a 'third-hand', as previously suggested [1,2], or if, in some cases, these could have been inflicted during post-mortem treatments of the dead [3].

This work is supported by the Calleva Foundation, as part of the funded project 'Adaptable butchers of Boxgrove'.

References: [1] Lozano, M., de Castro, J.M.B., Carbonell, E. and Arsuaga, J.L., 2008. Non-masticatory uses of anterior teeth of Sima de los Huesos individuals (Sierra de Atapuerca, Spain). J. Hum. Evol. 55(4), 713-728. [2] Lozano, M., de Castro, J.B., Arsuaga, J.L. and Carbonell, E., 2017. Diachronic analysis of cultural dental wear at the Atapuerca sites (Spain). Quat. Int. 433, 243-250. [3] Créte, L., Parfitt, S.A., Day, C. and Bello, S.M., 2024. Non-masticatory striations on human teeth from the British Upper Palaeolithic to the Neolithic. Humanit. Soc. Sci. Commun. 11(1), 1-17.

Podium Presentation, Session 4, Thursday 16:20 – 18:00

Châtelperronian cultural diversity at its western limits: shell beads and pigments from La Roche-à-Pierrot, Saint-Césaire (France)

Isabelle Crevecoeur[1], François Bachellerie[2], Brad Gravina[3,1], Solange Rigaud[1], Laure Dayet[4], Marc Thomas[5], Christelle Lahaye[6], Loïc Lebreton[7,8], Eugène Morin[9], Jean-Jacques Bahain[10], Mickaël Baillet[11], Edouard Bard[12], Cédric Beauval[13], Jean-Guillaume Bordes[1], Thibaut Devièse[12], Christophe Falguères[10], Damien Flas[14], Lisa Garbé[10], Guillaume Guérin[15], François Lacrampe-Cuyaubère[13], Camille Lesage[16], Carolina Mallol[17], Josserand Marot[18], Bruno Maureille[1], Alexandre Michel[19], Xavier Muth[20], Elise Tartar[5], Nicolas Teyssandier[5], Adrien Thibeault[1], Dominique Todisco[21], Olivier Tombret[10], Hélène Rougier[22]

1 - PACEA, UMR 5199, CNRS, Université de Bordeaux, France · 2 - Archéologie Alsace, France · 3 - Musée national de Préhistoire, France · 4 - EDYTEM, UMR 5204, CNRS, Université Savoie Mont Blanc, France · 5 - TRACES, UMR 5608, CNRS, Université de Toulouse Jean Jaurès, France · 6 - Archéosciences Bordeaux, UMR 6034, CNRS, Université Bordeaux Montaigne, EPHE-PSL, Université de Bordeaux, France · 7 - Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Spain · 8 - Departament d'Història i Història de l'Art, Universitat Rovira i Virgili, Spain · 9 - Department of Anthropology, Trent University, Canada · 10 - HNHP, UMR7194, CNRS, MNHN, Université de Perpignan Via Domitia, France · 11 - Microlithec, Human Origins group, Leiden University, The Netherlands · 12 - CEREGE, Aix Marseille Université, France · 13 - SARL Archéosphère, France · 14 - LAMPEA, UMR 7269, Université d'Aix-Marseille, France · 15 - Géosciences Rennes, UMR 6118, CNRS, Université de Rennes 1, France · 16 - ICArEHB, Faculdade das Ciências Humanas e Sociais, Universidade do Algarve, Portugal · 17 - Instituto Universitario de Bio-Orgánica Antonio González, Universidad de La Laguna, Spain · 18 - Service départemental de l'Archéologie, Conseil départemental de la Charente-Maritime, France · 19 - Service départemental de l'Archéologie, Conseil départemental de la Dordogne, France · 20 - SARL Get in Situ, Switzerland · 21 - IDEES, UMR 6266, CNRS, Université de Rouen, France · 22 - Department of Anthropology, California State University Northridge, U.S.A.

The period between ~55 and 42 ky in Eurasia witnessed considerable bio-cultural changes, including the gradual replacement of the final Neanderthal populations by dispersing *Homo sapiens* groups. This demographic turnover is accompanied by a higher degree of variability in stone tool technology and symbolic expressions, namely personal ornaments. The Châtelperronian of France and northern Spain has figured prominently in discussions regarding the timing and mechanisms underlying the replacement of Neanderthal populations by *Homo sapiens*, notably since the 1979 discovery of a partial Neanderthal skeleton found in what was described at the time as a Châtelperronian level (EJOP sup) at the site of La Roche-à-Pierrot. The site has since played a key role in discussions concerning the Middle-to-Upper Palaeolithic transition in Western Europe.

Excavated by F. Lévêque over a period of 11 years, the collapsed rock-shelter of La Roche-à-Pierrot produced a stratigraphic sequence preserving late Mousterian to recent Aurignacian occupations [1]. Since the beginning of the 2000s, the reassessment of Lévêque's lithic assemblage highlighted both incoherencies in material culture associations and stratigraphy [2]. In 2013, renewed fieldwork and geoarchaeological work have provided new information concerning site formation processes, allowing spatial inconsistencies to be tested and the site's chronology and lithostratigraphic sequence to be reassessed [3-4].

Here we report the first association, supported by a multi-proxy spatial analysis, of shell beads and pigments with Châtelperronian artefacts from the facies 3a from new excavations at the site of La-Roche-à-Pierrot, Saint-Césaire (France). The personal ornament assemblage is dominated by marine gastropods of the genus *Littorina*, two thirds of which present clear anthropogenic perforations. The red pigments are exogenous earthy and oolithic hematites. While Middle Palaeolithic artefacts are also present in facies 3a, statistically supported, spatial and taphonomic analyses demonstrate the shell beads and pigments to be clearly associated with its Châtelperronian component. While anthropogenically perforated shells are unknown from Middle Palaeolithic contexts, diverse perforated marine gastropods have been recovered from sites contemporaneous with the Châtelperronian in southeastern Europe and around the Mediterranean. This hitherto undocumented combination of a western European early Upper Palaeolithic industry and shell beads provides new evidence for tracing Palaeolithic cultural variability and the emergence of symbolic expressions between the various human groups present in Eurasia during this important period of human evolution.

The Collective Research Project of La Roche-à-Pierrot is funded by the Direction régionale des Affaires culturelles (DRAC) of the Région Nouvelle-Aquitaine and by the Département de Charente-Maritime (CG 17), France. Field research has also benefited from financial support of the research project of the Région Nouvelle-Aquitaine: Isotopes du calcium et anthropobiologie au Paléolithique moyen (n° 2019-1R40208), and from logistical and material support from Archéosphère. We thank the Service régional d'Archéologie (SRA) Nouvelle-Aquitaine, the Conseil départemental de la Charente-Maritime, and more specifically its Service d'Archéologie. This research benefited from the scientific framework of the University of Bordeaux's IdEx "Investments for the Future" program / GPR "Human Past".

References: [1] Lévêque, F., Backer, A.-M. et Guilbaud, M. (Eds.), 1993. Context of a Late Neandertal: Implications of a multidisciplinary research for the transition to Upper Paleolithic adaptations at Saint-Césaire, Charente-Maritime, France. Monographs in World Archaeology 16, Prehistory Press, Madison. [2] Gravina, B., Bachellerie, F., Caux, S., Discamps, D., Faivre, J.-Ph., Galland, A., Michel, A., Teyssandier, N., Bordes, J.-G., 2018. No reliable evidence for a Neanderthal-Châtelperronian association at La Roche-à-Pierrot, Saint-Césaire. Scientific Reports. 8, 15134. [3] Couillet, A., Rougier, H., Todisco, D., Marot, J., Gillet, O., Crevecoeur, I., 2022. New Visual Analytics Tool and Spatial Statistics to Explore Archeological Data: The Case of the Paleolithic Sequence of La Roche-à-Pierrot, Saint-Césaire, France. Journal of Computer Applications in Archaeology. 5, 19-34. [4] Todisco, D., Mallol, C., Lahaye, C., Guérin, G., Bachellerie, F., Morin, E., Gravina, B., Challier, A., Beauval, C.,

Bordes, J.-G., Colange, C., Dayet, L., Flas, D., Lacrampe-Cuyaubère, F., Lebreton, L., Marot, J., Maureille, B., Michel, A., Muth, X., Nehme, C., Rigaud, S., Tartar, E., Teyssandier, N., Thomas, M., Rougier, H., Crevecoeur, I., 2023. A multiscalar and multiproxy geoarchaeological approach to site formation processes at the Middle and Upper Palaeolithic site of La Roche-à-Pierrot, Saint-Césaire, France. Quaternary Science Reviews. 315, 108218.

Podium Presentation, Session 5, Friday 8:30 – 10:10

Is *Sahelanthropus* still the earliest bipedal hominin? An examination of the pros and cons

Guillaume Daver[1], Tony Chevalier[2], Nekoulnang D. Clarisse[3], Julian Karoui-Canedo[1], Andossa Likius[4,5], Hassane-Taisso Mackaye[5], Abderamame Moussa[5], Victoria A. Lockwood[1], Zoé Nowicki[1], Laurent Pallas[1,6,7], Nicolas Pappalardo[1], Alicia Blasi-Toccacceli[1,8], Djimdoumalbaye Ahounta[3], Adoum Mahamat[3], Jerome Surault[1], Franck Guy[1]

1 - PALEVOPRIM : Laboratoire de Paléontologie, Evolution, Paléoécosystèmes et Paléoprimatologie, Université de Poitiers, CNRS, Poitiers, France · 2 -HNHP : Histoire Naturelle de l'Homme Préhistorique, CNRS-MNHN-UPVD, EPCC-CERP · 3 - Service de Conservation et Valorisation des Collections Paléontologiques, Centre National de Recherche pour le Développement (CNRD), N'Djaména, Chad · 4 - Académie de l'Education Nationale du Nord (Faya), N'Djaména, Chad · 5 - Faculté des Sciences Exactes et Appliquées, Université de N'Djaména, N'Djaména, Chad · 6- Laboratory of Physical Anthropology, Graduate School of Science, Kyoto University, 606-8502 Kyoto, Japan · 7 - HNHP : Histoire Naturelle de l'Homme Préhistorique, CNRS-MNHN-UPVD, Musée de l'Homme, Paris, France · 8- Department of Anatomy, Midwestern University, Glendale, AZ 85012, USA

Since its discovery in 2001, *S. tchadensis* has been proposed as the earliest known hominin to date. However, diverse debates surrounding its hominin status and bipedal capabilities remain ongoing. Its relatively small canines and osteological traits suggestive of bipedalism, traditionally considered defining traits of the hominin clade, present an overall picture of a hominin capable of hominin-like bipedal behavior (though not exclusively or necessarily frequently) [1-3]. Yet, interpretations of these traits have faced challenges due to their variation in catarrhine monkeys and possible occurrence in Miocene apes, suggesting a taxonomic allocation of the *Sahelanthropus* remains to a non-bipedal hominid rather than a bipedal hominin [4-5]. Testing this alternative hypothesis is crucial, necessitating new data and refined arguments regarding the variation of traits observed in *S. tchadensis*.

Since 2022, a renewed team within the framework of Chadian paleontological program has relaunched excavations and refined research axes to deepen our understanding of cranial and postcranial variation of morphological traits seen on *Sahelanthropus* within a catarrhine primates framework. Acknowledging recent conflicting works, this contribution first presents new quantification protocols of ulnar curvature, ulnar trochlear notch morphology, and femoral anteversion using innovative 3D methods, based on an expanded comparative sample of extant and extinct catarrhines, including more than 95 hominoids and 174 cercopithecids.

Regarding the ulnae, our results illustrate significant morphofunctional variations across the extant comparative sample, potentially linked to locomotor habits. For instance, a more developed dorsal ulnar curvature in African great apes is suggested to relate to arboreal climbing behavior. Additionally, fossil hominin morphologies suggest a high behavioral diversity, ranging from terrestrial bipedalism to arboreal climbing and quadrupedalism. Our analyses confirm the arboreal aspects of *S. tchadensis*' locomotor repertoire. Furthermore, our results on femoral anteversion reveal that humans exhibit significantly higher anteversion (averaging 21°) compared to other hominoids (less than 10°). This difference may potentially account for distinct categories of locomotor behaviors, including bipedalism on one hand and quadrupedal/suspensory locomotion on the other. Moreover, no significant differences were observed among apes, suggesting that femoral anteversion fails to discriminate quadrupedality (knuckle-walking) and suspensory locomotion. We interpret a high degree of anteversion as indicative of bipedal behaviors, as seen in humans. Therefore, anteversion can be used to infer locomotor behavior (bipedal or non-bipedal) of extinct taxa.

Overall, our findings suggest that *S. tchadensis* is better characterized by orthograde arboreal behaviors, including some forms of climbing, whereas terrestrial quadrupedalism is not supported. Overall, we reaffirm our interpretations regarding bipedality in *S. tchadensis*, emphasizing the importance of using combinations of relevant functional features rather than isolated "magic" traits when evaluating extinct locomotor behaviors. Additionally, we clarify our understanding of the *S. tchadensis* locomotor repertoire and its implications regarding hypotheses of a non-bipedal hominid rather than a bipedal hominin.

Funding was provided by Palevoprim, the region "Nouvelle Aquitaine", the International Research Network 'Bipedal equilibrium"(CNRS-INEE GDRI0870) and the French National Agency Research (ANR HOMTECH, ANR-17-CE27-0005-02).

References: [1] Brunet, M., Guy, F., Pilbeam, D., Mackaye, H.T., Likius, A., Ahounta, D., Beauvilain, A., Blondel, C., Bocherens, H., Boisserie, J.-R., De Bonis, L., Coppens, Y., Dejax, J., Denys, C., Duringer, P., Eisenmann, V., Fanone, G., Fronty, P., Geraads, D., Lehmann, T., Lihoreau, F., Louchart, A., Mahamat, A., Merceron, G., Mouchelin, G., Otero, O., Campomanes, P.P., De Leon, M.P., Rage, J.-C., Sapanet, M., Schuster, M., Sudre, J., Tassy, P., Valentin, X., Vignaud, P., Viriot, L., Zazzo, A., Zollikofer, C., 2002. A new hominid from the Upper Miocene of Chad, Central Africa. Nature. 418, 145–151.
[2] Guy, F., Lieberman, D.E., Pilbeam, D., de León, M.P., Likius, A., Mackaye, H.T., Vignaud, P., Zollikofer, C., Brunet, M., 2005. Morphological affinities of the Sahelanthropus tchadensis (Late Miocene hominid from Chad) cranium. Proceedings of the National Academy of Sciences. 102, 18836–18841.
[3] Daver, G., Guy, F., Mackaye, H.T., Likius, A., Boisserie, J.-R., Moussa, A., Pallas, L., Vignaud, P., Clarisse, N.D., 2022. Postcranial evidence of late Miocene hominin bipedalism in Chad. Nature. 609, 94–100.
[4] Macchiarelli, R., Bergeret-Medina, A., Marchi, D., Wood, B., 2020. Nature and relationships of Sahelanthropus tchadensis. Journal of Human Evolution. 149, 102898.
[5] Meyer, M.R., Jung, J.P., Spear, J.K., Araiza, I.Fx., Galway-Witham, J., Williams, S.A., 2023. Knuckle-walking in Sahelanthropus? Locomotor inferences from the ulnae of fossil hominins and other hominoids. Journal of Human Evolution. 179, 103355.

Pecha Kucha Presentation, Session 2, Thursday 11:20 – 12:50

Internal morphology of *Homo floresiensis* postcanine teeth

Thomas W. Davies[1], Sofwan Noerwidi[2], Lucas K. Delezene[3], Philipp Gunz[1], Mykolas Imbrasas[1], Kornelius Kupczik[4], Nico Alamsyah[2], Thomas Sutikna[2,5], Matthew W. Tocheri[6,5,7], Matthew M. Skinner[8]

1 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 2 - Research Centre for Archaeometry, National Research and Innovation Agency, Jakarta, Indonesia · 3 - Department of Anthropology, University of Arkansas, Fayetteville, AR, USA · 4 - Department of Anthropology, Faculty of Social Sciences, Universidad de Chile, Santiago, Chile · 5 - Australian Research Council Centre of Excellence for Australian Biodiversity and Heritage, University of Wollongong, Wollongong, New South Wales, Australia · 6 - Department of Anthropology, Lakehead University, Thunder Bay, Ontario, Canada · 7 - Human Origins Program, National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA · 8 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

Homo floresiensis' place within the hominin clade remains unresolved. While early suggestions that the hominin skeletal remains from Liang Bua represent modern human individuals with some kind of genetic disorder or pathology have been largely discredited, there is still considerable interest in explaining the distinctive morphology of the species. In particular, does the morphological evidence suggest evolution from a *Homo erectus* ancestry, or from another early *Homo* species such as *Homo habilis*? Previous assessments of the species' dentition have alternatively emphasized similarities with *Australopithecus* and early *Homo* [1], *H. erectus* [2-3] or modern humans [4].

Here we use micro-CT scanning to image the internal structure of the *H. floresiensis* dentition in high resolution, allowing us to precisely characterize the expression of dental traits at the enamel-dentine junction (EDJ). We also quantified tooth shape using geometric morphometric analysis of EDJ shape in mandibular and maxillary postcanines (LP3-M3, UP3-M2), comparing them with a broad comparative sample of *Australopithecus*, *H. habilis*, *Homo* sp., *H. erectus*, and later *Homo* (n= 557).

The mandibular third premolars of *H. floresiensis* display a very distinct combination of EDJ features that is consistent among the individuals from Liang Bua cave (LB1, LB2, LB6). The protoconid dentine horn is worn, but appears to have been well developed. There is no metaconid dentine horn, and the mesial marginal ridge is entirely absent on the lingual side of the crown, creating an open and steeply inclined mesial fovea. The transverse crest is distally orientated and connects directly to the distal marginal ridge. This arrangement is distinct among hominins, but the absence of a metaconid, an open mesial fovea and an asymmetrical crown outline is typical of early australopiths, particularly *Australopithecus anamensis*. This observation is supported by the results of the GM analysis of EDJ shape.

The remaining premolars (LP4, UP3, UP4) are found to most closely resemble either *Australopithecus*, *H. habilis* or *H. erectus* in GM analyses. The LP4 (LB6) has continuous marginal ridges, a rounded crown outline and a well-developed talonid. Both maxillary premolars (LB1) have low and interrupted mesial marginal ridges and well-developed talons, and despite dental wear, it is clear that the protocone was much taller than the paracone.

Previous studies have described certain aspects of molar shape in *H. floresiensis* as modern-human-like with respect to the mesiodistally short, rounded crown shape and reduced cusp number. However, our analysis shows that the *H. floresiensis* molars are distinctly different from those of modern humans. These differences are evident both in the expression of specific traits and in our geometric morphometric analyses of EDJ shape. While the molars are mesiodistally shortened, the height and spacing of the preserved cusps in several molar positions (LM2, LM3, UM2) is distinct within our sample. Further, the molars have a low dentine body height (LM1, LM2, LM1, LM2), which is more similar to *Australopithecus* or early *Homo* than later members of the genus *Homo*. Overall, our results highlight the highly distinctive tooth morphology in the species, combining features seen in *Australopithecus*, early *Homo* and *H. erectus* with a large number of apomorphic dental traits.

For access to specimens and micro-CT scans, we would like to thank the National Research and Innovation Agency (BRIN; Jakarta), National Museums of Kenya, National Museum of Tanzania, Ethiopian Heritage Authority, Evolutionary Studies Institute (University of the Witwatersrand), Croatian Natural History Museum, ASBL Archéologie Andennaise (Royal Belgian Institute of Natural Sciences), Musée National de Préhistoire des Eyzies-de-Tayac, Musée d'Art et d'Archéologie du Périgord), Institut für Anatomie der Universität Leipzig, Museo Nacional de Ciencias Naturales, Croatian Academy of Sciences and Arts, Musée d'Angoulême, Musée d'Archéologie nationale de Saint-Germain-en-Laye, European Synchrotron Radiation Facility, National Museum of Natural History, Institut für Geowissenschaften, (Universität Heidelberg, Department of Archaeology (Belgrade University and the National Museum), Ephorate of Palaeoanthropology & Speleology of Southern Greece, Institutul de Antropologie "Francisc J. Rainer", Phyletisches Museum Jena, Senckenberg Forschungsinstitut und Naturmuseum, Museum für Naturkunde (Leibniz Institute for Evolution and Biodiversity Science), Royal Museum for Central Africa and the Taï Chimpanzee Project. This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (819960), the Social Sciences and Humanities Research Council of Canada Insight Grant (435-2017-1234) and the Max Planck Society.

References: [1] Brown, P., Maeda, T., 2009. Liang Bua *Homo floresiensis* mandibles and mandibular teeth: a contribution to the comparative morphology of a new hominin species. Journal of Human Evolution. 57, 571–596. [2] Kaifu, Y., Kono, R.T., Sutikna, T., Saptomo, E.W., Jatmiko, Due Awe, R., 2015. Unique Dental morphology of *Homo floresiensis* and its evolutionary implications. PLOS ONE. 10, e0141614. [3] Kaifu, Y., Kono, R.T., Sutikna, T., Saptomo, E.W., Jatmiko, N., Awe, R.D., Baba, H., 2015. Descriptions of the dental remains of *Homo floresiensis*. Anthropological Science. 123, 129–145. [4] Jacob, T., Indriati, E., Soejono, R.P., Hsü, K., Frayer, D.W., Eckhardt, R.B., Kuperavage, A.J., Thorne, A., Henneberg, M., 2006. Pygmoid Australomelanesian *Homo sapiens* skeletal remains from Liang Bua, Flores: Population affinities and pathological abnormalities. Proceedings of the National Academy of Sciences. 103, 13421–13426.

Poster Presentation Number 27, Session 1, Thursday 18:00 – 19:30

Preliminary study of the quartzite industry of a new archaeological site, Ruidera-Los Villares

Sara Díaz-Pérez[1], Carlos A. Palancar[2], Francesc Gascó Lluna[3], Gabriel Cifuentes-Alcobendas[4,5], Lucía Bermejo Albarrán[6], Isidoro Campaña Lozano[4], Felipe Cuartero Monteagudo[4], Marcos Terradillos Bernal[3], Daniel García-Martínez[7,8,9]

1 - Department of Stone Age Archaeology, Institute of Archaeology, Faculty of Historical and Pedagogical Sciences, University of Wroclaw · 2 - Paleoanthropology Group, Department of Paleobiology, Museo Nacional de Ciencias Naturales (MNCN-CSIC), Madrid, Spain · 3 - Universidad Isabel I de Castilla, Burgos · 4 - University of Alcala, Faculty of Philosophy and Letters, Department of History and Philosophy, Madrid, Spain · 5- IDEA (Institute of Evolution in Africa), University of Alcalá de Henares, Madrid, Spain · 6- Primeros Pobladores de Extremadura (EPPEX), Extremadura, Spain · 7 - Physical Anthropology Unit, Department of Biodiversity, Ecology, and Evolution, Faculty of Biological Sciences, Complutense University of Madrid, Madrid, Spain · 8 - Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Burgos, España · 9 - Laboratory of Forensic Anthropology, Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, Coimbra, Portugal.

In the Iberian Peninsula, ancient industries are, for the most part, located in open-air contexts, mainly in fluvial environments that cover the different basins of the Iberian Peninsula from the Atlantic coast to the Guadalquivir basin. A large number of these sites are formed by abundant lithic remains and, in in some cases, there is the appearance of faunal remains that allow a more complete approximation to the functionality of these sites.

The formation of the Iberian Peninsula by large sedimentary basins means that the study of these sites can be established following these depressed areas. Upper Guadiana Basin, in the centre of the Iberian Peninsula, is a historically abandoned area. However, recent excavations of other sites in the area such as Albalá and El Sotillo, with the presence of Large Cutting Tools, have begun to complete the history of the Lower Pleistocene in this area. That is why in 2023, a new archaeo-palentological site called Ruidera-Los Villares was excavated in the Upper Guadiana Basin. In this area several sites with Acheulean industry made of quartzite are located. Although it is a newly excavated site, an important discovery has been made of a lithic industry associated with a possible ancient industry made of quartzite, a predominant raw material in ancient dated industries due to its easy location in the form of pebbles used in the Iberian Peninsula in ancient chronologies to make bifaces but which in this case has been used to create an industry of small tools. However, despite being in an environment surrounded by lagoons, they are devoid of this raw material. The faunal remains found at the site dated from 346±23-21 (ESR and U series) [1] years ago, which could be correlated with an ancient industry, since the industrial aspects studied indicate features that are not very common in the context of the Upper Guadiana. Thus, we intend to present the first results of a technological and morphometric analysis of the first remains of lithic industry found at this site.

Thanks to the participants of the Ruidera-Los Villares excavation, the Junta de Patrimonio de Castilla La Mancha, the Mayoress of Ruidera and the directors of the Lagunas de Ruidera National Park.

References: [1] Martínez, D.G., Duval, M., Zhao, J., Feng, Y., Wood, R., Huguet, R., Cifuentes-Alcobendas, G., Palancar, C.A., Moya-Maleno, P.R., 2022. Los Villares locality (Ruidera, Castilla-La Mancha, Spain): a new Middle Pleistocene fossil assemblage from the Southern Iberian Plateau with possible evidence of human activity. Cuaternario Y Geomorfología/Cuaternario Y GeomorfologíA. 36, 7–35.

Podium Presentation, Session 1, Thursday 9:20 – 11:00

Using mammalian tooth enamel to building amino acid geochronologies to help better understand human evolution in southern Africa

Marc Dickinson[1], Laila Patinglag[2], Marcus Hill[2], Palesa Madupe[3,4], Alberto J. Taurozzi[3], Meaghan Mackie[3,5], Mirriam Tawane[6], Catherine Mollereau[7], Rebecca R. Ackermann[4], Neil Adams[8,9,10], Adrian Lister[10], Kate Scott[11], Shaw Badenhorst[12], Michaela Ecker[13], José Braga[12,14], Enrico Cappellini[3], Kirsty Shaw[2], Kirsty Penkman[1]

1 - Department of Chemistry, University of York, Heslington, York, UK · 2 - Manchester Metropolitan University, Manchester, UK · 3 - Geogenetics Section, Globe institute, University of Copenhagen, Denmark · 4 - Department of Archaeology, University of Cape Town, Cape Town, South Africa · 5 - Proteomics Program, Novo Nordisk Foundation Center for Protein Research, University of Copenhagen, Denmark · 6 - National Heritage Council South Africa, Pretoria, South Africa · 7 - Research Center on Animal Cognition (CRCA), Center of Integrative Biology (CBI), University of Toulouse, Toulouse, France · 8 - University of Leicester, Leicester, UK · 9 - Oxford University Museum of Natural History, Oxford, UK · 10 - Natural History Museum, London, UK · 11 - University of Oxford, Oxford UK · 12 - University of Witwatersrand, Johannesburg, South Africa · 13 - Kiel University, Kiel, Germany · 14 - Université de Toulouse, Toulouse, France

Understanding the precise timings of mammalian (including hominin) evolution during the Plio-Pleistocene epoch in Africa presents a significant challenge. The continent's diverse geography, fluctuating climate, and varied biozones have shaped intricate patterns of survival, expansion, contraction, and extinction among mammalian populations. However, current limitations in temporal resolution, impede our ability to confidently assess climate change and evolutionary models. Yet, the predictable breakdown of proteins and amino acids within a closed system fraction of tooth enamel offers a promising avenue for direct dating of mammalian remains from the last few million years. The intra-crystalline protein decomposition (IcPD) within the enamel of European proboscideans (elephants & mammoths), horses and bison, have recently been shown to provide robust relative dating information [1]. In this study, we have developed aminostratigraphies, utilising multiple taxa, for several archaeological sites across South Africa, including the Cave of Hearths, Kromdraai Units P and O, and Pniel 6. By leveraging this technique, we have been able to establish correlations between deposits, identify reworked & intrusive material, and date specimens lacking stratigraphic context due to depositional or curatorial processes. We also present IcPD data from *Paranthropus robustus* from Swartkrans and *Australopithecus* from Sterkfontein, highlighting the potential of IcPD for directly dating hominin remains within the region. These advances have the potential to provide invaluable insights into the temporal dynamics of a site's occupation and preservation, enhancing our understanding of human activities and environmental changes.

Furthermore, we are also testing microfluidic technology to develop a "lab-on-a-chip" approach for preparation of enamel samples, with a twofold aim: to reduce sample sizes from ~30 mg to ~ 1 mg, and to allow IcPD dating to be undertaken outside specialist labs, with the ultimate hope of sampling and analysis "in-country". Here we present our current progress with the lab-on-a-chip technology for amino acid geochronology.

Financial Support from the UK NERC through grants awarded to KEHP (NE/K500987/1 and NE/F01824X/1) and from the European Research Council under the European Union's Horizon 2020 Research and Innovation Programme Grant 865222 ("EQuaTe—Bridging Europe: A Quaternary Timescale for the Expansion and Evolution of Humans")

References: [1] Dickinson, M.R., Scott, K., Adams, N.F, Lister, A.M., Penkman, K.E.H., In press. Amino acid dating of Pleistocene mammalian enamel from the River Thames terrace sequence: a multi-taxon approach. Quaternary Geochronology

Podium Presentation, Session 4, Thursday 16:20 – 18:00

An Initial Upper Palaeolithic-type technology with evidence of secondary recycling from Le Moustier (France) before 46 thousand years ago

Igor Djakovic[1], Emmanuel Discamps[2], Giulia Gallo[2], Marc Thomas[2], Valentina Vacca[2], Marie Soressi[1], Brad Gravina[3,4]

1 - Faculty of Archaeology, Leiden University, Leiden, The Netherlands · 2 - TRACES UMR 5608, CNRS-Université de Toulouse-Jean Jaurès, Toulouse, France · 3 - Musée National de Préhistoire, Les Eyzies de Tayac, France · 4 - Univ. Bordeaux, CNRS, MC, PACEA, UMR-5199, Pessac, France

Initial Upper Palaeolithic (IUP) technologies across Eurasia are increasingly correlated with an early expansion of *Homo sapiens* populations between ~55-45 thousand years ago and, with the exception of Grotte Mandrin (France) [1], are exclusively found between final Mousterian and Early Upper Palaeolithic assemblages wherever they are identified. Here, we present a detailed technological, spatial, and site formation analysis of a lithic assemblage (~4200 artefacts) recovered during new excavations at Le Moustier (south-west France) and dating to before 46 thousand years ago [2]. Elements of this package were previously attributed [3] to the now outdated 'MTA Type-B' concept [4], and modern excavations allow us to better define this technology and confirm its position within the sequence. Stratigraphically positioned below almost two metres of Mousterian technologies (discoidal and Levallois), we demonstrate that this assemblage is characterised by the production of blades and Levallois-type points from a non-Levallois reduction system, the manufacture of 'Upper Palaeolithic' tool forms on laminar blanks (end-scrapers, burins, retouched blades), and a component of small convergent elements. In conjunction with spatial patterns, the presence of discoidal products and technological double patinas provide evidence that this technology was at least partly subject to secondary recycling via secant exploitation, which characterizes the overlying layers [5]. Additionally, the intentional fragmentation of points and blades – some exhibiting double patinas – represents a second expression of this recycling behaviour. We conclude that this assemblage reflects the partial re-working of an integrated IUP-type point-and-blade technology by subsequent occupations of groups producing discoidal technology – highlighting that secondary recycling behaviours can foster a conflation of otherwise distinct occupations and/or technologies.

We then frame this distinctive blade-and-point technology against the broader Eurasian IUP record, highlight the closest technological analogues, and expose some emerging patterning within Eurasian IUP technologies - integrating both geographic and temporal perspectives. We use this framing to subsequently present a critical discussion on the value and limitations of the Initial Upper Palaeolithic concept as it is currently employed. Finally, we reflect on the implications of an Initial Upper Palaeolithic-type technology located within the Mousterian record of south-west France. Namely, that a) IUP technologies are not only present in western Europe but also appear *prior* to the end of the Mousterian, and b) that this raises important questions concerning the potential maker(s) of this assemblage and, by extension, the demographic structure of the late Mousterian in far western Eurasia.

This research is funded by the Dutch Research council (NWO) 'Neandertal Legacy' grant (VI.C.191.070) awarded to M. Soressi.

References: [1] Slimak, L., Zanolli, C., Higham, T., Frouin, M., Schwenninger, J.-L., Arnold, L.J., Demuro, M., Douka, K., Mercier, N., Guérin, G., Valladas, H., Yvorra, P., Giraud, Y., Seguin-Orlando, A., Orlando, L., Lewis, J.E., Muth, X., Camus, H., Vandevelde, S., Buckley, M., Mallol, C., Stringer, C., Metz, L., 2022. Modern human incursion into Neanderthal territories 54,000 years ago at Mandrin, France. Science Advances. 8, eabj9496. [2] Valladas, H., Geneste, J.M., Joron, J.L., Chadelle, J.P., 1986. Thermoluminescence dating of Le Moustier (Dordogne, France). Nature. 322, 452–454. [3] Soressi, M. 2005. Late Mousterian lithic technology: its implications for the pace of the emergence of behavioural modernity and the relationship between behavioural modernity and biological modernity. In: d'Errico, F. & Blackwell, L. (Eds.), From tools to symbols: from early hominids to modern humans. Wits University Press, pp. 389-417. [4] Gravina, B., Discamps, E., 2015. MTA-B or not to be? Recycled bifaces and shifting hunting strategies at Le Moustier and their implication for the late Middle Palaeolithic in southwestern France. Journal of Human Evolution. 84, 83–98. [5] Thomas, M., Gravina, B., 2019. Techno-economic analysis of a Late Mousterian discoidal assemblage from the Lower Shelter of Le Moustier (Dordogne, France). Paléo. 30, 300–317.

Poster Presentation Number 28, Session 1, Thursday 18:00 – 19:30

Aurignacian occupations in the upland areas of the Balkans: new data from central Serbia

Tamara Dogandžić[1], Vesna Dimitrijević[2], Sofija Dragosavac[3], Jovana Janković[3], Tobias Lauer[4], Shannon P. McPherron[5], Senka Plavšić-Gogić[3], Mareike Stahlschmidt[6], Sahra Talamo[7], Dušan Mihailović[3]

1 - MONREPOS Archaeological Research Centre and Museum for Human Behavioural Evolution, Leibniz-Zentrum für Archäologie (LEIZA), Schloss Monrepos, Neuwied, Germany · 2 - Laboratory for Bioarchaeology, Department of Archaeology, Faculty of Philosophy, University of Belgrade, Serbia · 3 - Department of Archaeology, Faculty of Philosophy, University of Belgrade, Serbia · 4 - Eberhard Karls Universität Tübingen, Terrestrial Sedimentology, Department of Geosciences, Mathematisch-Naturwissenschaftliche Fakultät, Universität Tübingen, Tübingen, Germany · 5 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 6 - Department of Evolutionary Anthropology, University of Vienna, Vienna, Austria · 7 - Department of Chemistry G. Ciamician, Bologna University, Bologna, Italy

While *Homo sapiens* was present in Europe 46 ka ago and overlapped with the local Neanderthal populations for several millennia, it was the subsequent populations associated with the Aurignacian technocomplex between 43 ka and 38 ka BP that show genetic affinity with the later Palaeolithic populations in Europe [1], testifying to their consolidation on the continent. The Danube catchment area, as a natural corridor for dispersals, is important for understanding the adaptive behaviors of westwards moving *Homo sapiens* populations. We still lack a clear understanding of whether the bearers of Aurignacian overlapped with Neanderthals, whether this techno-complex is a homogeneous phenomenon, and whether its phases represent different dispersals or adaptive facies.

Here we present new data on sequences discovered at two rock-shelter sites in Serbia, Orlovača and Bukovac, located in the wider valley of Velika Morava, a tributary to the Danube. Late Middle and early Upper Palaeolithic occupations were discovered in the former and a later Aurignacian phase at the latter site. While the archaeological remains at these sites are rather sparse, the integration of lithic and faunal remains with chronology and site formation processes, contributes to our understanding of the population replacement period in this region. The last Middle Palaeolithic occupation at Orlovača is chronologically placed beyond the limits of radiocarbon ages. The chronology of the earliest phases of the Upper Palaeolithic are less certain, with dates ranging from 44 ka to 24 ka BP. In terms of lithic industries, the two layers at Orlovača are consistent with Protoaurignacian and Early Aurignacian. At Bukovac, late Aurignacian levels are dated in the range from 31 ka to 27 ka BP. A low density of finds characterizes all levels. Aside from clear evidence of human activities, faunal remains show high carnivore activity, primarily cave bears, hyenas, and wolves, also suggesting a rather ephemeral human occupation. The location of these sites is in an upland area of 250-400m asl, outside of the altitudinal belt where most Aurignacian sites in the wider Danube catchment area are clustered [2]. These occupations are likely transitory hunting camps within a logistically organized settlement system. The system seems consistent throughout the duration of Aurignacian and less likely related to fast dispersals of *Homo sapiens* but rather to particular land-use strategies.

This project has been funded by the Leibniz-Zentrum für Archäologie (LEIZA), Max Planck Society, NEEMO project of the Science Fund of the Republic of Serbia (7746827), and the Leakey Foundation.

References: [1] Posth, C., Yu, H., Ghalichi, A., Rougier, H., Crevecoeur, I., Huang, Y., Ringbauer, H., Rohrlach, A.B., Nägele, K., Villalba-Mouco, V., Radzeviciute, R., Ferraz, T., Stoessel, A., Tukhbatova, R., Drucker, D.G., Lari, M., Modi, A., Vai, S., Saupe, T., Scheib, C.L., Catalano, G., Pagani, L., Talamo, S., Fewlass, H., Klaric, L., Morala, A., Ruć, M., Madelaine, S., Crépin, L., Caverne, J.-B., Bocaege, E., Ricci, S., Boschin, F., Bayle, P., Maureille, B., Brun-Ricalens, F.L., Bordes, J.-G., Oxilia, G., Bortolini, E., Bignon-Lau, O., Debout, G., Orliac, M., Zazzo, A., Sparacello, V., Starnini, E., Sineo, L., Van Der Plicht, J., Pecqueur, L., Merceron, G., Garcia, G., Leuvrey, J.-M., Garcia, C.B., Gómez-Olivencia, A., Poltowicz-Bobak, M., Bobak, D., Luyer, M.L., Storm, P., Hoffmann, C., Kabaciński, J., Filimonova, T., Shnaider, S., Berezina, N., González-Rabanal, B., Morales, M.R.G., Marín-Arroyo, A.B., López, B., Alonso-Llamazares, C., Ronchitelli, A., Polet, C., Jadin, I., Cauwe, N., Soler, J., Coromina, N., Rufí, I., Cottiaux, R., Clark, G., Straus, L.G., Julien, M.-A., Renhart, S., Talaa, D., Benazzi, S., Romandini, M., Amkreutz, L., Bocherens, H., Wißing, C., Villotte, S., De Pablo, J.F.-L., Gómez-Puche, M., Esquembre-Bebia, M.A., Bodu, P., Smits, L., Souffi, B., Jankauskas, R., Kozakaitė, J., Cupillard, C., Benthien, H., Wehrberger, K., Schmitz, R.W., Feine, S.C., Schüler, T., Thevenet, C., Grigorescu, D., Lüth, F., Kotula, A., Piezonka, H., Schopper, F., Svoboda, J., Sázelová, S., Chizhevsky, A., Khokhlov, A., Conard, N.J., Valentin, F., Harvati, K., Semal, P., Jungklaus, B., Suvorov, A., Schulting, R., Moiseyev, V., Mannermaa, K., Buzhilova, A., Terberger, T., Caramelli, D., Altena, E., Haak, W., Krause, J., 2023. Palaeogenomics of Upper Palaeolithic to Neolithic European hunter-gatherers. Nature. 615, 117–126. [2] Hauck, T.C., Lehmkuhl, F., Zeeden, C., Bösken, J., Thiemann, A., Richter, J., 2018. The Aurignacian way of life: Contextualizing early modern human adaptation in the Carpathian Basin. Quaternary International. 485, 150–166.

Poster Presentation Number 29, Session 1, Thursday 18:00 – 19:30

Congenital bowing of the tibia in the Mesolithic infant from Grotta della Madonna (Praia a Mare, Calabria, southern Italy): inferences on funerary practices of the last Italian hunter-gatherers

Irene Dori[1], Vitale Stefano Sparacello[2], Giorgia Ciappi[1], Alessandro Riga[1], Tommaso Mori[1], Jacopo Moggi-Cecchi[1]

1 - Department of Biology, University of Florence, Italy · 2 – Department of Life and Environmental Sciences, University of Cagliari, Italy

Congenital curvature of long bones ("bowing") is a rare condition that can be generalized or affect a single bone element, principally the tibia, and is usually noticed at birth or shortly thereafter. Based on the direction to which the apex of the bowing points, three types of congenital curvature of tibia are described: antero-lateral, antero-medial (or anterior), and postero-medial (or posterior). The prognosis of this disorder is very different and varies depending on the type. The antero-lateral bowing type is one that degenerates in a tibial and/or fibular fracture with the development of a secondary pseudoarthrosis. The aetiology of congenital bowing is unclear, but it is often found in association with genetic disorders (such as neurofibromatosis type 1, amniotic band syndrome, osteogenesis imperfecta) [1].

In this work we present a re-assessment of a previously excavated but unpublished Mesolithic infant from Grotta della Madonna (Praia a Mare, province of Cosenza, Calabria) in which we noticed this condition. The macroscopic and micro-CT analyses showed bowing of the left tibia (antero-lateral type) affecting the distal third portion of the shaft. No other pathological abnormality could be discerned in the skeleton which, contrary to the few information from literature on the material, is attributable to a child of 4-5 months after birth.

The burial was discovered in 1966 during a series of excavations conducted by Dr. A. C. Blanc and Dr. L. Cardini of the "Istituto Italiano di Paleontologia Umana" (Rome) from 1957 to 1970. According to the excavation plate, the infant was buried on its side, presumably in a crouched position, with a pierced Cardium shell on the chest and a pebble with an anthropomorphic motif. Bones from the layer just below the burial provided a date of 1049-9927 cal BP, and a radiocarbon determination on the skeletal remains is in progress.

Congenital diseases are common and well documented in the European Upper Palaeolithic skeletal materials [2], raising questions on the degree of inbreeding [3], and the capacity for resilience, of these populations during the last Ice Age. It has been proposed that mortuary practices in the Mid to Late Upper Palaeolithic aimed at ritualizing, regulating, and sanctioning "exceptional individuals or exceptional events" [4]. These include diseases, often congenital due to low genetic variability and small populations size, and trauma/violence that could jeopardize the survival of small groups of hunter-gatherers, especially in an environmental context characterized by violent climatic fluctuations. Although Italian Early Mesolithic burials are rare, recent findings in northeastern Italy (Arma di Nasino, Ligury) [5] are compatible with a continuation of these funerary norms beyond the Younger Dryas, during a time of climatic amelioration. Grotta della Madonna may constitute further evidence of a continuity in biological traits and biocultural adaptations across the Pleistocene-Holocene boundary in southern Italy.

Fundings: ID - DM247 2022 MUR Italy Investment 1.2 "Funding projects presented by young researchers", grant number MCSA_0000035, project "IEPDA".

References: [1] Mastantuoni, G., Aulisa, A.G., Giordano, M., Savignoni, P., Toniolo, R.M., Falciglia, F., 2023. Anterolateral congenital tibial bowing: case report. Frontiers in Pediatrics. 11, 966358. [2] Trinkaus, E., 2018. An abundance of developmental anomalies and abnormalities in Pleistocene people. Proceedings of the National Academy of Sciences. 115, 11941–11946. [3] Posth, C., Yu, H., Ghalichi, A., Rougier, H., Crevecoeur, I., Huang, Y., Ringbauer, H., Rohrlach, A.B., Nägele, K., Villalba-Mouco, V., Radzeviciute, R., Ferraz, T., Stoessel, A., Tukhbatova, R., Drucker, D.G., Lari, M., Modi, A., Vai, S., Saupe, T., Scheib, C.L., Catalano, G., Pagani, L., Talamo, S., Fewlass, H., Klaric, L., Morala, A., Rué, M., Madelaine, S., Crépin, L., Caverne, J.-B., Bocaege, E., Ricci, S., Boschin, F., Bayle, P., Maureille, B., Le Brun-Ricalens, F., Bordes, J.-G., Oxilia, G., Bortolini, E., Bignon-Lau, O., Debout, G., Orliac, M., Zazzo, A., Sparacello, V., Starnini, E., Sineo, L., van der Plicht, J., Pecqueur, L., Merceron, G., Garcia, G., Leuvrey, J.-M., Garcia, C.B., Gómez-Olivencia, A., Poltowicz-Bobak, M., Bobak, D., Le Luyer, M., Storm, P., Hoffmann, C., Kabaciński, J., Filimonova, T., Shnaider, S., Berezina, N., González-Rabanal, B., González Morales, M.R., Marín-Arroyo, A.B., López, B., Alonso-Llamazares, C., Ronchitelli, A., Polet, C., Jadin, I., Cauwe, N., Soler, J., Coromina, N., Rufí, I., Cottiaux, R., Clark, G., Straus, L.G., Julien, M.-A., Renhart, S., Talaa, D., Benazzi, S., Romandini, M., Amkreutz, L., Bocherens, H., Wißing, C., Villotte, S., de Pablo, J.F.-L., Gómez-Puche, M., Esquembre-Bebia, M.A., Bodu, P., Smits, L., Souffi, B., Jankauskas, R., Kozakaitė, J., Cupillard, C., Benthien, H., Wehrberger, K., Schmitz, R.W., Feine, S.C., Schüler, T., Thevenet, C., Grigorescu, D., Lüth, F., Kotula, A., Piezonka, H., Schopper, F., Svoboda, J., Sázelová, S., Chizhevsky, A., Khokhlov, A., Conard, N.J., Valentin, F., Harvati, K., Semal, P., Jungklaus, B., Suvorov, A., Schulting, R., Moiseyev, V., Mannermaa, K., Buzhilova, A., Terberger, T., Caramelli, D., Altena, E., Haak, W., Krause, J., 2023. Palaeogenomics of Upper Palaeolithic to Neolithic European hunter-gatherers. Nature. 615, 117–126. [4] Sparacello, V.S., Rossi, S., Pettitt, P., Roberts, C.A., Riel-Salvatore, J., Formicola, V., 2018. New insights on Final Epigravettian funerary behavior at Arene Candide Cave (western Liguria, Italy). Journal of Anthropological Sciences. 96, 161-184. [5] Sparacello, V.S., Goude, G., Varalli, A., Dori, I., Gravel-Miguel, C., Riel-Salvatore, J., Palstra, S.W.L., Moggi-Cecchi, J., Negrino, F., Starnini, E., 2023. Human remains from Arma di Nasino (Liguria) provide novel insights into the paleoecology of early Holocene foragers in northwestern Italy. Scientific Reports. 13, 16415.

Poster Presentation Number 30, Session 1, Thursday 18:00 – 19:30

Foraging strategy and tree structure as drivers of terminal branch locomotion in savannah chimpanzees: implications for the emergence of hominin bipedalism

Rhianna C. Drummond-Clarke[1], Susan Chege Reuben[2], Fiona A. Stewart[1,2,3,4], Alex K. Piel[1,2], Tracy L. Kivell[1]

1 - Department of Human Origins, Max Planck Institute of Evolutionary Anthropology, Leipzig, Germany · 2 - Greater Mahale Ecosystem Research and Conservation Ltd., Mpanda, Tanzania · 3 - Department of Anthropology, University College London, London, UK · 4 - School of Biological and Environmental Sciences, Liverpool John Moores University, Liverpool, UK

Hominins are distinguished from other apes by habitual bipedalism. Whilst a shift from closed (e.g., tropical forest) to more open, heterogeneous environments (e.g., savannah) is considered central to the emergence and evolution of bipedalism, its selective pressures remain unclear. Traditionally, bipedalism has been linked to increased terrestriality in open habitats due to fewer arboreal pathways [1]. However, morphological features that are advantageous for arboreal locomotion persist in many fossil hominins, from the late Miocene to Pleistocene, suggesting arboreality remained an important aspect of hominin ecology [e.g., 2].

Chimpanzees are unique amongst extant apes in living across the forest-savannah habitat spectrum [3], providing a valuable opportunity to investigate the influence of habitat on ape behaviour in the absence of direct fossil evidence. Contrary to expectations, we previously found that chimpanzees (*Pan troglodytes schweinfurthii*) living in the savannah habitat of Issa Valley (Tanzania), were no more terrestrial than chimpanzees at more forested sites [4]. Furthermore, they used comparably high rates of suspension and quadrupedal walking, but low rates of climbing, when in the trees, and bipedalism was used primarily for terminal branch feeding [4]. These patterns raised questions as to why Issa chimpanzees maintain high levels of arboreality and frequent locomotion on terminal branches, despite living in an open habitat. Here, we test the hypothesis that Issa chimpanzee foraging strategy selects for higher levels of arboreality and, in particular, terminal branch locomotion. Specifically, we predicted that Issa chimpanzees forage for longer periods, in trees with relatively wide crowns and abundant terminal branch foods (characteristic of woodland feeding trees e.g., *Brachystegia* spp.), in response to spatially restricted food sources. We collected data on adult (7 males, 7 females) arboreal foraging behaviour over five months during focal follows, recording per arboreal foraging bout; start and end time (duration), number of occurrences of locomotion, food type consumed (e.g., flower, leaf), and food abundance within the crown. Feeding tree structure was also recorded, including diameter at breast height (DBH), crown shape, height and diameter, and number of branches. We recorded a total of 309 feeding bouts in 204 trees.

Foraging bout duration was positively correlated to the number of occurrences of locomotion. We tested for association between bout duration, food type and feeding tree structural characteristics using generalised linear mixed models, controlling for individual and temporal variation. We found that tree size and food abundance within the crown were important factors determining duration spent feeding in a tree (larger trees with more food = longer bouts). Food type was also a significant factor, with unripe fruit and seeds associated with longer foraging bouts compared to ripe fruits and leaves, especially in open crowns. Crown connectivity and shape, however, had no effect.

Whilst further analyses are needed on the availability and preference of feeding trees, our results suggest that high levels of arboreality and terminal branch locomotion at Issa may be due to chimpanzees selecting trees with abundant, terminal branch foods (i.e., hard seed pods of *Brachystegia* spp., small fruits of woodland *Ficus* species) driving longer foraging bouts per tree. Such a foraging strategy could select for bipedalism as a terminal branch behaviour to safely and efficiently navigate terminal branches [5] in open, but large, tree crowns characteristic of savannah-mosaic tree species. Results inform on the interaction between morphology, ecology, and ape behaviour in a savannah-mosaic, and have important implications for the interpretation of fossil hominid behaviour from morphology in analogous environments.

We thank The Leakey Foundation (RCDC, SCR) for funding this project, and the whole team at Greater Mahale Ecosystem Research and Conservation (GMERC) for field support. We also thank The Tanzania Wildlife Research Institute (TAWIRI), The Commission for Science and Technology (COSTECH), and the Mpanda District government for granting permission for research to be conducted. Finally, the UCSD/Salk Center for Academic Research and Training in Anthropogeny (CARTA) and Department of Human Origins, Max Planck Institute for Evolutionary Anthropology for support of GMERC.

References: [1] Rodman, P.S., McHenry, H.M., 1980. Bioenergetics and the origin of hominid bipedalism. American Journal of Physical Anthropology. 52, 103–106. [2] Green, D.J., Alemseged, Z., 2012. *Australopithecus afarensis* scapular ontogeny, function, and the role of climbing in human evolution. Science. 338, 514–517. [3] van Leeuwen, K.L., Hill, R.A., Korstjens, A.H., 2020. Classifying chimpanzee (*Pan troglodytes*) landscapes across large-scale environmental gradients in Africa. International Journal of Primatology. 41, 800–821. [4] Drummond-Clarke, R.C., Kivell, T.L., Sarringhaus, L., Stewart, F.A., Humle, T., Piel, A.K., 2022. Wild chimpanzee behavior suggests that a savanna-mosaic habitat did not support the emergence of hominin terrestrial bipedalism. Science Advances. 8, eadd9752. [5] Thorpe, S.K.S., Holder, R.L., Crompton, R.H., 2007. Origin of human bipedalism as an adaptation for locomotion on flexible branches. Science. 316, 1328–1331.

Poster Presentation Number 31, Session 1, Thursday 18:00 – 19:30

Tracing the age distribution of hominin groups from their footprints: application to Pliocene and Pleistocene sites

Jérémy Duveau[1,2,3]

1 - Paleoanthropology, Institute for Archaeological Sciences, Eberhard Karls University of Tübingen, Tübingen, Germany ·2 - DFG Center for Advanced Studies "Words, Bones, Genes, Tools: Tracking Linguistic, Cultural and Biological Trajectories of the Human Past", Eberhard Karls University of Tübingen, Tübingen, Germany · 3 - UMR 7194 Histoire Naturelle de l'Homme Préhistorique, CNRS, Muséum National d'Histoire Naturelle, Université Perpignan Via Domitia, Paris, France

Footprints are an original paleoanthropological material, representing a direct source of information on the locomotor behavior of the track-makers, as well as on their biological characteristics such as their stature and age. By representing brief periods of life - a singular time scale - footprints provide a picture of the size and composition of extinct hominin groups. Although some studies suggest that the majority of footprints in the fossil record were left by children, age estimates are not always carried out from footprints, or only on a site-by-site basis using different methods. No study has attempted to analyze the age profiles of all footprint sites using a single method. Yet the knowledge of the age of the individuals who left the footprints is fundamental to our understanding of each site, particularly when interpreting group structure or behavior.

The aim of this study is to analyze the age distribution patterns represented by hominin footprints from Pliocene and Pleistocene sites. To this end, 32 sites were considered, representing nearly 1,000 footprints attributed to 6 different taxa. The lengths of each footprint were collected by direct measurements on the material or using bibliographic data. An age class (child, adolescent or adult), less uncertain than a precise age, was estimated for each length in two steps. Firstly, foot lengths were estimated from footprint lengths using experimental ratios between these two variables. Secondly, age classes were estimated by positioning the foot lengths obtained on growth curves. A first growth model was determined using anthropometric data from various modern populations, including usually unshod individuals. For footprints attributed to a taxon other than *Homo sapiens*, the age class assignment was further strengthened using a growth model defined on Neandertal remains and another model based on non-human primates.

The results show that although children represent the most frequent age group from the footprints, the average age distribution of all sites is relatively balanced. For sites where different age classes are represented, the higher proportion of children can be explained by biometric reasons: as children are shorter than adolescents and adults, they need to make more strides, and therefore leave more footprints, to cover the same distance. The analyses also highlight the peculiarity of certain sites where only children are attributed to footprints, raising questions about group behavior and, in particular, why adolescents and adults were not present. Such results raise questions about the reliability of the information provided by the footprints. It is necessary to take into account uncertainties in the age class estimates, particularly for tall children and small adolescents or tall adolescents and short adults whose footprints may be associated with the wrong age class. Moreover, due to taphonomic agents or the very brief periods that these prints represent, only part of the social groups can be represented by the footprints.

This study was carried out as part of a postdoctoral grant funded by the FYSSEN foundation.

Poster Presentation Number 32, Session 1, Thursday 18:00 – 19:30

Analysis of metric, non-metric dental traits and dental topography in the transition from hunter-gatherer to agriculture in Near Eastern populations

Albert E. Dyowe-Roig[1], Laura M. Martínez[2,3], Alejandro Pérez-Pérez[2,3], Miquel Molist[1], Luís Hidalgo[2,3], Eric Coqueugniot[4], Juan José Ibáñez[5], Ali Metin Büyükkarakaya[6], Arkadiusz Sołtysiak[7], Ferran Estebaranz-Sánchez[3]

1 - Departament de Prehistòria, Universitat Autònoma de Bacelona, Barcelona, Spain · 2 - Departament de Biologia Evolutiva, Ecologia i Ciències Ambientals, Secció de Zoologia i Antropologia Biològica, Universitat de Barcelona, Barcelona, Spain · 3 - Institut d'Arqueologia de la Universitat de Barcelona, Barcelona, Spain · 4 - UMR Archéorient, Maison de l'Orient et de la Méditerranée. Lyon, France · 5 - Archaeology of Social Dynamics (ASD), Institución Milá i Fontanals de Investigación en Humanidades (IMF), Spanish National Research Council (CSIC), Barcelona, Spain · 6 - Human Behavioral Ecology and Archaeometry Laboratory (IDEA Lab), Hacettepe University, Ankara, Turkiye. · 7- Faculty of Archaeology, University of Warsaw, Poland

A major event in human history was the neolithization process, which resulted in a transition from hunting and gathering to agriculture and pastoralism. Around 12000 cal BP, during the Holocene, a time of global warming, agriculture was embraced. In the Near East, the Neolithic period saw changes in societal practices, including subsistence strategies and settlement patterns. Tooth size, enamel thickness, and wear analysis are important data for tracking nutritional and ecological adaptations in the Hominini lineage. Research indicates that the size of teeth has decreased throughout the course of evolution [1], with general trend from hunter-gatherers to agricultural societies.

Several researchers have proposed that the process of gracilization, characterized by the need to maintain chewing pressure in the face of reduced muscle mass, was the cause of the decrease in tooth size from the Paleolithic to the Neolithic [2]. However, some researchers have concluded that multiple reasons, including dietary changes, technological advances, and biological functional needs, were responsible for the shift in tooth size. These factors were all critical in reducing the selection pressure for larger teeth.

This study aims to determine whether changes in subsistence economy, and thus in diet, were directly related to the evolution of dental morphology, using tooth size, ASUDAS non-metric traits, and dental topography parameters (DNE, OPCR and Occlusal Relief Index) as indicators of morphological affinities between populations. On the other hand, the study aims to infer how the changes were between the different periods that gave way to the Neolithic, whether they occurred in both the upper and lower tooth, whether there were changes in all the teeth in the same way, whether it was a single population that expanded or, on the other hand, different populations suffered a similar process in different regions.

The sample studied (N=1994) corresponds to upper and lower premolars and molars from 31 different sites and periods (Natufian, PPNA, PPNB and Pottery Neolithic) in the Near East and Anatolia. On the one hand, tooth casts were made from the originals using the polyvinylsiloxane President MicroSystem (Coltène), on the other hand, part of the data was extracted from other studies [3]. a standard procedure in microwear studies due to its stable physical properties and high resolution of detail. The buccolingual and mesiodistal diameters of the crown were measured using a digital calliper.

The results indicate a shift in tooth size reduction between Natufians and the Pottery Neolithic, with both molars and premolars showing significant differences over time. Furthermore, the differences observed between the maxilla and mandible indicate that distinct selective pressures might have influenced the upper and lower dentition. However, non-metric dental traits did not show significant differences between periods ($p>0,05$). Despite this, there were some changes in topographic parameters. Our results suggest that while overall tooth size reduced over time, non-metric dental traits remained relatively stable.

We are grateful to all the curators and technical personnel of the different institutions where the specimens were molded. Grants PID2020-112963GB-I00, funded by MCIN/AEI/ 10.13039/501100011033 and by "ERDF A way of making Europe", by the "European Union".

References: [1] Estebaranz, F. Martínez, L. Hiraldo, O. Vanesa, E. Bonnin, A. Farrés, M. Pérez-Pérez, A., 2004. Tooth Crown size and dentine exposure in *Australopithecus* and early *Homo*: testing hypothesis of dietary related selective pressures. Anthropologie. XLII/1, 59-63. [2] Borgonini, M. Repetto, B., 1985. Dietary patterns in the Mesolithic samples from Uzzo and Molara Caves (Sicily): The evidence of teeth. Journal of Human Evolution. 14, 241-254. [3] Pinhasi, R., Eshed, V., Shaw, P., 2008. Evolutionary changes in the masticatory complex following the transition to farming in the southern Levant. American Journal of Physical Anthropology. 135, 136–148.

Poster Presentation Number 33, Session 1, Thursday 18:00 – 19:30

The effect of changing lifestyle, geographic region, climate, and terrain on human femoral robusticity and mobility

Stanislava Eisová[1,2], Victoria Roul[1,2], Hila May[1,2]

1 - The Department of Anatomy and Anthropology, School of Medicine, Faculty of Medical & Health Sciences, Tel-Aviv University · 2 - The Dan David Center for Human Evolution and Biohistory Research, Faculty of Medical & Health Sciences, Tel-Aviv University · 3 - Department of Anthropology, Natural History Museum, National Museum, Prague, Czech Republic

The Agricultural Revolution (ca. 15 thousand years ago; kya) was among the most significant socioeconomic transitions in human history. It affected all aspects of life and resulted in reduced mobility. This is expressed in the gracilization of the femoral bone, commonly measured using the midshaft cross-sectional geometry (CSG). The transition to a sedentary lifestyle first occurred in the Levant and only later spread into Europe. Nevertheless, despite the different environments, it had a similar effect on human skeletal morphology, demonstrating a similar temporal trends. These are characterized by a significant increase in the circularity of the femoral midshaft and a decline in bone rigidity and strength [1-5]. Nevertheless, the impact of the changing lifestyle in diverse Levantine and European environments has yet to be explored.

In this study, we aimed to examine the temporal trends in femoral midshaft CSG from the Upper Paleolithic to the late Holocene in the Levant and Europe while considering environmental factors, such as terrain and climate. The Levantine sample included populations from approximately 20 kya until the 5th century CE as follows: an Early Upper Paleolithic (EUP) femur (Ohalo H2), Natufian hunter-gatherers (N=30), Pre-Pottery Neolithic (PPN) B (N=38) and PPNC (N=28) early farmers, Chalcolithic farmers and herders (N=71), and Byzantine farmers (N=18). The European sample was previously published [3] and consists of CSG data from the Upper Paleolithic to Early Medieval times. Bone robusticity and strength were assessed by the relative subperiosteal cortical area, section moduli, and second moments of areas. Mobility level was estimated by the shape index of the cross-section. The absolute measures were controlled for cross-sectional size (i.e., the total subperiosteal area). All measurements were obtained from 2D cross-section CT images. Univariate and multivariate statistical analyses were carried out to compare between the groups.

We found significant differences between the Levantine and European femora in most features. In the Levant, the decrease in femoral strength and rigidity, along with increased circularity over time, was more pronounced than in Europe. In general, the hunter-gatherers of the Levant and Europe demonstrated similar bone strength and rigidity values. As opposed to that, with the transition to a farming subsistence strategy, the Europeans manifested higher values than the Levantine populations, with increasing differences over time. The midshaft cross-sectional shape also demonstrated a different pattern. Levantine hunter-gatherers had a larger shape index than the Europeans. This difference was maintained until the late Holocene when an index of 1 (round midshaft) was obtained for both groups. Moreover, both terrain and climate influenced CSG features, with terrain having a greater impact on the robusticity trend in the Levant. In conclusion, despite the similar trends observed between the Levant and Europe, the different environmental conditions affected bone robusticity and level of mobility. The harsh Levantine environment compared to the European probably resulted in reduced bone robusticity and higher mobility.

We would like to acknowledge the Israel Science Foundation (#1005/22), the United States-Israel Binational Science Foundation (#2019041), the Gerda Henkel Foundation (#AZ 06/F/22), the Israel Antiquities Authority, and the Dan David Foundation for the financial support. We would also like to thank Cristopher Ruff for making available previously collected European data at http://www.hopkinsmedicine.org/fae/CBR.html.

References: [1] Holt, B.M., 2003. Mobility in Upper Paleolithic and Mesolithic Europe: Evidence from the lower limb. American Journal of Physical Anthropology. 122, 200–215. [2] May, H., Ruff, C., 2016. Physical burden and lower limb bone structure at the origin of agriculture in the levant. American Journal of Physical Anthropology. 161, 26–36. [3] Ruff, C.B. (Ed.). 2018. Skeletal variation and adaptation in Europeans: Upper Paleolithic to the twentieth century. John Wiley & Sons. [4] Ruff, C.B., Holt, B., Niskanen, M., Sladek, V., Berner, M., Garofalo, E., Garvin, H.M., Hora, M., Junno, J.-A., Schuplerova, E., Vilkama, R., Whittey, E., 2015. Gradual decline in mobility with the adoption of food production in Europe. Proceedings of the National Academy of Sciences. 112, 7147–7152. [5] Ruff, C.B., Larsen, C.S., 2014. Long Bone Structural Analyses and the Reconstruction of Past Mobility: A Historical Review. In: Carlson, K.J., Marchi, D., (Eds.). Reconstructing mobility, Springer, US, pp. 13–29.

Poster Presentation Number 34, Session 1, Thursday 18:00 – 19:30

Artificial intelligence applications in use-wear analysis: a critical review

Anastasia Eleftheriadou[1], João Marreiros[1,2], Shannon McPherron[3]

1 - ICArEHB – Interdisciplinary Center for Archaeology and Evolution of Human Behaviour, Universidade do Algarve Faro, Portugal · 2 - Laboratory for Traceology and Controlled Experiments, MONREPOS-RGZM, Neuwied, Germany · 3 - Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

Stone tools play a pivotal role in the study of human evolution due to their functional and sociocultural significance [1]. To gain a deeper understanding of the lithic technological variability observed in the archaeological record, researchers have utilized use-wear analysis and controlled experiments, involving the multi-scale study of traces of use on an artifact's surface [2]. Quantification poses a challenge in the field due to the inconsistent use of terminology, workflows, and equipment [3-4]. In recent years, digital methods such as geometric morphometrics and image analysis have been used to address the lack of standardization [5]. A novel automated approach utilized to reduce user bias and increase efficiency is artificial intelligence (AI) [2]. Despite its acknowledged potential, the integration of AI into use-wear analysis remains limited. Before incorporating this method into the field, it is crucial to assess the current state-of-the-art, identifying any existing gaps and limitations.

In this study, a comprehensive literature review is used to examine how AI can be effectively integrated into use-wear analysis, with the primary objective of making recommendations to improve and expand its application. The critical assessment of published case studies facilitated the detection of potential research gaps, revealing patterns and trends in the prevalence of research questions, algorithms, and materials. Furthermore, the potential and limitations of AI were assessed by analyzing the obstacles encountered by researchers as well as the issues we observed in various AI applications.

The review included publications from 1998 onward, when the first AI paper on use-wear was identified. In view of the limited number of studies concerning lithic materials, the review also included studies on bone and wood artifacts, for a total of forty-one case studies. Data were collected in Microsoft Excel and subsequently converted into a CSV file. A total of 36 parameters were recorded in the database, concerning general information (e.g., publication date, affiliation), use-wear (e.g., equipment, magnification) and AI (e.g., sample size, algorithm type). Python scripts were used for the data analysis (descriptive statistics) and presentation, to ensure repeatability, reproducibility, and open accessibility. Based on the literature review, our study reveals a rapid increase in the publication rate of AI papers in use-wear analysis from 2018 onwards. There is a growing preference in the use of Neural Network algorithms, with the simultaneous decrease in the use of simpler algorithms such as clustering methods. The majority of researchers use programming languages over software, with the portion of cases sharing their code being marginally larger than the cases where data and/or code are not available. The limitations that commonly impede research, according to the authors, include issues with insufficient samples and the absence of reference databases. However, the most common issues identified in our study are analytical flaws, insufficient documentation, and poor model generalization, indicating the inability to use a model efficiently for different datasets.

Three major suggestions are proposed to enhance the current state of AI in use-wear analysis. Open science can enable the creation of more diverse and larger datasets, thus addressing the issue of insufficient data. Collaboration with computational archaeologists and computer scientists can also assist in the effective application of AI and thus create more powerful models that can be used by other researchers for different datasets. Finally, it is essential to acquire experimental and analytical data in a systematic manner to ensure their quality and reproducibility. To conclude, integrating open-source AI approaches offers unprecedented opportunities to enhance archaeological research methodologies (time efficiency, bias reduction) and provide insights into human evolution.

References: [1] Evans, A.A., Macdonald, D., 2011. Using metrology in early prehistoric stone tool research: further work and a brief instrument comparison. Scanning. 33, 294–303. [2] Marreiros, J., Calandra, I., Gneisinger, W., Paixão, E., Pedergnana, A., Schunk, L., 2020. Rethinking use-wear analysis and experimentation as applied to the study of past hominin tool use. Journal of Paleolithic Archaeology. 3, 475–502. [3] Borel, A., Deltombe, R., Moreau, P., Ingicco, T., Bigerelle, M., Marteau, J., 2021. Optimization of use-wear detection and characterization on stone tool surfaces. Scientific Reports. 11, 24197. [4] Calandra, I., Schunk, L., Rodriguez, A., Gneisinger, W., Pedergnana, A., Paixao, E., Pereira, T., Iovita, R., Marreiros, J., 2019. Back to the edge: relative coordinate system for use-wear analysis. Archaeological and Anthropological Sciences. 11, 5937–5948. [5] Ibáñez, J.J., Mazzucco, N., 2021. Quantitative use-wear analysis of stone tools: Measuring how the intensity of use affects the identification of the worked material. PLOS ONE. 16, e0257266.

Acknowledgements: This study was supported by ICArEHB – The Interdisciplinary Center for Archaeology and Evolution of Human Behaviour, funded by the Portuguese Foundation for Science and Technology (FCT) under program UIDP/04211/2020.

Podium Presentation, Session 12, Saturday 15:50 – 17:30

Taxonomic identification of a Pleistocene hominin tooth from Khudji, Tajikistan, through enhanced palaeoproteomic methods

Zandra Fagernäs[1], Viridiana Villa Islas[1], Gaudry Troché[1], Jan-Pieter Buylaert[2], Tura Khujageldiev[3], Redzhep Kurbanov[3], Jesper V. Olsen[4], Mikkel Winther Pedersen[1], Frido Welker[1]

1 - Globe Institute, University of Copenhagen, Copenhagen, Denmark · 2 - Department of Physics, Technical University of Denmark, Roskilde, Denmark · 3 - Institute of History, Archaeology and Ethnography, National Academy of Sciences of Tajikistan, Dushanbe, Tajikistan · 4 - Novo Nordisk Foundation Center for Protein Research, University of Copenhagen, Copenhagen, Denmark

In the absence of diagnostic morphological features, skeletal elements may be taxonomically unidentifiable or only identified to a higher taxonomic level. For hominin specimens, this may result in challenges of integrating morphological, molecular and archaeological datasets from the same site. A fragmented deciduous incisor was found in 1997 at the archaeological site of Khudji, Tajikistan, dated to approximately 40,000 years before present [1]. Through morphological analyses, it was determined that this tooth stems from either a modern human or a Neanderthal. After the subsequent discovery of Denisovans, this hominin group is also a potential candidate for taxonomic affinity of the Khudji tooth.

Here, we apply palaeoproteomic analysis to dentine from the Khudji tooth to establish its taxonomic identity. We initially find that although the dentine has a well-preserved endogenous proteome, it is heavily contaminated with modern proteins, with 21 out of a total of 34 identified protein groups deriving from human skin. We therefore apply a bleach decontamination protocol to a second subsample of dentine, and find that nearly all modern contamination is successfully removed, with no negative effects on the endogenous proteome. We thereafter reconstruct the partial amino acid sequences of 12 proteins, consisting of over 3,000 covered amino acid positions. Phylogenetic analyses show that the Khudji hominin groups together with published Neanderthal and modern human reference proteomes. A diagnostic amino acid polymorphism in collagen alpha-2 (I) chain (COL1A2) is identified: R996K, where a K is present in Denisovans, and R in modern humans, Neanderthals and the Khudji hominin. We therefore conclude that based on the currently available reference proteomes, and the data recovered from the dentine, the Khudji hominin is not a Denisovan. However, the question still remains whether it belongs to a modern human or a Neanderthal. Further analyses are ongoing to resolve this question.

The identification of the Khudji hominin as a Neanderthal would be consistent with the Mousterian lithic technology identified at the site [1], and add significant knowledge to the distribution of Neanderthals in Central Asia. Thus far, Neanderthals have only been conclusively identified in Central Asia at Obi-Rakhmat [2] and Teshik-Tash [3], as well as possibly at Sel'Ungur [4] and Anghilak [5]. Determination of the taxonomic identity of the Khudji tooth would therefore both show the applicability of palaeoproteomic analysis to the study of hominin groups in Central Asia, as well as contribute to uncovering the occupational histories of different hominin taxa during the Pleistocene in Central Asia.

This research has been made possible through funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme, grant agreement no. 948365 (PROSPER, awarded to F.W.), the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie grant agreement no. 101106627 (PROMISE, awarded to Z.F.), and the Leakey Foundation (awarded to Z.F.). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Council Executive Agency. Work at the Novo Nordisk Foundation Center for Protein Research is funded in part by the Novo Nordisk Foundation (grant number NNF14CC0001). The work at Khudji has been funded by the US National Geographic Society (grant 5915-97), and analysis of the material by grant 0121TJ1212 «History of the Tajik people». This work was partly supported by NordForsk through 'The timing and ecology of the human occupation of Central Asia', project number 105204.

References: [1] Trinkaus, E., Ranov, V.A., Lauklin, S., 2000. Middle Paleolithic human deciduous incisor from Khudji, Tajikistan. Journal of Human Evolution. 38, 575–584. [2] Bailey, S., Glantz, M., Weaver, T.D., Viola, B., 2008. The affinity of the dental remains from Obi-Rakhmat Grotto, Uzbekistan. Journal of Human Evolution. 55, 238–248. [3] Krause, J., Orlando, L., Serre, D., Viola, B., Prüfer, K., Richards, M.P., Hublin, J.-J., Hänni, C., Derevianko, A.P., Pääbo, S., 2007. Neanderthals in central Asia and Siberia. Nature. 449, 902–904. [4] Krivoshapkin, A., Viola, B., Chargynov, T., Krajcarz, M.T., Krajcarz, M., Fedorowicz, S., Shnaider, S., Kolobova, K., 2020. Middle Paleolithic variability in Central Asia: Lithic assemblage of Sel'Ungur cave. Quaternary International. 535, 88–103. [5] Glantz, M., Viola, B., Wrinn, P., Chikisheva, T., Derevianko, A., Krivoshapkin, A., Islamov, U., Suleimanov, R., Ritzman, T., 2008. New hominin remains from Uzbekistan. Journal of Human Evolution. 55, 223–237.

Podium Presentation, Session 12, Saturday 15:50 – 17:30

Inter-regional population connectivity, not drastic environmental shifts, explains the development of the Aurignacian in southern Italy

Armando Falcucci[1], Paolo Gambassini[2], Adriana Moroni[2]

1 - Department of Geosciences, Prehistory and Archaeological Sciences Research Unit, Eberhard Karls University of Tübingen, Tübingen, Germany · 2 - Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, UR Preistoria e Antropologia, Università di Siena, Siena, Italy

The emergence of the Aurignacian marks a pivotal cultural development in the early Upper Paleolithic. While *Homo sapiens* had arrived prior to its formation [1], it was during this period that our species diffused across a vast geographic expanse, spanning much of Europe. Therefore, understanding the biocultural processes driving the emergence, diffusion, and internal evolution of this technocomplex is paramount. Some scholars propose that the harsh environmental conditions of Heinrich Event 4 spurred an expansion of the ecological niche, evident archaeologically in the transition from the Protoaurignacian to the Early Aurignacian [2]. However, critical stratigraphic sequences necessary to test this hypothesis have been overlooked. Southern Italy, for instance, offers crucial insights into the early Upper Paleolithic through two high-resolution sites containing layers attributed to the late Mousterian, Uluzzian, and Aurignacian assemblages. Grotta di Castelcivita features three Aurignacian layers in stratigraphical continuity with the Uluzzian and positioned beneath the well-known Campanian Ignimbrite tephra, originating from a significant super-eruption in the nearby Phlegraean Fields dated to ~40 ka [3]. A few kilometers away, Grotta della Cala hosts four Aurignacian assemblages dated post-Campanian Ignimbrite, supported by newly acquired radiocarbon and OSL dating. We will present renewed studies at both sites, focusing on lithic technology and multivariate statistics, alongside new data on osseous tools and malacological remains. Remarkably, our findings indicate that the Early Aurignacian began in southern Italy prior to Heinrich Event 4 and the roughly contemporaneous Campanian Ignimbrite. Notably, the Cala Early Aurignacian unveils a previously unrecorded split-based point, underscoring its connections with other Early Aurignacian sites in northern Italy and beyond the Alps. Through quantitative analysis of the chrono-cultural variability in these two southern Italian assemblages, we will finally underline that varying degrees of population interconnectivity and cultural transmission processes [4] were the primary catalysts for cultural change in the early stages of the Aurignacian. Conversely, harsh climates and major environmental catastrophes played minimal to no role in this process, which also emphasizes the resilience of *Homo sapiens* foragers.

Fieldwork and research at Grotta di Castelcivita from 1974 to 1888 were funded by the University of Siena. Geological investigations received funding from the National Geographic Society (Exploration Grant Program, grant NGS-61617R-19 to I. Martini). The technological analysis presented in this study was supported by the German Research Foundation (DFG) under grant agreement no. 431809858 (project title: "Investigating Early Upper Paleolithic Technological Variability and Cultural Dynamics South of the Alps"; recipient: A. Falcucci). This research was supported by the PRIN 2022 TRACE project (PI Prof. Stefano Benazzi and Prof. Adriana Moroni).

References: [1] Mylopotamitaki, D., Weiss, M., Fewlass, H., Zavala, E.I., Rougier, H., Sümer, A.P., Hajdinjak, M., Smith, G.M., Ruebens, K., Sinet-Mathiot, V., Pederzani, S., Essel, E., Harking, F.S., Xia, H., Hansen, J., Kirchner, A., Lauer, T., Stahlschmidt, M., Hein, M., Talamo, S., Wacker, L., Meller, H., Dietl, H., Orschiedt, J., Olsen, J.V., Zeberg, H., Prüfer, K., Krause, J., Meyer, M., Welker, F., McPherron, S.P., Schüler, T., Hublin, J.-J., 2024. Homo sapiens reached the higher latitudes of Europe by 45,000 years ago. Nature. 626, 341-6. [2] Banks, W.E., D'Errico, N.F., Zilhão, J., 2013. Corrigendum to "Human-climate interaction during the Early Upper Palaeolithic: Testing the hypothesis of an adaptive shift between the Proto-Aurignacian and the Early Aurignacian". Journal of Human Evolution. 64, 232. [3] Giaccio, B., Hajdas, I., Isaia, R., Deino, A., Nomade, S., 2017. High-precision 14C and 40Ar/39Ar dating of the Campanian Ignimbrite (Y-5) reconciles the time-scales of climatic-cultural processes at 40 ka. Scientific Reports. 7, 45940. [4] Tostevin, G., 2019. Content matters: The materiality of cultural transmission and the intersection of Paleolithic archaeology with cultural evolutionary theory. In: Love, A.C., Wimsatt, W.C., (Eds). Beyond the Meme: Development and Structure in Cultural Evolution. University of Minnesota Press, Minneapolis, pp. 311-64.

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

selecting palaeontological bone samples for peptide sequencing. Journal of Proteomics. 230, 103986. [3] Sponheimer, M., Ryder, C.M., Fewlass, H., Smith, E.K., Pestle, W.J., Talamo, S., 2019. Saving Old Bones: a non-destructive method for bone collagen prescreening. Scientific Reports. 9, 13928. [4] Fewlass, H., Talamo, S., Kromer, B., Bard, E., Tuna, T., Fagault, Y., Sponheimer, M., Ryder, C., Hublin, J.-J., Perri, A., Sázelová, S., Svoboda, J., 2019. Direct radiocarbon dates of mid Upper Palaeolithic human remains from Dolní Věstonice II and Pavlov I, Czech Republic. Journal of Archaeological Science: Reports. 27, 102000. [5] Kot, M., Berto, C., Krajcarz, M.T., Moskal-del Hoyo, M., Gryczewska, N., Szymanek, M., Marciszak, A., Stefaniak, K., Zarzecka-Szubińska, K., Lipecki, G., Wertz, K., Madeyska, T., 2022. Frontiers of the Lower Palaeolithic expansion in Europe: Tunel Wielki Cave (Poland). Scientific Reports. 12, 16355.

Poster Presentation Number 35, Session 1, Thursday 18:00 – 19:30

The developing morphology of the hominin ilium: preliminary morphometric results

Carla Figus[1], Kristian J Carlson[2], Federica Collina[1], Antonino Vazzana[1], Antony Colombo[3], Eugenio Bortolini[1], Yoël Rak[4], Liubov V. Golovanova[5], Vladimir B. Doronichev[5], Rita Sorrentino[6], Maria Giovanna Belcastro[6], Jean-Jacques Hublin[7], Timothy M Ryan[8], Stefano Benazzi[1]

1 - Department of Cultural Heritage, University of Bologna, Italy · 2 - Department of Integrative Anatomical Sciences, Keck School of Medicine, USC, USA · 3 - Centre national de la recherche scientifique (CNRS) – Université Bordeaux-Montaigne, Pessac, France · 4 - Department of Anatomy and Anthropology, Sackler School of Medicine, Tel Aviv University, Israel · 5 - ANO Laboratory of Prehistory, St. Petersburg, Russia · 6 - Department of Biological, Geological and Environmental Sciences, University of Bologna, Italy · 7 - Collège de France, Paris, France · 8 - Department of Anthropology, Pennsylvania State University, USA

The human ilium plays an essential role in weight bearing, locomotion, and providing support for the body. The study of its ontogenesis offers valuable insights into both skeletal development and the evolutionary history of the human pelvis. Moreover, the comprehension of its developmental process, which is influenced by both genetic and epigenetic factors, is crucial for understanding the adult form and function. Among species, the ilium of *Homo sapiens* and Neanderthals show significant differences in their adult morphologies as well, reflecting plesiomorphic, autapomorphic, and functional modifications. The ontogenetic trajectories of these two species are thought to differ, with Neanderthal infants appearing to have reached skeletal maturity faster than humans.

Here, we analyze the external morphology of the ilium using Geometric Morphometrics (GM) to analyze its developmental pattern and to assess the differences between recent *Homo sapiens* (RH) and *Homo neanderthalensis* (HN). Statistical analyses were performed in R. The sample is composed of 28 ilia from the modern collection of the University of Bologna [1], divided into three age classes (0-1 year; 1-5 years; 5-11 years). The fossil sample comprised the well-preserved juvenile ilia of Mezmayskaia 1 (MZ1) [2] and Le Moustier 2 (LM2) [3], and the restored ilium of Amud 7 [4].

Shape space Principal Component Analysis (PCA) shows that the first three PCs explain 55.9% of the total variance. Most of the variance is explained by PC1 (28.2%), which is strongly correlated with size ($r=76\%$, $p=<0.001$), hence representing an allometric model of ontogenetic morphological modifications of the modern human ilium. PC2 and PC3 explain 16.4% and 10.7%, respectively, of the variance. ANOVA and Tukey post-hoc tests reveal significant differences along PC1 ($p=0.001$) and PC3 ($p=0.01$), with significant differences between the Neanderthal and Sapiens individuals in each age class only along PC3 scores. No significant differences are present between contiguous age classes.

Negative values along PC1 describe individuals whose ilia show a weakly developed anterior and posterior superior iliac spine, greater sciatic notch, and iliac crest curvature, i.e., younger individuals. PC1 positive values depict ilia with a more defined anterior and posterior superior iliac spine, greater sciatic notch, and a well-developed iliac crest curvature, i.e., older individuals. The acetabulum is more concave and defined in older individuals. PC2 scores describe ilia whose superior-inferior length is greater than the antero-posterior length (positive scores), while this difference is reduced in younger individuals (more negative values). PC3 scores describe differences linked to the development of the iliac crest curvature.

Along PC1, the fossil individuals fall in the middle of the variability of modern humans, towards more positive values. When PC2 and PC3 are considered, the fossils plot outside modern human variation, with MZ1 distant from the modern human cluster. Morphological differences between modern humans and Neanderthal individuals are mainly related to the curvature of the iliac crest, and a slightly different orientation in the acetabular area, i.e., more postero-lateral oriented in HN. The more posterolateral orientation of the acetabulum has been described by several studies [5] in individuals of different ages. This particular morphology has been described also in adult Neanderthal individuals and has been interpreted as linked to differences in locomotor biomechanics [5].

These preliminary results add knowledge to the growing corpus of literature on the development of the hominin pelvis. Future analyses will focus on increasing the fossil and comparison sample and including the other coxal bones.

We would like to thank prof. Bruno Maureille and the Musée national de Préhistoire for Le Moustier 2, which is part of its collections. This work is funded by the European Union under the Horizon Europe research and innovation program – Marie Sklodowska-Curie Actions, HORIZON-TMA-MSCA-PF-GF n.101108385-RISEN granted to C.F.

References: [1] Belcastro, M.G., Bonfiglioli, B., Pedrosi, M.E., Zuppello, M., Tanganelli, V., Mariotti, V., 2017. The History and Composition of the Identified Human Skeletal Collection of the Certosa Cemetery (Bologna, Italy, 19th–20th Century). International Journal of Osteoarchaeology. 27, 912–925. [2] Weaver, T.D., Coqueugniot, H., Golovanova, L.V., Doronichev, V.B., Maureille, B., Hublin, J.-J., 2016. Neonatal postcrania from Mezmaiskaya, Russia, and Le Moustier, France, and the development of Neandertal body form. Proceedings of the National Academy of Sciences. 113, 6472–6477. [3] Maureille, B., 2002. A lost Neanderthal neonate found. Nature. 419, 33–34. [4] Rak, Y., Kimbel, W.H., Hovers, E., 1994. A Neandertal infant from Amud Cave, Israel. Journal of Human Evolution. 26, 313–324. [5] Gicqueau, A., Schuh, A., Henrion, J., Viola, B., Partiot, C., Guillon, M., Golovanova, L., Doronichev, V., Gunz, P., Hublin, J.-J., Maureille, B., 2023. Anatomically modern human in the Châtelperronian hominin collection from the Grotte du Renne (Arcy-sur-Cure, Northeast France). Scientific Reports. 13, 12682.

Poster Presentation Number 36, Session 1, Thursday 18:00 – 19:30

Subsistence strategy and mobility of the Mesolithic population from Jebel Sabaloka (Sphinx) in central Sudan as inferred from the femoral cross-sectional geometry

Lukas Friedl[1,2], Isabelle Crevecoeur[3], Petra Brukner Havelková[4,5], Petr Velemínský[4], Ladislav Varadzin[5,6], Lenka Varadzinová[5]

1 - Department of Anthropology, University of West Bohemia, Pilsen, Czech Republic · 2 - Interdisciplinary Center for Archaeology and the Evolution of Human Behaviour, University of Algarve, Portugal · 3 - UMR 5199 PACEA, CNRS, Université de Bordeaux, Pessac, France · 4 - Department of Anthropology, Natural History Museum, National Museum, Prague, Czech Republic · 5 - Czech Institute of Egyptology, Faculty of Arts, Charles University, Prague, Czech Republic · 6 - Institute of Archaeology, Czech Academy of Sciences, Prague, Czech Republic

The Mesolithic is commonly understood as a transitional period in human history, through which human populations gradually shifted from hunting and gathering to food production. However, the nature of this transition is regionally specific and it is characterized not only by the shift in subsistence but also by increased sedentism. In North Africa, the same period is not a particularly well understood in terms of shifting subsistence strategies, in part because of scarcity of evidence. Here, we test assumptions about subsistence and mobility in early Holocene North Africa through femoral cross-sectional geometry on the osteological remains from the site of Sphinx in Jebel Sabaloka in central Sudan [1]. Archeological evidence suggests that while still foraging, the Mesolithic people from central Sudan may have been partially dependent on fresh water resources that made them significantly more sedentary [2]. Thus, we used specific femoral cross-sectional geometric properties to infer mobility and general robusticity levels. We compared the Mesolithic sample from Sabaloka (n=11), dated between ca. 8700 and 7900 cal BP [3] with a set of Terminal Pleistocene and Early Holocene samples from other regions in North Africa, fossil hominins (Neanderthals and Middle Paleolithic Homo sapiens), and European samples spanning from the Upper Paleolithic to recent times. The results show that the Sabaloka sample has a significantly lower midshaft and proximal femoral %CA (relative cortical area in a cross-section) than the other North African samples and generally similar to European samples (with the exception of proximal femoral %CA in Upper Paleolithic and Mesolithic samples). It indicates general gracility and likely decreased mechanical needs consistent with lower levels of general labor. Comparisons of Polar section modulus standardized for body size did not reveal any significant differences between Sabaloka and other samples, but this could have been caused by very low sample sizes due to missing body size estimates in a couple of the samples, including Sabaloka, where body size estimates were available for only three individuals. Graphical comparison nonetheless shows that for midshaft, Neanderthals, Middle Pleistocene H. sapiens, and Wadi Halfa (one of the North African samples) have higher average bone strength than the Mesolithic and later samples. In the proximal femur (80% section), there are no significant differences between Sabaloka and other samples either, however, bone strength distribution is reversed with Neanderthals and recent European samples showing higher values, consistent with higher loadings put on this bone region. Finally, midshaft cross-sectional shape index (Ix/Iy) in the Sabaloka sample indicates antero-posterior reinforcement indicative of higher mobility. Only Neanderthals and Holocene European samples (Mesolithic through recent) were significantly different in this parameter (rounder midshafts indicative of decreased mobility or in Neanderthals reflecting structural differences in the femur). Proximal femoral shape index (Imax/Imin) indicates that North African samples (including Sabaloka) had less oval cross-sections than European samples, which might have experienced pronounced bending forces in the proximal femur (in part likely as a result of sedentary, agricultural work). Overall, our results support a hypothesis that the Mesolithic population from Jebel Sabaloka (Sphinx site) still likely depended on foraging (higher mobility) but with relatively low levels of general mechanical demands put on their lower limbs. These results are consistent with fishing and fresh water resource exploitation practices being incorporated into their subsistence.

The authors thank the National Corporation for Antiquities and Museums of the Sudan for their support to the Sabaloka (West Bank) Research Project and their permission to export the human remains to the Czech Republic for detailed study and analyses. Preparation of this poster was supported by the Czech Science Foundation (projects no. GAČR 17 03207S and 23-06488S), International Research Project (IRP) ABASC (CNRS-INEE), Bordeaux University and the French government in the framework of the University of Bordeaux's IdEx "Investments for the Future" program/GPR "Human Past", and by the University of West Bohemia student grant support (SGS-2024-012). The acquisition of femoral CT scans was made possible by the Ministry of Culture of the Czech Republic (DKRVO 2024-2028/7.I.a, 00023272).

References: [1] Brukner Havelková, P., Crevecoeur, I., Villotte, S., Velemínský, P., Varadzin, L., Varadzinová, L. 2022. Palaeodemography and palaeopathology of Khartoum Mesolithic skeletal remains from Jebel Sabaloka in central Sudan: First insights from the site of Sphinx. Journal of the National Museum (Prague), Natural History Series, 191(1), 65–82. https://doi.org/10.37520/jnmpnhs.2022.00 [2] Varadzinová, L., Varadzin, L., Ambrose, S. H. 2023. New radiocarbon dates for postglacial reoccupation of the Sudanese Nile. Quaternary Science Reviews 302, 107953. https://doi.org/10.1016/j.quascirev.2023.107953 [3] Varadzinová, L., Varadzin, L., Brukner Havelková, P., Crevecoeur, I., Garcea, E. A. A. 2022. Archaeology of Holocene hunter-gatherers at the Sixth Nile Cataract, central Sudan / Données archéologiques sur les derniers chasseurs-cueilleurs pres de la sixième cataracte du Nil au Soudan central. Bulletin d'Archeologie Marocaine 27, 101–118.

Pecha Kucha Presentation, Session 7, Friday 13:30 – 15:00

From landmarks to lineages: advancing species tree inference using partitioned 'morph trees'

Julia Galway-Witham[1,2], Susan C. Antón[1,2]

1 - Center for the Study of Human Origins, Department of Anthropology, New York University · 2 - New York Consortium in Evolutionary Primatology

By nature, fossil records are fragmentary. This fragmentation can occur at various levels: they may only preserve a subset of the overall taxonomic diversity or only portions of the specimens themselves. The fossil record is, therefore, a biased sample of what lived in the past and scientists must rely on a limited number of fossils that may not be representative of the clade as a whole. To allow phenotypes to function in a unified way, skeletal elements are largely integrated structures [1]. Consequently, it is common for scientists to make rough inferences about the form of missing morphology of a fragmentary specimen, based on the preserved portions of its morphology [2]. Complicating this, however, is the fact that elements are not perfectly integrated. Some portions of a specimen covary more with each other than they do with other portions of the specimen: these are called morphological modules [3]. This variance in correlation structure allows organisms to develop and evolve. Consequently, we may find that these modules vary in their accuracy as indicators of the organism's underlying evolutionary history, further complicating the process of phylogenetic inference [4].

Here, we directly address potential differences in phylogenetic signals across morphological modules by taking inspiration from the concept of 'gene trees' and 'species trees' in population genetics to improve our phylogenetic inference methods for fragmentary fossils. Just as different genes within the same individual may produce different tree topologies, so too do different morphological modules from the same specimen differ in branching structure when used separately in phylogenetic inference. This novel method adapts existing population genetic methods that explicitly accommodate gene tree incongruence for use with morphological data. This is achieved by constructing individual 'morph trees' (analogous to gene trees) based on partitioned 3D data of different morphological modules, and inferring species trees from the clusters of morph trees.

The research presented here illustrates the ability of the method to analyse simulated 3D morphological datasets and compares the inferred species tree to the known species tree. We also compare the inferred species tree to reconstructions using unpartitioned data. Finally, we assess the ability of the method to derive the correct species tree given artificially fragmented data. To our knowledge, this work represents the first application of methods used for population genetics to improve phylogenetic inference using morphological data. This work has the potential for significant scientific importance by allowing us to maximise the use of available data, shining a light on overlooked theoretical assumptions of existing methods, and providing a scalable approach that has the potential for adoption by researchers of other clades.

JGW is jointly supported by the National Science Foundation Graduate Research Fellowship Program and the New York University MacCracken Fellowship.

References: [1] Olson, E.C., Miller, R.L., 1958. Morphological Integration. University of Chicago Press, Chicago. [2] Antón, S.C., Middleton, E.R., 2023. Making meaning from fragmentary fossils: Early *Homo* in the Early to early Middle Pleistocene. Journal of Human Evolution. 179, 103307. [3] Klingenberg, C.P., 2014. Studying morphological integration and modularity at multiple levels: concepts and analysis. Philosophical Transactions of the Royal Society B: Biological Sciences. 369, 20130249. [4] Cardini, A., Elton, S., 2008. Does the skull carry a phylogenetic signal? Evolution and modularity in the guenons. Biological Journal of the Linnean Society. 93, 813–834.

Poster Presentation Number 38, Session 1, Thursday 18:00 – 19:30

New elements on the Gravettian-Solutrean transition in westernmost Iberia: the production of Vale Comprido points at Portela 2 (Leiria, Portugal)

Cristina Gameiro[1], Diego Angelucci[1,2], Thierry Aubry[1,3], Vânia Carvalho[4], Luca Dimuccio[1,5], Telmo Gomes[6], Marina Igreja[1,7], Henrique Matias[1], Ana Luísa Rodrigues[8], Maurizio Zambaldi[1,2]

1 - UNIARQ - Centre for Archaeology, School of Arts and Humanities, University of Lisbon, Portugal · 2 -LaBAAF, University of Trento, Italy · 3 -Côa Parque - Fundação para a Valorização e a Salvaguarda do Vale do Côa, Portugal · 4 -Câmara Municipal de Leiria, Portugal · 5 -CEGOT - Centro de Estudos em Geografia e Ordenamento do Território, University of Coimbra, Portugal · 6 - SMAS de Leiria, Portugal · 7 -LARC, Património Cultural, I.P./ CIBIO – INBIO, Portugal · 8 -C2TN - Centro de Ciências e Tecnologias Nucleares, Instituto Superior Técnico, University of Lisbon, Portugal

In 2009, the opening of a ditch related to the Maceira (Leiria, Central Portugal) sanitation network led to the discovery of the Portela 2 archaeological site. The recovery of Vale Comprido lithic points has immediately suggested a Protosolutrean occupation, a transitional phase between the Gravettian and Solutrean periods, dated to Henrich Event (HE) 2 at the beginning of the Last Glacial Maximum [1-2]. This type of lithic point was identified as a formal tool in the mid-1990s [2] and is perceived as diagnostic of the Gravettian-Solutrean transition. The technology of the Protosolutrean is poorly known; however, this transitional phase is well documented in the central littoral region of Portugal, where the records exhibit a degree of resolution that remains unmatched in southwestern Europe [3].

Therefore the high refitting potential of the recovered lithic assemblage and the assumption that the site should extend beyond the limits of the 2009 excavated area, prompted new excavation campaigns during 2021 and 2022 in the scope of the PALEORESCUE project [4]. Field observations allowed to consider the archaeological site within the surrounding landscape, to recover a larger artefact assemblage, and to investigate the site formation processes through geoarchaeological and geochronological analyses [5].

Ten main archaeological units of stratification were identified during fieldwork, and further grouped into two geoarchaeological complexes. Overall, the studied sedimentary succession consists of remobilized Cretaceous and Pliocene siliciclastic deposits. Microstratigraphic, sedimentological and petrographic analyses suggest that the deposit was laid down by slope processes, such as one or multiple colluvial events, between the end of the Pleistocene and the beginning of the Holocene, without excluding a contribution of direct aeolian inputs and some alluvial interference. A later period of stability is then marked by the activation of the podzolisation process.

Palaeolithic lithic artefacts were found only in the top units of the stratification (SU 102-106), while below, the deposits are archaeologically sterile. The lithic assemblage recovered during the 2021 and 2022 campaigns amounts to 3428 artefacts. Debitage is directed towards producing elongated flakes and blades, then transformed into Vale Comprido points, which constitute most of the formal tools. Reduction sequence of blank production uses a stone hammer originating a thick butt and the typical dorsal basal thinning retouch of these points was, probably, performed at the site, but some of the points do not present the distal retouch. Small Cenomanian flint cobles were probably collected locally. Most of the blade cores feature a single platform and unidirectional, convergent debitage. Abrasion is absent and hinging is frequent – two characteristics consistent with hard stone hammer use. Most cores present negatives consistent with an elongated flake or blade debitage and feature a single platform and unidirectional debitage. To gather information on the possible use of the Vale Comprido points, a set of 14 pieces underwent use-wear analysis. The analysed material exhibits edges and surfaces marked by the presence of a mechanical weathering distributed uniformly, likely resulting from site conditions. These post-depositional alterations affect the Portela 2 materials, rendering them unsuitable for observation under the microscope. Spatial analysis on lithic artefacts shows a concentration of larger artefacts in the 2009 excavated area in contrast to the 2021-2022 ones, where smaller pieces and almost no cores were detected. This pattern distribution suggests that human occupation took place in the area nearby the present-day sewer lift station. From a qualitative perspective, it appears to be the best place to camp because it offers protection from the northern winds. The local availability of Cenomanian flint and the nearby existence of a water line / creek or a small lake (consistent with oral information) could explain the specialisation in Vale Comprido points production and the on-site hunting activities.

This work was financed by Portuguese funds through FCT - Fundação para a Ciência e a Tecnologia in the framework of the projects UIDB/00698/2020 (https://doi.org/10.54499/UIDB/00698/2020), UIDP/00698/2020 (https://doi.org/10.54499/UIDP/00698/2020) and PALEORESCUE (PTDC/HAR-ARQ/30779/2017). A special thanks to Câmara Municipal de Leiria and SMAS de Leiria for financial and logistic support.

References: [1] Zilhão, J., Aubry, T., Almeida, F., 1999. Un modèle technologique pour le passage du Gravettien au Solutréen dans le Sud-Ouest de l'Europe. XXIVème Congrès Préhistorique de France, pp. 165-183. [2] Zilhão, J., Aubry, T., 1995. La pointe de Vale Comprido et les origines du Solutréen. L' Anthropologie. 99, 125-142. [3] Zilhão, J., 2013. Seeing the leaves and not missing the forest: a Portuguese perspective of the Solutrean, In: Pastoors, A., Auffermann, B., (Eds). Pleistocene foragers on the Iberian Peninsula: their culture and environment, Neanderthal Museum, Mettmann, pp. 201–216. [4] Gameiro, C., Zambaldi, M., Dimuccio, L., Lucena, A., Carvalho, V., Gomes, T., 2022. "Portela 2 (Vale Brusco, Maceira, Leiria): primeiros resultados da campanha arqueológica de 2021". Al-Madan online. 25, 17-26. [5] Zambaldi, M., Dimuccio, L., Angelucci, D.E., Gameiro, C., 2022. Deciphering stratigraphy and formation processes at the open-air Portela 2 archaeological site (Central Portugal), 10th International Conference on Geomorphology, Coimbra, Portugal, 12–16 Sep 2022, ICG2022-243.

Poster Presentation Number 39, Session 1, Thursday 18:00 – 19:30

Dental tissue variability as a possible indicator of sexual dimorphism in Homo antecessor

Cecilia García-Campos[1,2], María Martinón-Torres[2,3], Mario Modesto-Mata[2,4], Laura Martín-Francés[2,5,6], Marina Martínez de Pinillos[2,7], José María Bermúdez de Castro[2,3]

1 - Universidad Autónoma de Madrid, Ciudad Universitaria de Cantoblanco, Madrid, Spain · 2 - Centro Nacional de Investigación sobre la Evolución Humana, Burgos, Spain · 3 - Anthropology Department, University College London, London, UK · 4 - Universidad Internacional de La Rioja (UNIR), La Rioja, Spain · 5 - Institut Català de Paleoecologia Humana i Evolución Social (IPHES), Tarragona, Spain · 6 - Centro Mixto Universidad Complutense de Madrid - Instituto de Salud Carlos III de Evolución y Comportamiento Humanos, Madrid, Spain · 7 - Laboratorio de Evolucion Humana (LEH), Universidad de Burgos, Burgos, Spain

Sexual dimorphism is an important aspect of the total variability observed in the fossil record. However, the current knowledge about sexual dimorphism in the human lineage mainly comes from the study of modern humans, Neanderthals, and pre-Neanderthal populations [1], whereas information available about the intrapopulation variability of the groups preceding these taxa is still ambiguous. In this preliminary study, the hominin sample from the Gran Dolina-TD6.2 site, within the Sierra de Atapuerca archaeological complex (Burgos, Spain), was assessed to evaluate the degree of variability in their permanent canine dental tissue proportions. We analyzed canines ATD6-13, belonging to individual H1 (the holotype of *H. antecessor*), and the canine ATD6-69, included within the maxilla ATD6-69 and belonging to individual H3 [2]. Microtomographic techniques were employed to measure and compare the crown volumes and surface areas of their enamel caps and dentine-pulp complexes [3]. Then, Pearson's Coefficient of Variation and the Euclidean Distance were assessed to evaluate the intrapopulation variability of the dental sample. The analysis of the two upper canines of Gran Dolina-TD6.2 reveals that the H1 canine has larger absolute crown dimensions (Vc, BS, OES, EDJS) than those of H3. Interestingly, despite this, individual H3 displays higher volume and relative enamel dimensions (3DAET, 3DRET, and OES/EDJS). Furthermore, our results showed marked intrapopulation variability in the dental tissue measurements of the canines from this site, with CV values compared to those of the dental samples from the Sima de los Huesos site (Spain), the Neanderthal site of Krapina (Croatia), as well as from a broad forensic collection of known sexes. This variability may be interpreted as an indicator of sexual dimorphism. If this is the case, H1 may be considered a male individual, whereas H3 would be female. This would concur with the hypothesis proposed in previous works. On the one hand, the H1 teeth are very large in the context of the variability known for the European Pleistocene fossil record. For this reason, H1 was previously estimated to represent a young male individual with an age at death of 12.9 years old according to current standards [4]. Likewise, the remarkable size difference between the teeth of the mandibles ATD6-5 (H1) and ATD6-96 (H7) led Carbonell et al. (2005) [5] to suggest that the former was probably male. On the other hand, except for the alveolar width, the facial dimensions of ATD6-69 are small, which has been associated with youth, between 10 and 12 years old [4]. However, the results obtained in various studies suggest that 85% of maxillary size is reached by the age of 6, which opens the door to the hypothesis that the size of this individual maxilla may be due to the effect of intersexual variability. Unfortunately, the small sample size of the TD6.2 population prevents us from obtaining conclusive inferences. The discovery of new fossils at this level of Gran Dolina could help better understand the intrapopulation variability of this sample and, therefore, confirm or refute these hypotheses. In any case, the results obtained in this study show the usefulness of the dental tissue proportions of permanent canines for assessing sexual dimorphism in modern and past human populations. They can be a particularly useful tool in paleoanthropological contexts, where other bone structures are often fragmented or absent, especially in those with a greater representation of subadult individuals.

This study has been supported by the Dirección General de Investigación of the Spanish Ministerio de Economía y Competitividad (MINECO /FEDER) grant number: PGC2018-093925-B-C31 and The Leakey Foundation through the personal support of G. Getty (2013) and D. Crook (2014-2020) to M. M-T.

References: [1] García-Campos, C., Modesto-Mata, M., Martinón-Torres, M., Martínez de Pinillos, M., Martín-Francés, L., Arsuaga, J.L., Bermúdez de Castro, J.M., 2020. Sexual dimorphism of the enamel and dentine dimensions of the permanent canines of the Middle Pleistocene hominins from Sima de los Huesos (Burgos, Spain). Journal of Human Evolution, 144,102793. [2] Bermúdez-de-Castro, J.M., Martinón-Torres, M., Martín-Francés, L., Modesto-Mata, M., Martínez-de-Pinillos, M., García-Cmpos, C., Carbonell, E., 2017. *Homo antecessor*: The state of the art eighteen years later. Quaternary International, 433A, 22-31. [3] Olejniczak, A.J., Smith, T.M., Feeney, R.N.M., Macchiarelli, R., Mazurier, A., Bondioli, L., Rosas, A., Fortea, J., de la Rasilla, M., Garcia-Tabernero, A., Radovčić, J., Skinner, M.M., Toussaint, M., Hublin, J.-J., 2008. Dental tissue proportions and enamel thickness in Neandertal and modern human molars. Journal of Human Evolution, 55, 12-23. [4] Bermúdez de Castro, J.M., Rosas, A., Carbonell, E., Nicolas, M.E., Rodríguez, J., Arsuaga, J.L., 1999. A modern human pattern of dental development in Lower Pleistocene hominids from Atapuerca-TD6 (Spain). Proceedings of the National Academy of Sciences USA. 96, 4210e4213. [5] Carbonell, E., Bermúdez de Castro, J.M., Arsuaga, J.L., Allue, E., Bastir, M., Benito, A., Caceres, I., Canals, T., Díez, J.C., van der Made, J., Mosquera, M., Olle, A., Perez- Gonzalez, A., Rodríguez, J., Rodríguez, X.P., Rosas, A., Rosell, J., Sala, R., Vallverdú, J, Verges, J.M., 2005. An early Pleistocene hominin mandible from Atapuerca-TD6, Spain. Proceedings of the National Academy of Sciences USA. 102, 5674e5678.

Podium Presentation, Session 8, Friday 15:20 – 17:00

The pattern of skeletal growth and development in Sima de los Huesos hominins

Rebeca García-González[1], Azahara Salazar-Fernández[1], Julia Muñoz-Guarinos[1], Laura Rodríguez[1,2], Guillermo Zorrilla-Revilla[1], Juan Luis Arsuaga[3,4], José Miguel Carretero[1,5]

1 - Laboratorio de Evolución Humana, Departamento de Historia, Geografía y Comunicación, Universidad de Burgos, Burgos, Spain · 2 - Área de Antropología, Universidad de León, León, Spain · 3 - Centro UCM-ISCIII de Investigación sobre la Evolución y Comportamiento Humanos, Avda, Madrid, Spain · 4 - Departamento de Paleontología, Facultad de Ciencias Geológicas, Universidad Complutense de Madrid, Ciudad Universitaria Madrid, Spain · 5 - Unidad Asociada de I+D+i al CSIC Vidrio y Materiales del Patrimonio Cultural (VIMPAC), Madrid, Spain

Many of the traits defining our unique pattern of growth and development were not present in australopiths emerging during the evolution of the genus *Homo*. Much of the evidence comes from studies on incremental records preserved in dental tissues [1]. However, although dental development may be a good proxy for the pace of growth, it is not necessarily informative of the tempo of growth and development of the postcranial skeleton [2]. Therefore, combining aspects of dental and skeletal development is crucial for obtaining a complete picture of the pattern of growth and development in past human species. Unfortunately, due to the scarcity of complete fossil non-adult skeletons, few studies have examined both aspects together, leading to controversial opinions, as seen in the case of the Nariokotome boy and Neandertals [3-4]. These controversial findings can be attributed to two main reasons. First, the use of different proxies for skeletal development, which show varying relationships with dental development, may lead to different conclusions. Second, these studies often focus on a single individual, lacking evidence of inter-individual variability. The ideal way to address these questions is to perform a comprehensive analysis of growth and development based on different proxies in fossil individuals belonging to the same paleodeme, such as the case of the Sima de los Huesos (SH) site [5]. SH is a well-known Middle Pleistocene site where more than 7,000 hominin remains have been recovered, representing a minimum of 29 individuals. Among these individuals, most are non-adults, highlighting this extraordinary collection as an unparalleled opportunity to examine growth and development variability in a fossil species. Previous studies on dental development have shown a relative advanced of the third molar along general reduced enamel formation times in SH hominins. Although, there has been no established association between non-adult dental individuals and those represented by different bones recovered from SH, the most plausible hypothesis is that these bones belong to some of the dental individuals.

Therefore, our main goal is to accomplish a comprehensive study on skeletal growth and development in this sample to complete our understanding of the relationship between dental and skeletal development in SH hominins. Given that growth and developmental variation increases with age, the ideal approach to account for as much variability as possible is to focus on bones with different tempos of growth and development. Modern humans, like great apes, ossify the appendicular skeletal joints in sequence starting from the elbow and finishing to the shoulder. Additionally, the rate at which various segments of the body grow differs, with the length of the femur accounting for more growth during the preadolescent phase, followed by the humerus, and lastly the growth of transverse dimensions. Consequently, we focus on the growth and development of the following three long bones: humerus, femur, and clavicle. The minimum number of non-adult individuals represented in the SH sample for each bone is 7, 14, and 10, respectively.

In these three bones, we conducted an analysis of the linear and appositional growth from the comparative analyses of growth in length and in the cross-sectional properties extracted from CT-scans. Moreover, we assessed maturational changes based on shape changes on epiphyses and metaphyseal surfaces using 3D geometric morphometric methods. Our preliminary findings show several differences in skeletal growth and development in Sima de los Huesos (SH) hominins compared to modern humans. These results will be interpreted within the broader context of the evolution of modern growth and development patterns. Additionally, we emphasize the implications of the methodological approach presented here for reconstructing the growth and development of fossil individuals represented solely by postcranial elements.

We thank the Sima de los Huesos excavation team and the Laboratory of Human Evolution from the University of Burgos. This project is funded by a PhD grant co-funded by the Government of Castilla y León and the European Union -BOCYL-D-07/07/2020 nº 135 p. 23452- and Spanish Ministry of Science, Innovation and Universities project PID2021-122355NB-C31.

References: [1] Smith, T.M., 2008. Incremental dental development: Methods and applications in hominoid evolutionary studies. Journal of Human Evolution. 54, 205–224. [2] Šešelj, M., 2012. Relationship between dental development and skeletal growth in modern humans and its implications for interpreting ontogeny in fossil hominins. American Journal of Physical Anthropology. 150, 38–47. [3] Dean, M.C., Smith, B.H., 2009. Growth and development of the Nariokotome youth, KNM-WT 15000 In: Grine, F.E., Fleagle, J.G., Leakey, R.E. (Eds). The First Humans – Origin and Early Evolution of the Genus *Homo*. Vertebrate Paleobiology and Paleoanthropology. Springer, Dordrecht, pp. 101–120. [4] Rosas, A., Ríos, L., Estalrrich, A., Liversidge, H., García-Tabernero, A., Huguet, R., Cardoso, H., Bastir, M., Lalueza-Fox, C., de la Rasilla, M., Dean, C., 2017. The growth pattern of Neandertals, reconstructed from a juvenile skeleton from El Sidrón (Spain). Science. 357, 1282–1287. [5] Arsuaga, J.L., Carretero, J.-M., Lorenzo, C., Gómez-Olivencia, A., Pablos, A., Rodríguez, L., García-González, R., Bonmatí, A., Quam, R.M., Pantoja-Pérez, A., Martínez, I., Aranburu, A., Gracia-Téllez, A., Poza-Rey, E., Sala, N., García, N., Alcázar de Velasco, A., Cuenca-Bescós, G., Bermúdez de Castro, J.M., Carbonell, E., 2015. Postcranial morphology of the middle Pleistocene humans from Sima de los Huesos, Spain. Proceedings of the National Academy of Sciences. 112, 11524–11529.

Podium Presentation, Session 10, Saturday 11:00 – 12:40

Unveiling a ~290 Kya hominin partial parietal bone from the "Ruidera-Los Villares" paleoanthropological site: filling the gap of the Middle Pleistocene record of the Iberian Peninsula

Daniel García-Martínez[1,2,3], Candelas Buenestado Ruíz[1], Sara Díaz Pérez[4], Josu Aranbarri[5], Lucía Bermejo Albarrán[6], Isidoro Campaña Lozano[7], Óscar Cambra-Moo[8], Gabriel Cifuentes-Alcobendas[9,10], Miren Del Val[3], Mathieu Duval[3], Raquel Dotes-Güendian[8], Manuel D. D'Angelo del Campo[8,11,12], Almudena Estalrrich[13], Beatriz Fernández Cascón[13], Dario Fidalgo-Casares[13], Cecilia García Campos[8], Marta Gómez Recio[13], Francesc Gascó-Lluna[14], Armando González-Martín[8], Rosa Huguet[13]. Miguel López Cano[13], José María López-Rey[13], Mario Modesto Mata[3], Davinia Moreno[3], Mariano Padilla Cano[15], Miriam Pérez de los Ríos[1], Pedro R. Moya-Maleno[16], Mailys Richard[17], Markus Bastir[13], Antonio Rosas[13], Tomás Torres Medina[1], Carlos A. Palancar[13]

1 - Physical Anthropology Unit, Biodiversity, Ecology and Evolution Department, Universidad Complutense de Madrid, Madrid, Spain · 2 - Laboratory of Forensic Anthropology, Centre for Functional Ecology, Department of Life Sciences, Universidade de Coimbra, Coimbra, Portugal · 3 - CENIEH (National Research Center on Human Evolution), Paseo de la Sierra de Atapuerca 3, Burgos, Spain · 4 - Institute of Archaeology, University of Wrocław, Wrocław, Poland · 5 - Department of Geography, Prehistory and Archeology, Universidad del País Vasco/Euskal Herriko Unibertsitatea, UPV/EHU · 6 - Primeros Pobladores de Extremadura (EPPEX), Extremadura, Spain · 7 - Department of Ecology and Geology, Faculty of Sciences, Universidad de Málaga, Spain · 8 - Laboratorio de Poblaciones del Pasado (LAPP), Department of Biology, Faculty of Sciences, Universidad Autónoma de Madrid · 9 - Instituto de Evolución en África, Universidad de Alcalá Madrid, Spain · 10 - Universidad de Alcalá, Department of History and Philosophy, Madrid, Spain · 11 - Consejo Nacional de Investigaciones Científicas y Técnicas, Centro Científico Tecnológico-Tandil (CONICET, CCT Tandil), Provincia de Buenos Aires, Argentina · 12 - Universidad Nacional del Centro de la Provincia de Buenos Aires (UNCPBA), Facultad de Ciencias Sociales (FACSO), Laboratorio de Ecología Evolutiva Humana (LEEH), Unidad de Enseñanza Universitaria Quequén (UEUQ). Necochea, provincia de Buenos Aires, Argentina · 13 - Grupo de Paleoantropología, Departamento de Paleobiología, Museo Nacional de Ciencias Naturales (MNCN - CSIC) · 14 - Faculty of Humanities and Social Sciences, Universidad Isabel I, Burgos, Spain · 15 - Museo de Anatomía Comparada de Vertebrados, Biodiversity, Ecology and Evolution Department, Universidad Complutense de Madrid, Madrid, Spain · 16 - Área de Prehistoria, Facultad de Geografía e Historia, Complutense University of Madrid, c/Profesor Aranguren S/N, 28040 Madrid, Spain · 17 - Archéosciences Bordeaux, UMR 6034 CNRS-Université Bordeaux Montaigne, Maison de l'Archéologie, Université Bordeaux Montaigne, Pessac, France

After a road construction in the 1960s, faunal fossils were surface collected by locals at the "Los Villares" house state (Ruidera, Ciudad Real). The study of the fossils showed the presence of cutmarks on some herbivore bones dated around 300-400 ka by a combined ESR-Uranium series approach [1]. A systematic excavation of 10 m² was carried out in 2023 to clarify the spatial and stratigraphic extension of the fossil assemblage. We observed that the site is formed by red breccias with speleothem fragments, interpreted as the sedimentary infill of an eroded rock shelter, some of them being in a secondary position. The faunal analysis showed that small bovids dominate the association, although the greatest diversity is found among carnivores. The mammal community is compatible with other Iberian sites from the late Middle Pleistocene, suggesting a rocky ecosystem with scattered vegetation. The reduced lithic tools assemblage consists of quartzite cores and flakes with few extractions, possibly attributed to an ancient industry. Finally, a partial human parietal bone from a large hominin stands out among the fossil remains found during this campaign. The fossil, about 8x7x1 centimeters, preserves enough morphological features to make its anatomical assessment as part of the coronal suture, the temporal line, and a "human-like" middle meningeal artery imprint [2]. OSL dating yields a preliminary age of 290 ± 24 ka. As the fossil remains were not found in situ, establishing the sedimentary context and dose rate calculation was complicated. A thin layer of sediment was extracted from the inner part of the fossil, under controlled red light conditions. The inner core was used to extract the quartz for equivalent dose calculation. The external part that had been exposed to light was removed and kept for ICP-MS analysis to determine the beta dose rate. Gamma dose rate was derived from a sediment sample which apparently corresponded to the same unit where the fossil belonged. Comparing the anatomy of the fossil remains, RV'23-005 has a maximum thickness of 11.37 mm in the area above the temporal bone squama, whereas other fossils from the Iberian Peninsula such as the Skull 5 from Sima de los Huesos have a maximum thickness in that area around 8.5 mm [3]. Also, we quantified the angulation of the parietal bone at the temporal line showing RV'23-005 an angle of 131,2º, whereas other European groups such as the Sima de los Huesos and Neanderthals presented, on average, a much lower angulation (123.26º and 114.69º). The results of the partial parietal bone RV'23-005 add valuable data on the variability of the scarce remains from Middle Pleistocene human anatomy of the Iberian Peninsula, where some fossil sites such as Atapuerca Sima de los Huesos and Galería (Burgos, Spain), and Gruta de Aroeira (Portugal) stand out. Because of the complicated taxonomical interpretation of the Middle Pleistocene in Europe [4], the potential attribution of a precise species of the genus *Homo* for RV'23-005 is an ongoing investigation. Its morphology and features could represent an *H. heidelbergensis* deme [sensu 5] from the southern Iberian Plateau that could shed light on the peopling of Western Europe and the evolution of the human lineages.

We thank Antonio Ruiz Reinosa, guard of the house state, for their kindness and collaboration regarding the preservation of the archaeo-paleontological heritage in Los Villares. We also want to acknowledge Ignacio Mosqueda (Parque Natural de las Lagunas de Ruidera), Josefa Moreno (Ruidera mayoress), and Omar Collado (Albergue juvenile Alonso Quijano). Finally, we want to thank the excavation team for their great work in the first excavation campaign. DGM is funded by the PR3/23-30817 project (UCM), and the excavation campaign was funded by www.goteo.org and institutions such as the Laboratorio de Poblaciones del Pasado (UAM). Part of this work has been supported by Spanish Ministry of Science and Innovation (MICINN/ FEDER): PID2021-122356NBI00.

References: [1] García Martínez, D., Duval, M., Zhao, J., Feng, Y., Wood, R., Huguet, R., Cifuentes-Alcobendas, G., Palancar, C.A., Moya-Maleno, P.R., 2022. Los Villares locality (Ruidera, Castilla-La Mancha, Spain): a new Middle Pleistocene fossil assemblage from the Southern Iberian Plateau with possible evidence of human activity. Cuaternario y Geomorfología. 36, 7–35. [2] Bruner, E., Sherkat, S., 2008. The middle meningeal artery: from clinics to fossils. Child's Nervous System. 24, 1289–1298. [3] Sala, N., Pantoja-Pérez, A., Gracia, A., Arsuaga, J.L., 2022. Taphonomic-forensic analysis of the hominin skulls from the Sima de los Huesos. The Anatomical Record. 307, 2259–2277. [4] Di Vincenzo, F., Manzi, G., 2023. *Homo heidelbergensis* as the Middle Pleistocene common ancestor of Denisovans, Neanderthals and modern humans. Journal of Mediterranean Earth Sciences, 15. [5] Rosas, A., Bastir, M., Alarcón, J.A., 2019. Tempo and mode in the Neandertal evolutionary lineage: A structuralist approach to mandible variation. Quaternary Science Reviews, 217, 62-75.

Podium Presentation, Session 12, Saturday 15:50 – 17:30

A sedimentary ancient DNA perspective on human and carnivore persistence through the Last Glacial Maximum in El Mirón Cave, Spain

Pere Gelabert[1,2,3], Victoria Oberreiter[1,2,3], Lawrence Guy Straus[4,5], Manuel Ramón González Morales[6], Susanna Sawyer[1,2], Ana B. Marín-Arroyo[5], Jeanne Marie Geiling[5], Florian Exler[1,7], Olivia Cheronet[1,2], José-Miguel Tejero[2,9], Ron Pinhasi[1,2]

1 - Department of Evolutionary Anthropology, University of Vienna, Vienna, Austria · 2 - Human Evolution and Archeological Sciences (HEAS), University of Vienna, Vienna, Austria · 3 - These authors contributed equally to this work · 4 - Department of Anthropology, University of New Mexico, Albuquerque, NM, USA · 5 - Grupo I+D+i EvoAdapta, Departamento de Ciencias Históricas, Universidad de Cantabria, Santander, Spain · 6 - Instituto Internacional de Investigaciones Prehistóricas de Cantabria (Universidad de Cantabria, Gobierno de Cantabria, Santander), Santander, Spain · 7 - Department of Environmental Geosciences, Centre for Microbiology and Environmental Systems Science, University of Vienna, Austria · 8 - Department of Environmental Geosciences, Centre for Microbiology and Environmental Systems Science, University of Vienna, Austria · 9 - Seminari d'Estudis i Recerques Prehistòriques (SERP), University of Barcelona, Barcelona, Spain

Caves are primary sites for investigating human and carnivore occupation and subsistence patterns throughout the Palaeolithic. Iberia served as a critical human and animal refugium in Europe during the Last Glacial Maximum (LGM), 26.5 to 19 thousand years before the present (cal. kya), marked by significant climatic cooling and environmental changes. As such, the Iberian Peninsula is a key location for understanding human population dynamics before, during and after these climatic events [1]. However, the limited number of human fossils represents a challenge for delving into human population movements [2]. During this period, several megafauna species also disappeared from the archaeological record. Nevertheless, the fragmented archaeozoological register complicates the precise determination of extirpation dates. Here, we used sedimentary ancient DNA (sedaDNA) [3] to complement the archaeozoological record and infer patterns of human activity related to animal presence during the Paleolithic. We recovered and analysed sedaDNA data from the lower archaeological stratigraphic sequence of El Mirón cave (Cantabria, Spain), encompassing the Late Mousterian (associated with Neanderthals), Gravettian (c. 31.5 cal kya), Solutrean (c. 24.5-22cal kya), and Initial Magdalenian (d. 21-20.5 cal kya) periods, associated with anatomically modern humans [4]. We identified 29 species of animals including humans from layers spanning the Mousterian to the Initial Magdalenian. 14 of these species had not been identified from the archaeozoological (i.e., osteological) record, including the presence of hyenas in the Magdalenian. Additionally, the phylogenetic analysis of the animal DNA retrieved from El Mirón sediments, including 72 mammalian mitochondrial sedaDNA genomes, shows the presence of simultaneous different faunal mtDNA lineages of key species such as wolves, leopards or bears. Finally, we recovered three human mtDNA sequences from Solutrean levels as well as nuclear human DNA from the same levels, that, together with published data, pre and post-LGM, point to mtDNA haplogroup continuity in Iberia throughout the Solutrean period.

References: [1] Marín-Arroyo, A.B., Geiling, J.-M., Jones, J.R., González Morales, M.R., Straus, L.G., Richards, M.P., 2020. The Middle to Upper Palaeolithic transition at El Mirón Cave (Cantabria, Spain). Quaternary International. 544, 23–31. [2] Posth, C., Yu, H., Ghalichi, A., Rougier, H., Crevecoeur, I., Huang, Y., Ringbauer, H., Rohrlach, A.B., Nägele, K., Villalba-Mouco, V., Radzeviciute, R., Ferraz, T., Stoessel, A., Tukhbatova, R., Drucker, D.G., Lari, M., Modi, A., Vai, S., Saupe, T., Scheib, C.L., Catalano, G., Pagani, L., Talamo, S., Fewlass, H., Klaric, L., Morala, A., Rué, M., Madelaine, S., Crépin, L., Caverne, J.-B., Bocaege, E., Ricci, S., Boschin, F., Bayle, P., Maureille, B., Le Brun-Ricalens, F., Bordes, J.-G., Oxilia, G., Bortolini, E., Bignon-Lau, O., Debout, G., Orliac, M., Zazzo, A., Sparacello, V., Starnini, E., Sineo, L., van der Plicht, J., Pecqueur, L., Merceron, G., Garcia, G., Leuvrey, J.-M., Garcia, C.B., Gómez-Olivencia, A., Poltowicz-Bobak, M., Bobak, D., Le Luyer, M., Storm, P., Hoffmann, C., Kabaciński, J., Filimonova, T., Shnaider, S., Berezina, N., González-Rabanal, B., González Morales, M.R., Marín-Arroyo, A.B., López, B., Alonso-Llamazares, C., Ronchitelli, A., Polet, C., Jadin, I., Cauwe, N., Soler, J., Coromina, N., Rufí, I., Cottiaux, R., Clark, G., Straus, L.G., Julien, M.-A., Renhart, S., Talaa, D., Benazzi, S., Romandini, M., Amkreutz, L., Bocherens, H., Wißing, C., Villotte, S., de Pablo, J.F.-L., Gómez-Puche, M., Esquembre-Bebia, M.A., Bodu, P., Smits, L., Souffi, B., Jankauskas, R., Kozakaitė, J., Cupillard, C., Benthien, H., Wehrberger, K., Schmitz, R.W., Feine, S.C., Schüler, T., Thevenet, C., Grigorescu, D., Lüth, F., Kotula, A., Piezonka, H., Schopper, F., Svoboda, J., Sázelová, S., Chizhevsky, A., Khokhlov, A., Conard, N.J., Valentin, F., Harvati, K., Semal, P., Jungklaus, B., Suvorov, A., Schulting, R., Moiseyev, V., Mannermaa, K., Buzhilova, A., Terberger, T., Caramelli, D., Altena, E., Haak, W., Krause, J., 2023. Palaeogenomics of Upper Palaeolithic to Neolithic European hunter-gatherers. Nature. 615, 117–126. [3] Gelabert, P., Sawyer, S., Bergström, A., Margaryan, A., Collin, T.C., Meshveliani, T., Belfer-Cohen, A., Lordkipanidze, D., Jakeli, N., Matskevich, Z., Bar-Oz, G., Fernandes, D.M., Cheronet, O., Özdoğan, K.T., Oberreiter, V., Feeney, R.N.M., Stahlschmidt, M.C., Skoglund, P., Pinhasi, R., 2021. Genome-scale sequencing and analysis of human, wolf, and bison DNA from 25,000-year-old sediment. Current Biology. 31, 3564-3574.e9. [4] Hopkins, R.J.A., Straus, L.G., González Morales, M.R., 2021. Assessing the chronostratigraphy of El Mirón Cave, Cantabrian Spain. Radiocarbon. 63, 821–852.

Poster Presentation Number 40, Session 1, Thursday 18:00 – 19:30

Neanderthal on the mountains: lithic technological behaviour at Samarina 1 (Pindus Mt., Greek Macedonia)

Jacopo Gennai[1], Paolo Biagi[2], Elisabetta Starnini[1], Nikos Efstratiou[3]

1 - University of Pisa, Department of Civilizations and Forms of Knowledge, Pisa, Italy · 2 - Ca' Foscari University of Venice, Department of Asian and North African Studies, Venice, Italy · 3 - Aristotle University of Thessaloniki, Faculty of Philosophy, Department of Archaeology, Thessaloniki, Greece

The Balkan Peninsula has long been recognised as a major European prehistoric crossroad. Yet, the Middle Palaeolithic period in the Southern Balkan Peninsula remains enigmatic due to the scarcity of stratified sites and the predominance of surface contexts lacking radiometric dating. This study focuses on the Greek region of Western Macedonia within the Pindus Mountain range. A long-term survey project has significantly advanced our understanding of prehistoric archaeology discovering an intensive activity of Neanderthals. Notably, the Samarina 1 findspot, situated at an altitude of approximately 1500 meters above sea level, emerges as a key location offering insights into the Middle Palaeolithic. Systematic surface collections, coupled with square grid and artefacts' coordinates recording, retrieved 1609 artefacts from erosion patches. Notably, at the edge of the erosion patches, buried lithics are found in the soil profile. A preliminary analysis recognised artefacts coming from the whole reduction sequence [1]. Cores and complete blanks measuring above 40 mm in module (length and width combined) have been subjected to a new and in-depth technological analysis. The lithic assemblage from Samarina 1 is characterised by the prevalent application of the Levallois method on locally available siliceous limestone. The round nodules break into substantial flakes and chunks, featuring natural convexities suitable for surface flaking. The technological analysis reveals dominance of the recurrent modality of the Levallois method, resulting in unidirectional and centripetal flakes, as well as bidirectional Levallois blades. While radiometric dating is currently unavailable due to the surface nature of the lithic spot, the techno-typological features confidently place Samarina 1 within the Middle Palaeolithic. No diagnostic artefacts from other periods are found mixed in the assemblage. Hence, the Samarina lithic assemblage provides an opportunity to explore Neanderthal population behaviour and dynamics at high altitudes. Moreover, the high-altitude survey project contributes to the broader understanding of the settlement patterns in this region and the Middle Palaeolithic peopling in the Balkans. It highlights the need for continued research to uncover the complexities of this period in this pivotal European geographical area.

Jacopo Gennai is funded by the European Union's Horizon Europe research and innovation programme under the grant agreement No. 101061427 – MobiliTy. Paolo Biagi, Elisabetta Starnini, and Nikos Efstratiou research at the site is jointly supported from grants from the Aristotle University, Thessaloniki (Greece), Ca' Foscari University, Venice (Italy), The Prefecture of Western Macedonia (Greece), and the Institute for Aegean Prehistory (INSTAP, USA). E.S. received funds from the University of Pisa (Italy), Excellence Project of the Department of Civilizations and Forms of Knowledge, n. 429999-DIP-ECCELL-CIVILTA-2018-2022.

References: [1] Biagi, P., Nisbet, R., Starnini, E., Efstratiou, N., Michiniak, R., 2017. Where mountains and Neanderthals meet: The Middle Palaeolithic settlement of Samarina in the Northern Pindus (Western Macedonia, Greece). Eurasian Prehistory. 12, 3–76.

Poster Presentation Number 41, Session 1, Thursday 18:00 – 19:30

Analysis of sulcal markings on volunteer endocasts through MRI-derived segmented model and establishment of an atlas of observed sulci on the endocast

Victor Giolland[1], Nicole Labra[2], Andréa Filippo[1], Aurélien Mounier[1], Mélanie Didier[3], Eric Bardinet[3], Mathieu D. Santin[3], Yann Leprince[4], Denis Rivière[4], Jean François Mangin[4], Antoine Balzeau[1]

1 - MNHN · 2 - London's global university · 3 - Paris Brain Institute · 4 - NeuroSpin

The study of endocasts in fossil hominins for determining brain sulci is a complex field, subject to inherent biases stemming from the limitations of usual models (isolated endocasts, atlases of the brain, etc.). Traditional latex molds have been replaced by «virtual» endocasts using CT or microCT data, broadening research opportunities. A previous study attempted blind identification of sulci on the same *Homo sapiens* endocast, involving 14 paleoneurologists experts [1], for which we had the real brain to verify the correspondence between both models. It revealed significant differences between each evaluator's assessments and the actual position of sulci (especially within frontal, central and parietal areas), as well as the presence of marks not associated with sulci. These findings emphasize the complexity of interpretation, biases inherent in scientific literature, and the overall imprecision of this identification method. Eventually, these findings highlight variation in perception among viewers regarding what is observable on an endocast. To cope with this issue, we studied MRI data from a large sample (68 volunteers) using different sequences to better understand the relationship between markings on the endocast and brain sulci by comparing them directly. This will enable the establishment of a comprehensive model, enabling more precise inference of the accuracy of identifications made on fossil material. The initial findings indicate that orbital, superior and inferior temporal (excluding the two ascending branches from its posterior part, which do not appear as consistently), occipital sulci and the occipital part of the intraparietal sulci are visible in most of our subjects with remarkable precision. They all correspond to the inferior part of the brain, which was something to be expected regarding the experiments from previous paper [1]. The Sylvian fissures, central sulci, as well as the ascending and horizontal branches of the Broca's area, three relevant sulci in the study of brain evolution, are also adequately represented. However, they may be visible on one side only, on both sides, or be entirely absent. Several factors may account for this: there are endocasts more prominently marked than others, the resolution of the 3D model, as well as the presence of artifacts due to segmentation. All of them provide insights into language evolution and the expansion of the frontal cortex in the human lineage. The frontal sulci (including the pre-central sulci) exhibits significant variability among individuals, rendering them inherently challenging to discern on the endocast. Moreover, this region features markings unrelated to underlying sulci, further complicating readability on this portion of the endocast. A notable difference exists with the parietal lobe, much smoother on the endocast, where pattern correspondence with sulci can quickly become deceptive. Many markings are often identified as postcentral or intraparietal but do not correspond to any sulcus in this area. Nevertheless, inter-individual variability of brains, as well as the subjectivity of observations, lead us to be cautious in our interpretations. However, the sample size of our study compensates for these limitations, rendering our model more reliable than all methods used up to now. The aim of this study is to construct an atlas of observed sulci on the endocast that can subsequently be applied to fossils. The goal is not to unravel all sulci, which would be a hard task given their complexity, but to establish a sufficiently robust framework of data to enhance the quality of future descriptions.

References: [1] Labra, N., Mounier, A., Leprince, Y., Rivière, D., Didier, M., Bardinet, E., Santin, M.D., Mangin, J.F., Filippo, A., Albessard-Ball, L., Beaudet, A., Broadfield, D., Bruner, E., Carlson, K.J., Cofran, Z., Falk, D., Gilissen, E., Gómez-Robles, A., Neubauer, S., Pearson, A., Röding, C., Zhang, Y., Balzeau, A., 2023. What do brain endocasts tell us? A comparative analysis of the accuracy of sulcal identification by experts and perspectives in palaeoanthropology. Journal of Anatomy. 244, 274–296.

Poster Presentation Number 42, Session 1, Thursday 18:00 – 19:30

Description and identification of cercopithecid craniodental remains from Member E of the Shungura Formation, Ethiopia

Gabrielle Gourdet[1], Laurent Pallas[1,2], Jean-Renaud Boisserie[1,3], Blade Engda Redae[1,4], Amélie Beaudet[1,5,6]

1 - Laboratoire de Paléontologie, Évolution, Paléoécosystèmes et Paléoprimatologie (PALEVOPRIM), UMR 7262 CNRS · 2 - Histoire Naturelle de l'Homme Préhistorique, Département Homme et Environnement, UMR 7194 CNRS · 3 - Centre français des études éthiopiennes, UAR 3137 CNRS & MEAE, Ethiopia · 4 - Institute of Human Origins, Arizona State University, USA · 5 - Department of Archaeology, University of Cambridge, United-Kingdom · 6 - School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, South Africa

The Shungura Formation, located in the Lower Omo Valley, yielded an extensive fossil primate record, including hominins and cercopithecids. In particular, numerous specimens of large bodied papionin monkeys were recovered from the Member E (2.4 - 2.3 Ma) and attributed to *Theropithecus oswaldi oswaldi*, *Theropithecus brumpti* and a third, recently named taxon, *Soromandrillus quadratirostris* [1]. While the presence of *Theropithecus* in African Plio-Pleistocene sites is widely acknowledged, the identification of *Papio* and *Soromandrillus* in eastern African early Pleistocene deposits is still debated. For instance, the holotype of *Soromandrilus quadratirostris*, a partial cranium from the neighbouring Usno Formation (3.3-3.2 Ma) was initially attributed to *Papio quadratirostris* and later reattributed to *Theropithecus quadratirostris* and, alternatively, to *Soromandrillus quadratirostris*. Since over 50% of the hypodigm of *S. quadratirostris* stems from the Member E, the description of new craniodental specimens collected by the Omo Group Research Expedition (OGRE; [2]) from Shungura is crucial to test the hypothesis of the presence of three, taxonomically distinct, large bodied papionins during that time period, with substantial implications for our understanding of the catarrhine niche partitioning in Member E, including *Paranthropus* and early *Homo*. Here we described seventeen new papionin craniodental remains from Member E and compared them to fossil specimens of *Theropithecus baringensis*, *Th. brumpti* and *Th. o. oswaldi* from the Kenyan fossiliferous deposits of Chemeron, Nachukui and Koobi Fora. Fossil taxa were also compared with 41 crania and mandibles of extant *Th. gelada*, *Papio* spp., *Lophocebus* spp., *Cercocebus* spp., *Mandrillus* spp. and *Macaca* spp. With the aim of taxonomically identifying these new fossil remains, we performed craniodental linear measurements on fragmentary fossils as well as landmark-based geometric morphometric and Procrustes analyses on the best-preserved crania and mandibles [3]. We tentatively attributed nine of the described specimens from Member E to *Th. o. oswaldi* and *Th. brumpti*. Moreover, even though our sample is limited, our comparative study confirms that, contrary to *Th. o. oswaldi*, *Th. brumpti* from Member E have smaller teeth than specimens from other geological members [4]. Specimens previously attributed to *Soromandrillus* show phenetic affinities with fossil *Theropithecus* and extant *Papio* and *Mandrillus*. As such, besides contributing to the description of new fossil specimens from Shungura, our quantitative analysis of craniodental papionin remains from Ethiopia provides further information on the recently erected *Soromandrillus* genus and papionin taxic diversity throughout the Plio-Pleistocene while emphasizing the need for an exhaustive review of the fossil record.

We thank the CNRS (CPJ - Hominines) for funding and we are grateful to the GDR Rift and the doctoral school Rosalind Franklin (formerly Theodore Monod - University of Poitiers) for research grants awarded to L.P. We acknowledge the Ethiopian Heritage Authority for granting research permit to the OGRE and we are grateful to all participants of the OGRE for their work. We thank the regional (South Ethiopia) and zonal administrations, the Nyangatom and Dassanetch Weredas, and their people for their help and reception, and all the funding supports (notably Ministry of Europe and Foreign Affairs, ANR, CNRS) to OGRE.

References: [1] Gilbert, C.C., 2013. Cladistic analysis of extant and fossil African papionins using craniodental data. Journal of Human Evolution. 64, 399–433. [2] Boisserie, J.-R., Guy, F., Delagnes, A., Hlukso, L.J., Bibi, F., Beyene, Y., Guillemot, C., 2008. New palaeoanthropological research in the Plio-Pleistocene Omo Group, Lower Omo Valley, SNNPR (Southern Nations, Nationalities and People Regions), Ethiopia. Comptes Rendus Palevol. 7, 429–439. [3] Frost, S.R., Marcus, L.F., Bookstein, F.L., Reddy, D.P., Delson, E., 2003. Cranial allometry, phylogeography, and systematics of large-bodied papionins (primates: Cercopithecinae) inferred from geometric morphometric analysis of landmark data. The Anatomical Record Part A: Discoveries in Molecular, Cellular, and Evolutionary Biology. 275A, 1048–1072. [4] Leakey, M.G., 1993. Evolution of Theropithecus in the Turkana Basin. In: Jablonski, N.G. (Ed.), *Theropithecus*: The Rise and Fall of a Primate Genus. Cambridge University Press, Cambridge, pp. 85–124.

Poster Presentation Number 43, Session 2, Friday 17:00 – 18:30

Denisovans, *Homo longi* and East Asian "archaic *Homo sapiens*": one or multiple clade(s)?

Pierre Gousset[1], Florent Détroit[1], Jérémie Bardin[2]

1 - UMR 7194 HNHP, CNRS, UPVD, Muséum National d'Histoire Naturelle, Paris, France · 2 - UMR 7207 CR2P, Sorbonne Université, MNHN, CNRS, Paris, France

Continental East Asia was peopled by at least three hominin species: *Homo erectus*, *Homo sapiens*, and at least one chronologically intermediate taxon of which the unity, the identity and the phylogenetic relationships with other species are hotly debated. The fossil specimens in question are variably classified into one, two or three of the following groups: (1) Denisovans, rare and fragmentary fossils identified through molecular data [1]; (2) *Homo longi*, a species recently described based on a particularly complete cranium [2] and (3) the taxonomically informal group of "archaic *Homo sapiens"*.

Teeth are the main anatomical elements found in common in these three groups. Thus, a cladistic analysis was carried out based on dental (crown and root) morphology to better understand the status of these groups. This analysis took advantage of a standardized system to describe morphological characters of the teeth (ASUDAS). The high intra-taxon variability was taken into account thanks to the implementation of character state frequencies by taxon in the character-by-taxon matrix [3]. Continuous characters were analyzed as such using TNT software [4].

The results indicate that Denisovans, *Homo longi* and East Asian "archaic *Homo sapiens*" form a monophyletic group. Astonishingly, this clade does not appear as a sister-taxon to *Homo neanderthalensis*. While this result was found by another phylogenetic analysis based on morphology [5], it contradicts molecular analyses that demonstrated the close phylogenetic link between Denisovans and *Homo neanderthalensis* [1]. We performed additional analyses taking into account the phylogeny known from the molecular data and again retrieved Denisovans, *Homo longi* and East Asian "archaic *Homo sapiens*" as a monophyletic group. In every analysis, this clade was among the most stable ones based on Bremer support.

The results altogether support the monophyly of these three groups. Building upon geographical and chronological data and distribution of Denisovan ancestry in current populations, the synonymy of these groups is proposed here. However, additional studies are required to understand why their phylogenetic relationships based on morphology repeatedly contradict those based on molecular data. Other anatomical elements (i.e. other body parts) are currently under study to shed further light on this issue.

We are grateful to Véronique Barriel, Guillaume Billet, Sandrine Prat and Clément Zanolli for precious methodological advices and access to the collections.

References: [1] Peyrégne, S., Slon, V., Kelso, J., 2023. More than a decade of genetic research on the Denisovans. Nature Reviews. Genetics. 25, 83-103. [2] Ji, Q., Wu, W., Ji, Y., Li, Q., Ni, X., 2021. Late Middle Pleistocene Harbin cranium represents a new *Homo* species. The Innovation. 2, 100132. [3] Smith, E.N., Gutberlet, R.L., 2001. Generalized Frequency coding: a method of preparing polymorphic multistate characters for phylogenetic analysis. Systematic Biology. 50, 156–169. [4] Goloboff, P.A., Mattoni, C.I., Quinteros, A.S., 2006. Continuous characters analyzed as such. Cladistics. 22, 589–601. [5] Ni, X., Ji, Q., Wu, W., Shao, Q., Ji, Y., Zhang, C., Liang, L., Ge, J., Guo, Z., Li, J., Li, Q., Grün, R., Stringer, C., 2021. Massive cranium from Harbin in northeastern China establishes a new Middle Pleistocene human lineage. The Innovation. 2, 100130.

Podium Presentation, Session 10, Saturday 11:00 – 12:40

Contrasting patterns of natural selection led to parallel brain size increases in Neanderthals and Early *Homo sapiens*

Mark Grabowski[1,2], Rob Fitt[3], Laura T. Buck[1], Kjetil L. Voje[4]

1 - Research Centre in Evolutionary Anthropology and Palaeoecology, Liverpool John Moores University, Liverpool UK · 2 - Department of Biosciences, University of Oslo, Oslo, Norway · 3 - School of Biological and Environmental Sciences, Liverpool John Moores University, Liverpool, UK· 4- Natural History Museum, University of Oslo, Oslo, Norway

Neanderthals are viewed as possessing slightly larger brains than Homo sapiens, though differing substantially in overall shape. Previous studies suggest that both lineages independently evolved larger brain sizes after they split from their last common ancestor. However, the factors driving observed morphological changes, and the competing roles of selection and genetic drift within each lineage, remain unknown. Here we use a novel modeling approach that can fit and compare various models of within-lineage evolution and a newly compiled dataset of Middle and Late Pleistocene endocranial volumes, coupled with paleoclimate data for individual fossil sites, to test hypotheses on the causes of Neanderthal and early Homo sapiens brain-size evolution. Our approach allows for comparison of multiple univariate and multivariate models of adaptation, stasis, and drift for different parts of the time sequence, including evolution towards adaptive optima that can be influenced by other factors. First, we show that Neanderthals and early Homo sapiens adapted towards separate brain size optima, with the latter unexpectedly substantially larger than the former. Second, we find that African Homo erectus exhibited evolutionary stasis, with complementary evolutionary shifts to larger brain sizes in each lineage occurring at the end of this taxon. Finally, we show that starting at around 130 thousand years ago, brain sizes in the Neanderthal lineage are no longer evolving independently from surface temperature ($R = 0.85$), but the opposite pattern appears in early Homo sapiens near the origins of our lineage ($R = -0.51$). Our results suggest that selection due to the effects of similar environmental factors drove brain size evolution in both taxa, but in different directions and starting at different points of time. By combining the use of cutting-edge time-series models with rigorous brain size data and accounting for measurement and reconstruction error, our findings provide new insights into the tempo and mode of Neanderthal and early Homo sapiens evolution.

This research was supported by an Erasmus+ Training grant to MG, with assistance from the Young CAS Fellow project "The importance of measurement theory in Paleobiology" to KLV, funded by the Norwegian Academy of Science and Letters and hosted by the Centre for Advanced Study (Oslo) in 2022-2023.

Podium Presentation, Session 1, Thursday 9:20 – 11:00

Primitive sulcal pattern of LB 1 endocast suggests deep evolutionary roots of *Homo floresiensis*

Philipp Gunz[1], Sofwan Noerwidi[2], Nico Alamsyah[2], Thomas Sutikna[2,3], Carmen Ramoser[1], Alina Sandberg[1], Alfred Anwander[4], Yannick Becker[4], Tobias Gräßle[5], Carsten Jaeger[6,7], Maelig Chauvel[6], Evgeniya Kirilina[6], Markus Morawski[7], Nikolaus Weiskopf[6,8], Angela Friederici[4], Catherine Crockford[9,10], Roman Wittig[9,10], Matthew M. Skinner[11], Matthew W. Tocheri[3,12,13], EBC Consortium

1 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 2 - Research Centre for Archaeometry, National Research and Innovation Agency, Jakarta, Indonesia · 3 - Australian Research Council Centre of Excellence for Australian Biodiversity and Heritage, University of Wollongong, Wollongong, New South Wales, Australia · 4 - Department of Neuropsychology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany · 5 - Ecology and Emergence of Zoonotic Diseases, Helmholtz Institute for One Health, Helmholtz Centre for Infection Research, Greifswald, Germany · 6 - Department of Neurophysics, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany · 7 - Medical Faculty, Center of Neuropathology and Brain Research, Paul Flechsig Institute, University of Leipzig, Leipzig, Germany · 8 - Faculty of Physics and Earth System Sciences, Felix Bloch Institute for Solid State Physics, Leipzig University, Leipzig, Germany · 9 - Institute for Cognitive Sciences Marc Jeannerod, UMR CNRS, University Claude Bernard Lyon, Bron, France · 10 - Taï Chimpanzee Project, CSRS, Abidjan, Côte d'Ivoire · 11 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 12 - Department of Anthropology, Lakehead University, Thunder Bay, Ontario, Canada · 13 - Human Origins Program, National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA

The *Homo floresiensis* skeletal remains from Liang Bua, Flores (Indonesia), have sparked ongoing debates ever since their discovery ~20 years ago [1]. The holotype specimen, LB1, is notably small in stature and brain size. Yet despite its chimpanzee-like endocranial volume previous work has highlighted several human-like sulcal features on LB1's endocranial imprint [2]. Specifically, the endocast was described as displaying frontal and temporal lobes derived towards the human-condition, as well as a lunate sulcus in a posterior position. These characteristics were previously thought to be associated with advanced socio-cultural behaviours, such as fire use and large-game hunting, and the general interpretation was that *Homo floresiensis* descended from a much larger-brained hominin with a derived sulcal pattern. Here, we re-evaluate these features based on new high-resolution micro-computed tomography (micro-CT) scans of the LB1 cranium with an isotropic voxel size of 50 μm.

Identifying sulcal imprints on endocasts is often challenging. To address this, we have established a comparative primate framework using both brains and corresponding endocasts from the same individuals [3-4]. We collect primate brains and skulls post-mortem from animals that have died naturally at field sites in Africa and at European zoos. Brains are extracted soon after death, fixated in formalin, and later scanned using magnetic resonance imaging (MRI). We also perform micro-CT scans of the defleshed or frozen skulls to generate virtual endocasts in Avizo. For our analyses, we use geometric morphometrics, measuring both brains and endocasts using landmarks and sliding semilandmarks (807 3D coordinates in total) in the software Viewbox.

The virtual endocast of LB1 preserves detailed impressions of brain sulci, cranial sutures, and blood vessels. Using thin-plate spline warping based on the geometrically corresponding (semi)landmark coordinates on each external surface [5], we map the sulcal pattern of extant apes, humans, and fossil hominins onto the endocranial surface of LB1. This accounts for differences in overall endocranial shape, and makes it possible to evaluate how closely LB1's sulcal impressions match predictions based on other species.

Contrary to earlier interpretations based on lower-resolution CT scans, we find that LB1 exhibits an ape-like sulcal pattern in the parietal and occipital lobes. Based on the sulcal impressions there is no clear evidence of reorganization in the prefrontal cortex, which houses Broca's region in modern humans. This primitive sulcal pattern indicates a brain organization similar to that of apes, australopiths [5], and some early *Homo* specimens. These results challenge the prevailing hypothesis that *Homo floresiensis* evolved from Asian *Homo erectus* via island dwarfism, suggesting instead that this hominin may have deeper evolutionary roots.c

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 819960), and the Max Planck Society under the inter-institutional funds of the president of the Max Planck Society for the Hominoid Brain Connectomics (now Evolution of Brain Connectivity: EBC) project.

References: [1] Brown, P., Sutikna, T., Morwood, M.J., Soejono, R.P., Jatmiko, Saptomo, E.W., Due, R.A., 2004. A new small-bodied hominin from the Late Pleistocene of Flores, Indonesia. Nature 431, 1055-1061. [2] Falk, D., Hildebolt, C., Smith, K., Morwood, M.J., Sutikna, T., Brown, P., Jatmiko, Saptomo, E.W., Brunsden, B., Prior, F., 2005. The brain of LB1, *Homo floresiensis*. Science 308, 242-245. [3] Grässle, T., Crockford, C., Eichner, C., Girard-Buttoz, C., Jäger, C., Kirilina, E., Lipp, I., Düx, A., Edwards, L., Jauch, A., Kopp, K.S., Paquette, M., Pine, K., Haun, D.B.M., McElreath, R., Anwander, A., Gunz, P., Morawski, M., Friederici, A.D., Weiskopf, N., Leendertz, F.H., Wittig, R.M., Consortium, E., 2023. Sourcing high tissue quality brains from deceased wild primates with known socio-ecology. Methods in Ecology and Evolution 14, 1906-1924. [4] Friederici, A.D., Wittig, R.M., Anwander, A., Eichner, C., Grässle, T., Jäger, C., Kirilina, E., Lipp, I., Düx, A., Edwards, L.J., Girard-Buttoz, C., Jauch, A., Kopp, K.S., Paquette, M., Pine, K.J., Unwin, S., Haun, D.B.M., Leendertz, F.H., McElreath, R., Morawski, M., Gunz, P., Weiskopf, N., Crockford, C., Consortium, E., 2024. Brain structure and function: a multidisciplinary pipeline to study hominoid brain evolution. Frontiers in Integrative Neuroscience 17, 1299087. [5] Gunz, P., Neubauer, S., Falk, D., Tafforeau, P., Le Cabec, A., Smith, T.M., Kimbel, W.H., Spoor, F., Alemseged, Z., 2020. *Australopithecus afarensis* endocasts suggest ape-like brain organization and prolonged brain growth. Science Advances. 6, eaaz4729.

Poster Presentation Number 44, Session 1, Thursday 18:00 – 19:30

Dental morphology of *Homo erectus* juvenile from China (Luanchuan, Henan) and the new discovery of a deciduous lower second molar

Guo Lin[1,2], Zhao Lingxia[1,3]

1 - Key Laboratory of Vertebrate Evolution and Human Origins, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing · 2. Faculty of Biology, Department of Anthropology, Lomonosov Moscow State University, Moscow · 3. CAS Center for Excellence in Life and Paleoenvironment, Beijing

The dental fossil record of *Homo erectus* from China has always attracted the attention of evolutionary anthropologists with its series of archaic and distinguished features [1-2] such as buttressing and accessory structures, "Dendrite-like" EDJ (enamel-dentine junction), stout roots and taurodontism [3]. Any new material is crucial to understanding the variation of East Asian *Homo erectus* and its affinities with other hominins. In 2012, several fossil hominins associated with rich large mammal fauna and a few stone artifacts were discovered from the Sunjiadong cave, Luanchuan county, Henan province, China. The geological age of the Luanchuan hominins is Middle Pleistocene according to the faunal assemblage.

The seven hominin specimens recovered represent 3 individuals, including 2 juveniles (ages 6~7 and 11~12 years respectively) and 1 adult. The first juvenile is represented by a left maxillary fragment with upper M1, isolated left upper P2 germ, a left lower dm2, a left mandible fragment with lower M1, and isolated left lower M2 germ. The other two individuals are isolated teeth: left lower M2 (the secound juvenile) and right lower lateral I2 (adult). Dental development of the juvenile maxilla and mandible, deciduous molar and two isolated tooth germs, which might all belong to the same individual, match dental development patterns in juvenile modern humans. The age of M1 emergence of the Luanchuan hominins was possibly at six years of age [4].

This study provides a new analysis of outer and inner morphology of these seven teeth by microtomography (micro-CT) with broad comparative materials from *Australopithecus* to modern humans worldwide. Dimension and morphology of the Luanchuan teeth match Homo erectus from Zhoukoudian, with the common features such as shovel upper second incisor; triangular swelling, mesial and distal accessory crest, and bifurcated essential crest on upper second premolar; developed hypocone, cingulum-protocone crest on Carabelli cusp and oblique crest on upper first molar; Y5-type lower molars, deflecting wrinkle and different types of protostylid, mesial groove of protoconid on lower first and second molars. The protoconid buccal mesial groove on lower molars, which has not received much attention in previous studies, could be an archaic trait that can be traced back to *Australopithecus*. The EDJ surface of thr premolar and molars also displays the crenulate features and the pulpal cavity of molars reveals taurodontism. These features demonstrate the general characteristics of Middle Pleistocene *Homo erectus* in China.

Specially, the deciduous lower second molar represents the only well-preserved *Homo erectus* dm2 with stratigraphic records in China and also in East Asia. Therefore, it provides us with unique evidence. Through a broad comparative study of metrical and morphological features, we have demonstrated the characteristics of the Luanchuan dm2 and discussed the implications of the different traits in human evolution. The Luanchuan dm2 is similar to Zhoukoudian *Homo erectus* and demonstrates certain primitive characteristics such as a narrow crown (small crown index), buccal mesial groove on protoconid, lingual mesial groove on metaconid, and fine crests on hypoconid on EDJ. It also exhibits distinctive characteristics such as a basin-shaped anterior fovea and a special pattern on EDJ: dw with type 3 DTC. Additionally, the groove pattern Y6 and protostylid are common features in Asian *Homo erectus* and modern populations of Asia. Some of the primitive features are preserved in Holocene modern populations, such as the relatively narrow crown and talonid crest presented in the Houtaomuga neolithic and bronze age site.

This study has been supported by the Strategic Priority Research Program of the Chinese Academy of Sciences (XDB26000000).

References: [1] Xing, S., Martinón-Torres, M., Bermúdez de Castro, J.M., 2018. The fossil teeth of the Peking Man. Scientific Reports. 8, 2066. [2] Zanolli, C., Pan, L., Dumoncel, J., Kullmer, O., Kundrát, M., Liu, W., Macchiarelli, R., Mancini, L., Schrenk, F., Tuniz, C., 2018. Inner tooth morphology of *Homo erectus* from Zhoukoudian. New evidence from an old collection housed at Uppsala University, Sweden. Journal of Human Evolution. 116, 1–13. [3] Liu, W., Athreya, S., Xing, S., Wu, X., 2022. Hominin evolution and diversity: a comparison of earlier-Middle and later-Middle Pleistocene hominin fossil variation in China. Philosophical Transactions of the Royal Society B: Biological Sciences. 377. [4] Zhao, L.X., Li, X., Gu, X.J., Du, B.P., Shi, J.H., Gao, X., 2018. Middle Pleistocene Hominins from Sunjiadong site of Luanchuan in Henan Province in Central China[J]. Acta Anthropologica Sinica. 37, 192-205.

Podium Presentation, Session 12, Saturday 15:50 – 17:30

Reconstructing social-economic interaction from technological signatures on ivory beads of the Swabian Aurignacian

Shuqin Guo[1], Natasha T. Singh[1], Marian Vanhaeren[1,2], Sibylle Wolf[1,3], Rudolf Walter[1], Nicholas J. Conard[1,3]

1 - Department of Early Prehistory and Quaternary Ecology, University of Tübingen, Tübingen · 2 - CNRS, UMR 5199 PACEA, University of Bordeaux · 3 - Senckenberg Centre for Human Evolution and Palaeoenvironment at the University of Tübingen, Tübingen, Germany

Double perforated beads made from mammoth ivory represent the most abundant type of personal ornament found in the Swabian Aurignacian. These artifacts provide valuable insights into technological gestures, division of labor, and social identity of the populations who lived in this region between ca. 43 and 35 ka BP [1-2]. Despite decades of study of the *chaîne opératoire* of these iconic artifacts, the techniques and specific gestures used to produce the perforations remain to be determined [3]. Through controlled experiments, we attempt to determine the precise function and manner of display of these personal ornaments [2].

Here we present a sample of 74 double perforated beads from Archaeological Horizon IV at Hohle Fels Cave in the Ach Valley corresponding to multiple stages in the manufacturing process. Our study uses typology, traceology, experimental archaeology and ethnoarchaeological comparisons to establish techniques of production and modes of perforation. We use replicated lithic technology to manufacture experimental beads as has been hypothesized in recent technological studies [4]. We then use conclusions drawn from the experimentally produced beads to evaluate competing functional interpretations.

We identify four classes of artifacts: the roughed-out form, unfinished, finished, and broken beads, among which the finished beads are the most numerous. Through traceological analysis, we identify five main patterns on the surfaces of perforations which likely relate to production processes. Dividing the regions of perforation into four sectors allows us to document the frequency of these five patterns in each sector. We then use these observations to conduct systematic experiments to investigate the causes of different traces.

Experiments on modes of manufacture and display provide insights into the social and economic lives of the occupants at Hohle Fels. By comparing our experimental collections with the archaeological samples, we reconstruct techniques used to shape and perforate Aurignacian ivory beads and identify variability in display of these ornaments. Additionally, this paper discusses potential signatures of individual craftspeople and likely social differentiation within the groups of people occupying the site.

We thank Bernhard Röck and Louis Corrigan for generously providing mammoth ivory. Our thanks go to Alexander Janas and Josh London for their support and helpful advice.

References: [1] Higham, T., Basell, L., Jacobi, R., Wood, R., Ramsey, C.B., Conard, N.J., 2012. Testing models for the beginnings of the Aurignacian and the advent of figurative art and music: The radiocarbon chronology of Geißenklösterle. Journal of Human Evolution. 62, 664–676. [2] Wolf, S., 2015. Schmuckstücke: die Elfenbeinbearbeitung im Schwäbischen Aurignacien. Tübingen: Kerns. [3] Hahn, J., 1992. Eiszeitschmuck auf der Schwäbischen Alb. Alb und Donau, Kunst und Kultur 5. [4] Bataille, G., Conard, N. J., 2018. Burin-core technology in Aurignacian horizons IIIa and IV of Hohle Fels Cave (Southwestern Germany): Die Stichelkern-Technologie der Aurignacien-Horizonte IIIa und IV der Hohle Fels-Höhle (Südwestdeutschland). Quartär–Internationales Jahrbuch zur Erforschung des Eiszeitalters und der Steinzeit. 65, 7-49.

Podium Presentation, Session 1, Thursday 9:20 – 11:00

Evolutionary-ontogenetic foundations of modern body form: insights from KNM-WT 15000 (*Homo erectus*)

Martin Haeusler[1], Shanel Müller[1], Jasmin Köchli[1], Guillermo Bravo Morante[1], Christine Tardieu[2], Nicole Torres Tamayo[1], Tea Jashashvili[3], Chris Ruff[4]

1 - Institute of Evolutionary Medicine, University of Zürich, Zürich, Switzerland · 2 - UMR 7179 C.N.R.S/Département Adaptations du Vivant, Museum Nationale d'Histoire Naturelle, Paris, France · 3 - Department of Integrative Anatomical Sciences at the Keck School of Medicine, University of Southern California, Los Angeles, USA · 4 - Johns Hopkins University School of Medicine, Baltimore, USA

The body shape of modern humans is thought to have evolved in *Homo erectus*, reflecting important evolutionary changes in paleobiology with respect to the australopithecine ancestors. These changes involve modifications in body energetics, locomotion, and ranging behaviour like long-distance walking and endurance running, enabling them to successfully adapt their subsistence strategies to a changing environment. Thus, *H. erectus* represents the earliest hominin species to show body proportions, stature and body weight close to ours, while relatively minor modifications occurred in later hominins. However, the tempo and mode of the transition from the ancestral pattern, with relatively short legs and small brains in *Australopithecus*, to the modern human body shape are unclear.

Most of what we know about *H. erectus* body proportions is based on a single male specimen, the 1.47 Ma old KNM-WT 15000 skeleton from Nariokotome, Kenya, whose age estimates vary widely. While tooth microanatomy suggested a chronological age of 7.6–8.8 years [1], the epiphyseal fusion pattern of the elbow implied a skeletal age of 13–13.5 years relative to modern human standards [1], and the shape of the distal femoral epiphysis indicated an age of at least 15 years [2]. Similarly, reconstructions of his body proportions and stature-at-death estimates diverge significantly, with predictions based on lower limb length converging on 157 cm [3]. In contrast, a body height of only 141–146 cm has been suggested when vertebral dimensions are included [4]. Part of this discrepancy may be due to the paucity of juveniles of similar age in the modern human reference samples, as well as the divergent age estimates of KNM-WT 15000.

To explore the growth pattern and reassess his stature, we performed a virtual anatomical reconstruction of the entire KNM-WT 15000 skeleton and compared it to an age series of modern human juvenile and subadult Europeans. The taphonomically deformed and crushed distal femoral epiphyses were virtually restored from micro-CT scans. The vertebral column was reconstructed from high-resolution 3D surface scans of the original fossils and compared to 100 CT-generated 3D models of 8–17-year-old modern humans using 3D landmarks. The height of the joint space of the knee and foot height were reconstructed from upright standing radiographs of similarly aged children.

Our results confirmed that length-to-width proportions of the distal femoral epiphysis as well as femur length of KNM-WT 15000 compare best with modern human adolescents [2,5]. On the other hand, the linear dimensions of the vertebral bodies and articular processes of KNM-WT 15000 and thus his spinal height are very similar to those of 9–10-year-old boys but not to those of older individuals. This resulted in a stature-at-death reconstruction of KNM-WT 15000 that was intermediate between the different approaches of previous estimates [3,4]. In addition, our findings suggest that the axial skeleton of KNM-WT 15000 may have differed from the appendicular skeleton in rates and timing of development compared to modern humans. This is known as heterochrony, a key concept in synthesizing development and evolution. Heterochrony may reflect a simple shift in growth rate, or the onset or termination of growth, influencing various morphological traits. In the context of human evolution, heterochrony has been used to explain the evolution of our large brain size that started with *H. erectus* approximately 2 million years ago. Further research is needed to determine whether heterochronic growth between the axial and the limb skeleton was a general feature in *Homo erectus*, which would contribute to a deeper understanding of the evolutionary processes and the unique developmental trajectories that distinguish our species.

Financial support comes from the Swiss National Science Foundation grants No. 310030_212984 and 31003A_176319.

References: [1] Dean, M.C., Smith, B.H., 2009. Growth and Development of the Nariokotome Youth, KNM-WT 15000. In: Grine, F.E., Fleagle, J.G., Leakey, R.E. (Eds). The First Humans – Origin and Early Evolution of the Genus *Homo*. Vertebrate Paleobiology and Paleoanthropology. Springer, Dordrecht, pp. 101–120. [2] Tardieu, C., 1998. Short adolescence in early hominids: Infantile and adolescent growth of the human femur. American Journal of Physical Anthropology. 107, 163–178. [3] Ruff, C., 2007. Body size prediction from juvenile skeletal remains. American Journal of Physical Anthropology. 133, 698–716. [4] McCarthy, R., Kanani, D., Cunningham, D.L., Wescott, D.J., 2021. Revised estimates of stature-at-death and body proportions for KNM-WT 15000 (*Homo erectus*). American Journal of Physical Anthropology. S71, 67. [5] Rissech, C., Schaefer, M., Malgosa, A., 2008. Development of the femur—Implications for age and sex determination. Forensic Science International. 180, 1–9.

Poster Presentation Number 45, Session 1, Thursday 18:00 – 19:30

Zoo animals in morphometric studies; problem or not? The chimpanzee maxilla as example

Hester Hanegraef[1], Fred Spoor[1,2]

1 - Centre for Human Evolution Research, Natural History Museum, London, United Kingdom · 2 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

Morphological studies typically aim to avoid using osteological samples that derive from captive animals because it is assumed that their morphology is not representative of wild populations. Rearing environments indeed differ between wild and captive individuals. For example, mechanical properties of the diets provided to captive animals can be drastically different from the food present in their natural habitats, which could impact cranial morphology and dental health. However, sometimes it cannot be avoided to include captive individuals, for example, when the relevant specimens, such as a specific subspecies, are rarely sampled from the wild. In these cases, the impact of captivity needs to be assessed to understand whether and how morphological analyses may be affected. Given the prominence of chimpanzees (*Pan troglodytes*) in comparative analyses of human evolution and the key role of the maxilla in such studies, we examined morphological differences between the maxillae of wild and captive individuals of this species. Size and shape were analysed using three-dimensional geometric morphometric methods based on computed tomography scans of 94 wild and 30 captive specimens from various zoos, institutes, and sanctuaries that were either caught in the wild or born in captivity. Captive individuals have on average larger and more asymmetrical maxillae than wild chimpanzees, and significant differences are present in their maxillary shapes. A large proportion of these shape differences are attributable to static allometry, but wild and captive specimens still differ significantly from each other after allometric size adjustment of the shape data. Levels of shape variation are higher in the captive group, while the degree of size variation is likely similar in our two samples. Results will be discussed in the context of ontogenetic growth trajectories, changes in dietary texture, an altered social environment, and generational differences. Additionally, sample simulations show that size and shape differences between chimpanzees and bonobos (*Pan paniscus*) are exaggerated when part of the wild sample is replaced with captive chimpanzees. Overall, this study confirms that maxillae of captive chimpanzees should not be included in morphological or taxonomic analyses when the objective is to characterise the species. It seems plausible that this conclusion can be extrapolated to extant primates more broadly.

This research is supported by the Calleva Foundation and the Max Planck Society. We thank all museums, institutions, and curators that provided access to CT scans: Max Planck Institute for Evolutionary Anthropology; Royal Museum for Central Africa; National Museum of Natural History, Smithsonian Institution; Naturmuseum Senckenberg; Peabody Museum of Archaeology and Ethnology, Harvard University; Museum of Comparative Zoology, Harvard University; Digital Morphology Museum, Kyoto University.

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

The MEGAPAL survey: new results on the Lower Paleolithic of the Megalopolis Basin, southern Greece

Katerina Harvati[1,2,3], Vangelis Tourloukis[1,4], Nicholas Thompson[1], Domenico Giusti[1,2], Georgia Tsartsidou[5], Athanassios Athanassiou[5], George Konidaris[1], Effrosyni Roditi[1], Eleni Panagopoulou[5], Panagiotis Karkanas[6]

1 - Paleoanthropology, Institute for Archaeological Sciences, Department of Geosciences, Eberhard Kalrs University of Tübingen · 2 - Senckenberg Centre for Human Evolution and Palaeoenvironment, Department of Geosciences, Eberhard Kalrs University of Tübingen · 3 - DFG Center for Advanced Studies 'Words, Bones, Genes, Tools' · 4 - University of Ioannina · 5 - Ephorate of Paleoanthropology-Speleology, Hellenic Ministry of Culture · 6 - Wiener Laboratory, American School of Classical Studies at Athens

Greece lies on a main dispersal corridor between continents and is part of a major southern European glacial refugium [1-2]. Despite its important biogeographic position, paleoanthropological research has been relatively sparse. The Lower Paleolithic is particularly poorly known. Only one excavated open-air site in primary context, Marathousa 1 (Megalopolis basin; [3]) exists, dating to ca. 450 ka. It was discovered in 2013 during targeted systematic survey for stratified remains by our joint team from the Ephorate of Paleoanthropology–Speleology, Hellenic Ministry of Culture, and the University of Tübingen Paleoanthropology working group, and excavated in 2013–19.

In 2018 we initiated the five-year Megalopolis Paleoenvironmental (MEGAPAL) project, with the goal of surveying section profiles in the Megalopolis lignite mines, focusing on the lower part of the geological sequence, in order to uncover archaeological sites older or contemporary with Marathousa 1. Furthermore, we aimed to develop a chronological / paleoenvironmental framework for human activities in the basin during the Pleistocene.

Five new stratified sites were discovered, with lithic assemblages attributed to the Lower Palaeolithic (Kyparissia 4 and 3), the early Middle Palaeolithic (Choremi 7), as well as the transition between these two chrono-cultural periods (Tripotamos 4). The stratigraphic position of Kyparissia 4 suggests an age of up to 700 ka. Faunal remains of cervids (including the giant deer *Praemegaceros verticornis*), hippopotamids (*Hippopotamus antiquus*), large bovids (*Bos* and/or *Bison*), suids (*Sus scrofa*), rhinoceroses (*Stephanorhinus* sp.), few carnivorans (*Vulpes*, *Felis*), rodents (including *Castor fiber*), birds and turtles, as well as a tooth of *Macaca sylvanus*, were recovered, together with 53 lithic artifacts. While the fauna is typical of an early Middle Pleistocene age, the lithics resemble those from the later Marathousa 1. Kyparissia 3 is stratigraphically intermediate between Kyparissia 4 and Marathousa 1. It yielded primarily elephant (*Palaeoloxodon antiquus*) remains, but also hippopotamids, cervids and suids, associated with 19 lithic artifacts. Marathousa 2 is stratigraphically similar to Marathousa 1, dating to ca. 450 ka. It mainly preserved a partial skeleton of *Hippopotamus antiquus* with cutmarks, associated with an isolated flint flake [4]. Tripotamos 4 is stratigraphically younger than Marathousa 1 and 2, estimated to date to ca. 400 ka. It yielded a higher density of lithics (N=206), showing affinities with the artifacts from the older sites, but also presenting potentially noteworthy differences in aspects of core exploitation and tool type frequencies. The fauna consists mainly of cervids and bovids, but includes also elephants and hippopotamuses. Finally, Choremi 7 is stratigraphically younger than Tripotamos 4, estimated to date to ca. 300 ka, consistent with its lithic assemblage (N=116), which shows Middle Paleolithic affinities. Faunal remains include mainly cervid bone-shaft fragments, bird remains, and some bones with cutmarks, alongside wood and other plant remains. Further refinement of the sites' geological age is ongoing.

Our results indicate that the Megalopolis basin was inhabited by humans during much of the Middle Pleistocene, and the Megalopolis sites present a unique opportunity to investigate human behavior and adaptation through time during an important period of human evolution and in an as-yet understudied region. Preliminary palaeoenvironmental and palaeoclimatic results suggest that all sites are associated with cold environmental conditions, in agreement with their chronological placement in the glacial periods of the Middle Pleistocene. Therefore, the overall evidence indicates that the Megalopolis basin served as one of the southernmost refugia for the early human populations of Pleistocene Europe [5].

MEGAPAL is a collaboration between the Ephorate of Palaeoanthropology-Speleology and the American School of Classical Studies, Athens, under the direction of Dr. Panagopoulou, Dr. Karkanas and Prof. Dr. Harvati. Funding by the European Research Council (CoG 724703).

References: [1] Harvati, K., Panagopoulou, E. and Runnels, C., 2009. The paleoanthropology of Greece. Evolutionary Anthropology, 18, pp. 131-143. [2] Tourloukis, V., and Karkanas, P., 2012. The Middle Pleistocene record of Greece and the role of the Aegean in hominin dispersals: new data and interpretations. Quaternary Science Reviews 43, pp. 1-15. [3] Panagopoulou E., Tourloukis V., Thompson N., Konidaris G., Athanassiou A., Giusti D., Tsartsidou G., Karkanas P., Harvati K., 2018. The Lower Palaeolithic site of Marathousa 1, Megalopolis, Greece: overview of the evidence. Quaternary International, 497, 33-46. [4] Konidaris, G., Tourloukis, V., Boni, G., Athanassiou, A., Giusti, D., Thompson, Syrides, G.N., Panagopoulou, E., Karkanas, P., Harvati, K., 2023. Marathousa 2: A new Middle Pleistocene locality in Megalopolis Basin (Greece) with evidence of human exploitation and megafauna (*Hippopotamus*). PaleoAnthropology. 2023, 34-55. [5] Roditi E., Bocherens H., Konidaris G.E., Athanassiou A., Tourloukis V., Karkanas P., Panagopoulou E., Harvati K., 2024. Life-history of *Palaeoloxodon antiquus* reveals Middle Pleistocene glacial refugium in the Megalopolis basin, Greece. Scientific Reports. 14, 1390.

Poster Presentation Number 46, Session 1, Thursday 18:00 – 19:30

Combining geometric morphometrics and phylogenetic comparative methods: a new approach to decipher evolutionary trends in human evolution

Hugo Hautavoine[1], Antonio Profico[2], Antoine Balzeau[1], Aurélien Mounier[1,3,4]

1 - Histoire Naturelle de l'Homme Préhistorique (HNHP, UMR 7194), MNHN/CNRS/UPVD, Musée de l'Homme, Paris, France · 2 - Department of Biology, University of Pisa, Pisa, Italy · 3 - Turkana Basin Institute, Nairobi, Kenya · 4 - CNRS, UAR 3129 – UMIFRE 11 3 Maison Française d'Oxford, Oxford, United Kingdom

Deciphering evolutionary trends within a phylogenetic context from 3D shape data is a long-standing issue in phylogenetic multivariate comparative methods (PCMs; [1]). Phylogenetic modelling combines PCMs and geometric morphometrics to calculate potential ancestors' morphologies at each node of a phylogenetic tree [2-3], following different evolutionary models. This method is therefore of paramount interest to explore evolutionary trends in a phylogeny using 3D landmark' coordinates. However, its potential is limited as it is constrained by the scarcity of the fossil record and the use of mean shapes for each terminal taxa of the phylogeny to calculate the virtual common ancestors (VCAs). Moreover, when 3D shape data are used as morphological variables, PCMs do not allow to explore the variation in intensity of the phylogenetic signal at a local scale. Here we present new functionalities to phylogenetic modelling approaches, through the coding of R functions. The first function, *nodeCoord*, calculates VCAs without relying on the mean shapes of each terminal taxon of the phylogeny, instead, *nodeCoord* models a population of VCAs using the bootstrapping method to emulate the available morphological variation of each terminal taxon of a phylogenetic tree. As an add-on to this function, *projPCA* makes it possible to predict the VCAs shape by projecting them into the full morphospace defined by the shapes of each terminal taxon and the original sample (specimens). Then, to map the strength of the phylogenetic signal on a very fine scale, we coded the function *phyloSigval*, which estimates the value of the phylogenetic signal, i.e., Blomberg's K [4], at each 3D landmark. In order to visualize these values in 3D [5], the *phyloSigmap* function assigns a color shade to each landmark according to the Blomberg's K value associated with it. To explore the potential of these functions, we apply them to a dataset of 3D shape collected from 263 3D crania defined by 56 cranial landmarks and 724 surface semilandmarks. In addition, we defined a fully resolved phylogeny of the genus *Homo* with 29 terminal taxa. Following several evolutionary hypotheses, we calculate with *nodeCoord* different populations of VCAs for the node representing the common ancestry between *Homo neanderthalensis* and *H. sapiens*, placed at 600 ka, and compare it to the available fossil record from the Chibanian (i.e., 0.77 to 0.12 Ma). For each evolutionary hypothesis, the phylogenetic signal is calculated using *phyloSigval*. This study allows us to explore at a very fine scale the morphological cranial differences under an evolutionary perspective between the Neanderthal and the *H. sapiens* lineages.

References: [1] Revell, L.J., 2011. Phytools: an R package for phylogenetic comparative biology (and other things). Methods in Ecology and Evolution. 3, 217–223. [2] Mounier, A., Mirazón Lahr, M., 2016. Virtual ancestor reconstruction: Revealing the ancestor of modern humans and Neandertals. Journal of Human Evolution. 91, 57–72. [3] Mounier, A., Mirazón Lahr, M., 2019. Deciphering African late middle Pleistocene hominin diversity and the origin of our species. Nature Communications. 10, 3406. [4] Blomberg, S.P., Garland, T., Ives, A.R., 2003. Testing for phylogenetic signal in comparative data: Behavioral traits are more liable. Evolution. 57, 717–745. [5] Del Bove, A., Menéndez, L., Manzi, G., Moggi-Cecchi, J., Lorenzo, C., Profico, A., 2023. Mapping sexual dimorphism signal in the human cranium. Scientific Reports. 13, 16847.

Poster Presentation Number 47, Session 1, Thursday 18:00 – 19:30

Stone Age human presence in the lower Save River valley, southern Mozambique

Jonathan Haws[1,2], Nuno Bicho[2], João Cascalheira[2], Mussa Raja[2,3], Milena Carvalho[2], Gina Buckley[2], Li Li[2], May Murungi[2], Elena Skosey-Lalonde[2], Ana Gomes[2], Jovan Galfi[2], Judite Nhanombe[2], Stella Gujamo[2], Milton Chirindza[2], Michael Benedetti[2,4], Ilona Benedetti[4], Michael Daniels[5]

1 - University of Louisville · 2 - ICArEHB, Universidade do Algarve, Faro, Portugal · 3 - Universidade Eduardo Mondlane, Maputo, Mozambique · 4 - University of North Carolina Wilmington · 5 - University of Denver

Southern Mozambique, with extensive Quaternary-aged deposits, shows great potential to inform on early modern human behavior. Despite its geographic proximity to well-known southern African hotspots of Stone Age archaeology, the area represents a major gap in our knowledge due to civil war and political instability in the late 20th century. In 2023, with an ERC award to Nuno Bicho, the DISPERSALS project began a systematic survey of the lower Save River valley in the southern half of Mozambique. The objective of the project is to investigate the migration and dispersal dynamics of early *Homo sapiens* in Africa through the study of human occupation of the Limpopo and Save River valleys in southern Mozambique over the last 100,000 years. The first stage is to systematically survey the extant Quaternary deposits in the lower Save Valley to discover new Late Pleistocene archaeological and fossil-bearing sites. The coastal plain has coastal sand deposits dated to the Last Interglacial [1] but this area had no previously documented Stone Age sites. We chose this valley because of the occurrence of exposed Quaternary gravel and sand deposits along drainages leading into the Save River. The region also lies on the margin of the eastern African coastal forest where important sites like Panga ya Saidi [2] are located. The initial reconnaissance survey in 2019 found that these deposits on the north side of the valley contained abundant raw material in the gravels and lithic scatters dated to the Middle and Later Stone Age. Approximately 100 lithic scatters were identified and mapped during the 2023 season. These range in age from Earlier Stone Age to Later Stone Age. Testing at one locality, Zimuara 1, confirmed the presence of stratified deposits in a ~2m-thick soil exposed in a quarry. Later Stone Age (LSA) were found in a buried contexts within the well-developed soil. An OSL age of 40 ± 3 ka provides the oldest dates for the LSA in Mozambique and allows us to begin building a regional chronology for the Stone Age. Here, we report the preliminary results survey and test excavations of Zimuara 1.

Test excavation at the Zimuara 1 locality produced a stratified series of at least four and maybe six occupation horizons. These occupations all appear to date to the Later Stone Age. The flake-based lithic industry is characterized by the production of small centripetal cores, mainly on quartz, lacking preparation seen on similar Middle Stone Age cores. Unmodified flakes and chips dominate the assemble with few retouched pieces. No organic preservation has been observed in the artifact horizons. Sediment samples were collected for geochemical analyses and OSL dating, and results are still pending.

European Research Council (ERC) Horizon Europe Research and innovation program Dispersals, resilience, and innovation in Late Pleistocene SE Africa Grant agreement ID: 10105276 2023-2027

References: [1] Armitage, S.J., Botha, G.A., Duller, G.A.T., Wintle, A.G., Rebêlo, L.P., Momade, F.J., 2006. The formation and evolution of the barrier islands of Inhaca and Bazaruto, Mozambique. Geomorphology. 82, 295–308. [2] Faulkner, P., Miller, J.M., Quintana Morales, E.M., Crowther, A., Shipton, C., Ndiema, E., Boivin, N., Petraglia, M.D., 2021. 67,000 years of coastal engagement at Panga ya Saidi, eastern Africa. PLOS ONE 16, e0256761.

Poster Presentation Number 48, Session 1, Thursday 18:00 – 19:30

The masticatory habits of Arcy-sur-Cure Neandertal individuals (Yonne, France): a multiscale wear analysis on dental arches

Juliette Henrion[1], Jean-Jacques Hublin[2], Bruno Maureille[1]

1 - Univ. Bordeaux, CNRS, Ministry of Culture, PACEA, UMR 5199, F-33600, Pessac, France · 2 - Chaire de Paléoanthropologie, Collège de France, 75231, Paris, France

In Arcy-sur-Cure, several neighboring prehistoric caves have yielded Neandertal remains in association with Mousterian artifacts. The 'Grotte de l'Hyène' and the 'Grotte du Bison' preserved sub-complete to fragmented dental arches. A maxilla (with 13 teeth: ULM2 to URM1) and mandible (with 14 teeth: LLM2 to LRC/LRP4 to LRM3) were discovered in 1951 in the 'Grotte de l'Hyène' [1] and a hemi-maxilla (with 6 teeth: URC to URM3) was discovered in 2008 in the 'Grotte du Bison' [2]. They are respectively attributed to an elder adult and two middle-aged or younger adult individuals, based on dental wear degrees.

Distinctive dental wear patterns, ranging from pits and scratches to severe dentin exposure and tooth fracture, are evident across these dental arcades, with intriguing wear on 'Grotte de l'Hyène' maxilla. The physical properties of food particles and/or other material processed, the teeth alignment, and the masticatory pressures influence the crown topography over time. Investigating dental chipping, occlusal reduction (enamel faceting and dentin exposure), and micro-wear texture allow for the reconstruction of individual life histories, masticatory biomechanics, dietary preferences, and environmental niches [3-5]. Furthermore, Neandertal non-masticatory behaviors were especially investigated, with their specific maxillo-facial and dental morphology (e.g. La Ferrassie I, Ochoz I, Krapina 49 and 58, Spy 1 and 2) and extreme anterior dental wear (e.g. Shanidar I, Les Pradelles LP01-D11 # H03).

In this study, we used an exploratory methodological approach to examine oral mechanics, combining qualitative and quantitative analyses. Crown topography, enamel thickness and dentine exposure are compared to buccal micro-wear stigmata to examine processes leading to severe occlusal reduction along the dental arcade and non-dietary behavioral specificities.

Despite taphonomic damages and conservation biases hindering quantitative micro-wear analyses, significant non-masticatory wear (such as scrapings and pitting) is identified. With a simple wear topography, the 'Grotte de l'Hyène' mandible exhibits scrapings with serrated profiles, on the buccal wall of the right canine and post-canine teeth (notably on the second molar). The 'Grotte de l'Hyène' maxilla presents complex coronal wear with steep distal basins. It results into important relief in relation to the occlusal basin elongation, with important occlusal pitting. On the right side, the crown reliefs are higher and sharp-edged; consequently, the dentin exposure area are larger, despite similar distribution of enamel loss and chipping on both sides of the dental arch. The hemi-maxilla from the 'Grotte du Bison' displays less occlusal reduction but prominent buccal wear features, with large pitting on the upper part of the canine and premolars buccal wall, in addition to important chipping and oblique scratches.

These results shed light on the strategies employed during mastication. We assessed lateral preferences, occlusal or lateral masticatory mechanics for anterior and post canine teeth, and the mechanical properties of processed materials. For the 'Grotte de l'Hyène' mandible, this individual likely handled hard ligneous material with their right teeth. Harder material(s) could have been dealt with by the 'Grotte du Bison' individual. Ultimately, we highlight different non-masticatory behaviors from Arcy-sur-Cure Neandertals, from incidental events to complex work for 'Grotte de l'Hyène' maxilla. Overall, topographic analyses also indicate lateral preferences of the 'Grotte de l'Hyène' individuals. Further studies would aim at comparing those results to dietary micro-/macro-wear of preserved molar occlusal facets.

We would like to thank the Regional Archeological Service of Bourgogne-Franche-Comté (Y. Pautrat), the Musée National de Préhistoire – Les Eyzies (dir. J.-J. Cleyet-Merle and now N. Fourment) for granting access to the original. We are thankful to M. Julien, M. Girard for discussions about Leroi-Gourhan fieldworks at Arcy-sur-Cure. and H. Temming (MPI) for granting us the access to the CT scans of the two Grotte du Bison fossils. We are deeply thankful to A. Souron and A. Quefelec for their availability and advises. This project is supported by UMR PACEA and ArScAn, founded by a CNRS MITI PhD grant (J. Henrion) and the Région nouvelle Aquitaine scientific project ADNER (codir. P. Bayle & B. Maureille, convention no. AAPR2021-2020-11779310). This research benefited from the scientific framework of the University of Bordeaux's IdEx "Investments for the Future" program / GPR "Human Past" and PACEA scientific teams "EuraPal" and "EvoDivBio".

References: [1] Leroi-Gourhan, A., 1958. Étude des restes humains fossiles provenant des Grottes d'Arcy-sur-Cure. Annales de Paléontologie. 44, 87–148. [2] David, F., D'Iatchenko, V.I., Enloe, J.E., Girard, M., Hardy, M., Lhomme, V., Roblin-Jouve, A, Tillier, A.-M., Tolmie, C., 2009. New Neandertal remains from the Grotte du Bison at Arcy-sur-Cure, France. Journal of Human Evolution. 57, 805–809. [3] El Zaatari, S., Grine, F.E., Ungar, P.S., Hublin, J.-J., 2011. Ecogeographic variation in Neandertal dietary habits: Evidence from occlusal molar microwear texture analysis. Journal of Human Evolution. 61, 411–424. [4] Belcastro, M.G., Mariotti, V., Riga, A., Bonfiglioli, B., Frayer, D.W., 2018. Tooth fractures in the Krapina Neandertals. Journal of Human Evolution. 123, 96–108. [5] Fiorenza, L., Benazzi, S., Kullmer, O., Zampirolo, G., Mazurier, A., Zanolli, C., Macchiarelli, R., 2019. Dental macrowear and cortical bone distribution of the Neanderthal mandible from Regourdou (Dordogne, Southwestern France). Journal of Human Evolution. 132, 174–188.

Pecha Kucha Presentation, Session 7, Friday 13:30 – 15:00

Biomechanical approach to the third hand hypothesis in Neanderthals

María Hernaiz-García[1], Ali Najafzadeh[1,2], Stefano Benazzi[3], Rachel Sarig[4,5], Jing Fu[2], Jean-Jacques Hublin[6,7], Ottmar Kullmer[8,9], Ariel Pokhojaev[4], Rita Sorrentino[10], Antonino Vazzana[3], Erica Piccirilli[3], Luca Fiorenza[1]

1 - Biomedicine Discovery Institute, Department of Anatomy and Developmental Biology, Monash University, Melbourne, Australia · 2 - Department of Mechanical and Aerospace Engineering, Monash University, Melbourne, Australia · 3 - Department of Cultural Heritage, University of Bologna, Ravenna, Italy · 4 - Department of Oral Biology, The Goldschleger School of Dental Medicine, Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel · 5 - Dan David Center for Human Evolution and Biohistory Research, Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel · 6 - Chaire de Paléoanthropologie, CIRB (UMR 7241-U1050), Collège de France, Paris, France · 7 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 8 - Division of Palaeoanthropology, Senckenberg Research Institute and Natural History Museum Frankfurt, Frankfurt a. M, Germany · 9 - Department of Palaeobiology and Environment, Institute of Ecology, Evolution, and Diversity, Goethe University, Frankfurt a. M, Germany · 10 - Department of Biological, Geological and Environmental Sciences, University of Bologna, Bologna, Italy

The Anterior Dental Loading Hypothesis (ADLH) suggests the facial morphology of Neanderthals represents an evolutionary adaptation to heavy dental loads derived from the use of the anterior teeth as a third hand [1]. Many studies have attempted to test the ADLH by examining the Neanderthal capacity to produce large bite forces based on muscular force estimation and mid-facial anatomy performance. However, no research has yet evaluated the biomechanical behaviour of the Neanderthal front teeth. Neanderthal incisors and canines are larger and wider than that of *Homo sapiens* and often exhibit advance levels of wear compared to the posterior dentition. Moreover, Neanderthal front teeth are morphologically robust, characterised by high frequency of expression of shovel shape, labial convexity and marked lingual tubercles in comparison to *Homo sapiens* [2]. As the rest of tooth types, Neanderthal incisors and canines show a thin-enamelled pattern as opposed to *Homo sapiens* [3]. If Neanderthals were using their incisors and canines during para-masticatory activities, their adaptive anatomy should help in withstanding heavy occlusal loads. To test this hypothesis, we apply a methodological approach that combines dental macrowear information, kinematic simulation and finite element analysis (FEA). We identify the contacting areas via virtual kinematic simulations and use this information to apply load to the FE models. Additionally, we measure the enamel thickness due to its potential link to the improvement of the biomechanical performance by increasing the resistance against tooth failure. Here we are presenting a biomechanical analysis of the upper left central incisor (LI^1) and lower left central incisor (LI_1) of the Neanderthal Le Moustier 1 and two *Homo sapiens* specimens, Qafzeh 9 (Middle Palaeolithic) and Ohalo II (Upper Palaeolithic). The moderate shovel shape, well-developed lingual tubercle and the strong labial convexity of Le Moustier LI^1 appears to concentrate the tensile stress along the grooves of the occlusal surface. This means a higher mechanical resistance to occlusal loads compared to the LI^1 of Qafzeh 9 and Ohalo II. Although LI_1s are characterised by a simpler morphology compared to their upper counterparts, they show similar results. Differences in the stress distribution patterns between the two species compared in the study, and between Qafzeh 9 and Ohalo II that belong to different Palaeolithic chronological periods provide evidence of a dental robusticity reduction that has taken place during human evolution. Less marked and absent dental features in Qafzeh 9 and Ohalo II lead to a wider dispersion of the tensile stress along the crown and root. The thicker enamel of the *Homo sapiens* individuals in presence of gracile morphological features seems not to be that efficient when dissipating occlusal loads. Moreover, the more advance level of wear of Ohalo II LI^1 and LI^1 (score 4; [4]) decreases coronal tensile stress due to an enlargement of the contact area and changes in loading direction [5]. On the light of these results, the thinner enamel of Le Moustier LI^1 could be compensated by the presence of robust features (shovel shape, labial convexity, lingual tubercle, as well as longer and wider roots) improving its biomechanical performance.

We would like to thank Almud Hoffmann, the curator of the Museum für Vor-und Frühgeschichte in Berlin, for providing access to the original specimen and allowing the acquisition of µCT data of Le Moustier 1 bone remains. We are very thankful to Dieter Schulz, who has performed the professional physical and physiological repositioning of the dental crowns from high resolution casts. We also want to thank Christine Hemm for surface scanning the reconstructions of the dental arches of Le Moustier 1 and Qafzeh 9, and for preparing the single crown models for the kinematic OFA analysis. We also want to express our gratitude to Jana Storsberg, who did the detail OFA mapping of the macrowear facet pattern with the Polyworks Modeller module. Moreover, we are deeply indebted to Huynh Nguyen for his invaluable comments and suggestions on the creation of the finite element models. This study was supported by the Australian Research Council, Australia (grant number: DP190100465) and by the Monash Biomedicine Discovery Institute PhD scholarship.

References: [1] Rak, Y., 1986. The Neanderthal: a new look at an old face. Journal of Human Evolution, 15, 151-164. [2] Bailey, S., 2006. Beyond shovel-shaped incisors: Neandertal dental morphology in a comparative context. Periodicum Biologorum, 108, 253-267. [3] Smith, T. M., Olejniczak, A. J., Zermeno, J. P., Tafforeau, P., Skinner, M. M., Hoffmann, A., Radovčić, J., Toussaint, M., Kruszynski, R., Menter, C., Moggi-Cecchi, J., Glasmacher, U. A., Kullmer, O., Schrenk, F., Stringer, C., & Hublin, J. J., 2012. Variation in enamel thickness within the genus *Homo*. Journal of human evolution, 62, 395-411. [4] Smith, B.H., 1984. Patterns of molar wear in hunter–gatherers and agriculturalists. American Journal of Physical Anthropology, 63, 39-56. [5] Benazzi, S., Nguyen, H.N., Kullmer, O., Hublin, J.-J., 2013. Unravelling the functional biomechanics of dental features and tooth wear. PLoS One, 8, e69990.

Poster Presentation Number 49, Session 1, Thursday 18:00 – 19:30

Exploring population-level variation in the later Pleistocene Cercopithecids from the Middle Awash study area (Afar Rift, Ethiopia)

Raquel Hernando[1,2], Catherine E. Taylor[3], Marianne F. Brasil[4], Tesla A. Monson[4], Ryan M. Yohler[5], Leslea J. Husko[1]

1 - Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Burgos, Spain · 2 - Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Tarragona, Spain · 3 - College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Colorado · 4 - Department of Anthropology, Western Washington University, WA, USA · 5 - Department of Integrative Biology, University of California, Berkeley, California, USA

The anatomical and behavioral variation within a population provides the core of evolution by natural selection. Unfortunately, paleoanthropologists rarely have the opportunity to investigate population-level variation because of the scarcity of the paleontological record. Mammalian terrestrial fossils are rare, and fossils of primates even more so. However, there is a unique opportunity to study population-level variation within the primate fossil assemblages recovered from the later Pleistocene deposits at Halibee in the Middle Awash research area in the Afar Region of Ethiopia. In total, 977 non-human primates have been recovered spanning two main time horizons, the Faro Daba beds (ca. 100,000 years ago) and the Chai Baro beds (>158,000 years) of the Dawaitoli Formation [1]. Three taxa have been described within this large assemblage: cf. *Chlorocebus* (n = 328) [2], *Colobus cf. Guereza* (n = 360) [3], and *Papio hamadryas* ssp. (n = 143) [4].

The *Papio hamadryas* ssp. assemblage derives only from the geologically older sediments of Chai Baro. There is considerable overlap in craniodental variation between the Chai Baro assemblage and extant samples of *P. h. cynocephalus*, *P. h. Anubis*, and *P. h. hamadryas*, and therefore it cannot be confidently attributed to a specific sub-species. This pattern of overlapping anatomical variation aligns with genomic studies that reveal hybridization between lineages and the likely existence of ghost populations.

The *Colobus cf. guereza* assemblage derives only from the younger deposits at Faro Daba. The morphologies of these fossils are intermediate between those of the older Asbole *Colobus* sample and extant *Colobus guereza*, with a pattern of sexual dimorphism that matches the living populations. This morphological pattern suggests that the Asbole and Faro Daba *Colobus* may be ancestral to the extant *Colobus guereza* currently known from this same geographic region.

The cf. *Chlorocebus* assemblage derives from both geological strata, and therefore provides a particularly rare opportunity to study variation across three time horizons: >158,000 years ago, ca. 100,000 years ago, and living *Chlorocebus* in the region. The level of anatomical variation in the fossil assemblages can be attributed to one species, but also shows subtle differences between Chai Baro and Faro Daba that may reflect microevolution or non-genetic indicators of behavioral variation.

In addition to the paleontological research, we will report preliminary results of our new dental microwear texture analysis (DMTA) study on these cercopithecid fossils that is to begin in May of 2024. Microscopic features on dental enamel exhibit different turnover rates, with rapid renewal on occlusal surfaces and long-term accumulation on buccal surfaces [5]. Our DMTA will provide a complementary dataset to the cranial, dental, and postcranial variation used in the taxonomic analyses, providing another window into how population variation in these three cercopithecids changed over time.

Thanks to the Middle Awash Research Project members for recovering and preserving these fossils, and to Ethiopian Heritage Authority for granting permission to study them. Thank you to B. Asfaw, Y. Beyene, and T.D. White for the invitation to study these fossils. This research was also supported with funding from the European Research Council within the European Union's Horizon Europe (ERC-2021-ADG, Tied2Teeth, project number 101054659). R. H is beneficiary of Juan de la Cierva postdoctoral fellowship (JDC2022-050014-I) - MICIU/AEI/10.13039/501100011033 and European Union NextGenerationEU/PRTR.

References: [1] Niespolo, E.M., WoldeGabriel, G., Hart, W.K., Renne, P.R., Sharp, W.D., Shackley, M.S., Ambrose, S.H., Asfaw, B., Beyene, Y., Brasil, M.F., Carlson, J.P., Sahle, Y., White, T.D., 2021. Integrative geochronology calibrates the Middle and Late Stone Ages of Ethiopia's Afar Rift. Proceedings of the National Academy of Sciences. 118, e2116329118. [2] Taylor, C.E., Brasil, M.F., Monson, T.A., Yohler, R.M., Hlusko, L.J., 2022. Halibee fossil assemblages reveal later Pleistocene cercopithecins (Cercopithecidae: Primates) in the Middle Awash of Ethiopia. American Journal of Biological Anthropology. 180, 6–47. [3] Brasil, M.F., Monson, T.A., Taylor, C.E., Yohler, R.M., Hlusko, L.J., 2022. Hundreds of *Colobus* (Cercopithecidae: Primates) fossils from the later Pleistocene of Ethiopia's Middle Awash study area. American Journal of Biological Anthropology. 180, 77–114. [4] Brasil, M.F., Monson, T.A., Taylor, C.E., Yohler, R.M., Hlusko, L.J., 2022. A Pleistocene assemblage of near-modern *Papio hamadryas* from the Middle Awash study area, Afar Rift, Ethiopia. American Journal of Biological Anthropology. 180, 48–76. [5] Teaford, M.F., Oyen, O.J., 1989. Differences in the rate of molar wear between monkeys raised on different diets. Journal of Dental Research. 68, 1513–1518.

Poster Presentation Number 50, Session 1, Thursday 18:00 – 19:30

The paleodietary reconstruction of *Theropithecus oswaldi* from Kenya suggest a dietary change during the Pleistocene

Luis Hidalgo-Trujillo[1,2], Ferran Estebaranz-Sánchez[2], Alejandro Pérez-Pérez[1,2], Juan José Ibáñez[2], Albert E. Dyowe Roig[3], Laura Martínez[1,2]

1 - Departament de Biologia Evolutiva, Ecologia i Ciències Ambientals. Facultat de Biologia, Universitat de Barcelona, Barcelona · 2 - Institut d'Arqueología de la Universitat de Barcelona (IAUB), Facultat de Geografía i Historia, Barcelona · 3 - Departamento de Prehistoria, Universidad Autónoma de Barcelona, Barcelona, Spain

The *Theropithecus gelada* primates are the only extant graminivorous primate belonging to the Cercopithecidae family, that inhabit Ethiopian ecosystems. According to fossil evidence, extinct *Theropithecus* were highly abundant during the Late Pliocene and Early to Middle Pleistocene in East and South Africa. Fossil remains have also been found to a lesser extent in North Africa, Southeastern Europe, and Asia, suggesting that the radiation and evolution of the lineage occurred during the Pleistocene alongside the dispersal of hominins.

Isotopic analysis indicates that 4 Ma, the earliest African *Theropithecus* had a diet primarily composed of C4 resources. Progressively, the genus increased the proportion of C4 resources in its diet until 1 Ma when it has a nearly 100% C4-derived diet similar to that described to the unique extant species, *Theropithecus gelada* [1]. However, some studies suggest that extinct *Theropithecus oswaldi* had a more abrasive and variable diet with the incorporation of hard, brittle items as a response to the climatic variations that affected these ecosystems during the Pleistocene [2-3].

The aim of the present study is to explore the potential of 3D buccal dental microtexture to reconstruct the paleodietary signal of *Theropithecus* and to analyze if there is a trend in the abrasiveness of the diet throughout time. Dental samples of *Theropithecus oswaldi* correspond to fossils recovered from the Koobi Fora site (Kenya) and were obtained from the originals curated at the Kenyan National Museum following standard protocols [4]. Buccal microtexture patterns were analyzed and compared with an extant Cercopithecoidea sample. Buccal surfaces were observed with with a Sensofar Plu Neox confocal microscope at 20X magnification, and thirty-six ISO surface texture parameters were extracted using Mountain 7® software following a standard ISO workflow [4].

The results indicate that between 1.9-1.74 million years ago, *T. oswaldi* specimens from Koobi Fora had a microtexture pattern similar to hard-fruit eaters as *Cercocebus torquatus*, with dales and peaks. However, the most recent specimens showed a pattern like extant *T. gelada*, characterized by surfaces with thin, sharp peaks probably related to the ingestion of grasses. These results indicate a temporal shift in the dietary regime of *T. oswaldi* from the Koobi Fora site, probably in response to changes in climatic conditions and resource availability. Interpreting the evolution of the *Papionini* lineage and the *Theropithecus* lineage, will provide clues about the evolution of hominins, as both lineages expanded during the Plio-Pleistocene in East and South Africa and were subject to the same climatic restrictions and ecological changes from closed ecosystems to open.

We are grateful to all the curators and technical personnel of the different institutions where the specimens were molded. Grants PID2020-112963GB-I00, funded by MCIN/AEI/10.13039/501100011033 and by "ERDF A way of making Europe", by the "European Union". www.paleobaboonproject.science.

References: [1] Cerling, T.E., Chritz, K.L., Jablonski, N.G., Leakey, M.G., Manthi, F.K., 2013. Diet of *Theropithecus* from 4 to 1 Ma in Kenya. Proceedings of the National Academy of Sciences. 110, 10507–10512. [2] Martínez, L.M., Estebaranz-Sánchez, F., Ferràndez-Cañadell, C., Romero, A., Ribot, F., Galbany, J., Gibert, L., Pérez-Pérez, A., 2020. Buccal dental-microwear and feeding ecology of Early Pleistocene *Theropithecus oswaldi* from Cueva Victoria (Spain). Journal of Human Evolution. 142, 102736. [3] Teaford, M.F., 1993. Dental microwear and diet in extant and extinct *Theropithecus*: preliminary analyses. In: *Theropithecus*: The Rise and Fall of a Primate Genus. Cambridge University Press, pp. 331–350. [4] Martínez, L.M., Estebaranz-Sánchez, F., Romero, A., Ibáñez, J.J., Hidalgo-Trujillo, L., Avià, Y., Pérez-Pérez, A., 2022. Effectiveness of buccal dental-microwear texture in African Cercopithecoidea dietary discrimination. American Journal of Biological Anthropology. 179, 678–686.

Podium Presentation, Session 12, Saturday 15:50 – 17:30

AMS dating reveals early presence of *Homo sapiens* at the Kozarnika site (Bulgaria) 45-50,000 years ago

Tom Higham[1,2], Rachel Hopkins[3,4], Jean-Luc Guadelli[5], Dustin White[6], Chris Stringer[7], Michael Buckley[8], Aleta Guadelli[9], Philippe Fernandez[10], Nikolai Sirakov[11]

1 - Department of Evolutionary Anthropology, University of Vienna, Vienna, Austria · 2 - Human Evolution and Archaeological Science (HEAS) Network, Vienna, Austria · 3 - RLAHA, University of Oxford, Oxford, United Kingdom · 4 - Meow Wolf, Inc., NM, USA · 5 - PACEA-UMR 5199 CNRS, Université de Bordeaux, France · 6 - Department of Chemistry, University of York, United Kingdom · 7 - Natural History Museum, London, United Kingdom · 8 - Manchester Institute of Biotechnology, University of Manchester, United Kingdom · 9 - National Institute of Immovable Cultural Heritage, Sofia, Bulgaria · 10 - LAMPEA UMR 7269, CNRS, Aix Marseille Univ., Aix-en-Provence, France · 11 - National Institute of Archaeology with Museum-Bulgarian Academy of Sciences, Sofia, Bulgaria

The site of Kozarnika in Bulgaria is a key, deep (~6 m) archaeological sequence spanning the Lower, Middle and Upper Palaeolithic of Europe. In its latter phases, it documents the transition from a Neanderthal-dominated Europe, to one in which only modern humans are present. The process of this transition is of major importance to understanding the timeline of hominin dispersals, extinctions and replacement in Europe.

We obtained 37 new AMS radiocarbon dates to build a robust chrono-stratigraphy for the site through sampling humanly modified bones, artefacts and human remains. We focussed particularly on dating the Initial Upper Palaeolithic phase of the occupation, in geological layer 6/7, because of its potential link with early dispersing *Homo sapiens* populations. We built a series of Bayesian models of the results to test the inclusion or exclusion of various determinations. We used a KDE model approach to plot the entire set of results, and compared them with others regional sites.

The KDE Models show that the latter phases of human occupation at Kozarnika comprised five distinct periods, dated between about 50-26,000 years ago. We found that the 6/7 phase ranged from 48,500-44,050 cal BP, probably starting from about 49,960 cal BP. We think the most likely occupants at this time are modern humans, as indirectly evidenced by a *Homo sapiens* tooth found within the same context. The stone tool evidence from the site contains some Levallois pieces, however, with echoes of the earlier Middle Palaeolithic. This mix of stone tools of different traditions may represent interstratification – with alternating visits by both Neanderthals and modern humans. Aside from the evidence from Apidima (Greece) which dates to about 210,000 years ago [1], Kozarnika is the earliest site found in eastern Europe from the last 100,000 years which contains evidence for the presence of modern humans.

Neanderthal presence might in fact extend closer to 43,130-41,490 cal BP (95.4% prob.), ended by the start of the earliest Kozarnikian industry at the cave; the Kozarnikien très ancien, as elsewhere in Europe with similar industries. The application of sediment DNA approaches might help to unlock further evidence about the humans that were present during this crucial period, as the Middle Palaeolithic ended and the early Upper Palaeolithic began.

Kozarnika cave fieldwork and post-excavation work is funded by the National Institute of Archaeology and Museum of the Bulgarian Academy of Sciences (N. Sirakov) and UMR5199 CNRS PACEA (J.-L. Guadelli), financially supported by the Advisory Committee of the Archaeological Research abroad of the French Ministry of Foreign Affairs (Mission Paléolithique de Bulgarie directed by J.-L. Guadelli). The bulk of the radiocarbon component of the research leading to these results was based on funding from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013); ERC grant 324139 "PalaeoChron" awarded to T. Higham. Other radiocarbon measurements were obtained as part of the RESET (Response of Humans to Abrupt Environmental Transitions) project funded by the Natural Environment Research Council (NERC) of the UK. The research of CS is supported by the Calleva Foundation (Grant Number SDV17014) and the Human Origins Research Fund. We thank the excavation teams of the Kozarnika site and the staff of the Oxford Radiocarbon Accelerator Unit at the University of Oxford for their work.

References: [1] Harvati, K., Roding, C., Bosman, A., Karakostis, F., Grun, R., Stringer, C., Karkanas, P., Thompson, N., Koutoulidis, Moulopoulos, L., Gorgoulis, V.G., Kouloukoussa, M., 2019. Apidima Cave fossils provide earliest evidence of Homo sapiens in Eurasia. Nature. 571, 500–504.

Podium Presentation, Session 8, Friday 15:20 – 17:00

A preliminary report of the first evidence for genetic correlations between cranial and dental variation in a primate

Leslea J. Hlusko[1], Jessica Joganic[2], James M. Cheverud[3], Mario Modesto-Mata[1,4], Arthur Thiebaut[1], Michael C. Mahaney[5]

1 - Centro Nacional de Investigación sobre la Evolución Humana, Burgos, Spain · 2 - National Parks Service, Arkansas, USA · 3 - Loyola University Chicago, Chicago, Illinois, USA · 4 - Universidad Internacional de La Rioja (UNIR), Logroño, Spain · 5 - The University of Texas Rio Grande Valley, Texas, USA

Craniodental variation is at the core of much of paleoanthropological research. From cladistic analyses that assume independence between characters to predictions of body size from cranial and dental traits, a wide variety of assumptions have been made about the biological etiology of craniodental variation, and often these assumptions are inconsistent. With advances in quantitative genetic methodologies, we are now able to test hypotheses of how pleiotropic effects influence primate craniodental variation, and from there, improve our understanding of how genetic modularity has influenced evolution. Previous research has shown that dental and cranial size are both heritable [1-4], but to date, there have been no analyses of how their additive genetic effects interrelate.

We tested the hypothesis that variation in cranial size is genetically independent of variation in molar size using a quantitative genetic analysis of variation within a captive breeding colony of baboons (*Papio hamadryas*) at the Southwest National Primate Research Center. All family relationships are known and mating opportunities controlled to prevent in-breeding. Data collection on living animals was approved by institutional animal care and use committees. We collected mesiodistal (MD) and buccolingual (BL) dimensions for all maxillary molars from high-resolution casts made from approximately 630 individuals [2]. We also calculated eight linear dimensions characterizing cranial, facial, and muzzle length and width from JLJ's 3-d landmarks collected with a microscribe from the skulls of approximately 1,000 individuals [4]. Combined dental and cranial data were available for 448 to 541 individuals, depending on the specific pair of traits.

Using a maximum likelihood approach implemented in the computer package SOLAR-eclipse [5], we estimated the phenotypic, genetic, and non-genetic ("environmental") correlations for all possible combinations of MD and BL maxillary molar dimensions and the eight cranial distances, including age, sex, and age-by-sex effects in the regression. The statistical significance of each genetic correlation was calculated using a likelihood ratio, in which the difference between the unconstrained and a constrained analysis (in which the genetic correlation is set to either 1 or 0) is approximately a chi-square distribution. Many of the traits were i-normalized prior to analysis in order to conform to the assumption in the analytical method that phenotypic variation is normally distributed.

Our results demonstrate evidence of genetic correlations between some pairs of craniodental dimensions. Although our results are preliminary, as these sample sizes are relatively small for quantitative genetic analyses, we find suggestive patterns. For example, we find that the length of the entire cranium has a phenotypic and a genetic correlation with molar dimensions, but not an environmental correlation. Similarly, the length of the muzzle has a genetic and phenotypic, but not an environmental correlation with molar dimensions. Facial width has an environmental but not a phenotypic or genetic correlation with molar dimensions. And, the width of the muzzle at the premolar-molar contact is phenotypically, genetically, and environmentally correlated with the MD length of the second molar. Although preliminary, these results clearly demonstrate the new insight to craniodental studies in paleoanthropology that will be gained from a quantitative genetic approach to skeletal variation.

This research was funded in part by the European Research Council within the European Union's Horizon Europe (ERC-2021-ADG, Tied2Teeth, project number 101054659). We thank the Southwest National Primate Research, supported by NIH National Center for Research Resources Grant P51 RR013986, for access and assistance. This work was supported by National Science Foundation Division of Behavioral and Cognitive Sciences Grants 0500179, 0616308, and 0130277 (to L.J.H.) and 1232439 (to J.L.J. and J.M.C.).

References: [1] Hlusko, L.J., Weiss, K.M., Mahaney, M.C., 2002. Statistical genetic comparison of two techniques for assessing molar crown size in pedigreed baboons. American Journal of Physical Anthropology. 117, 182–189. [2] Hlusko, L.J., Mahaney, M.C., 2009. Quantitative genetics, pleiotropy, and morphological integration in the dentition of *Papio hamadryas*. Evolutionary Biology. 36, 5–18. [3] Roseman, C.C., Willmore, K.E., Rogers, J., Hildebolt, C., Sadler, B.E., Richtsmeier, J.T., Cheverud, J.M., 2010. Genetic and environmental contributions to variation in baboon cranial morphology. American Journal of Physical Anthropology. 143, 1–12. [4] Joganic, J.L., Willmore, K.E., Richtsmeier, J.T., Weiss, K.M., Mahaney, M.C., Rogers, J., Cheverud, J.M., 2017. Additive genetic variation in the craniofacial skeleton of baboons (genus *Papio*) and its relationship to body and cranial size. American Journal of Physical Anthropology. 165, 269–285. [5] Kochunov, P., Jahanshad, N., Marcus, D., Winkler, A., Sprooten, E., Nichols, T.E., Wright, S.N., Hong, L.E., Patel, B., Behrens, T., Jbabdi, S., Andersson, J., Lenglet, C., Yacoub, E., Moeller, S., Auerbach, E., Ugurbil, K., Sotiropoulos, S.N., Brouwer, R.M., Landman, B., Lemaitre, H., den Braber, A., Zwiers, M.P., Ritchie, S., van Hulzen, K., Almasy, L., Curran, J., deZubicaray, G.I., Duggirala, R., Fox, P., Martin, N.G., McMahon, K.L., Mitchell, B., Olvera, R.L., Peterson, C., Starr, J., Sussmann, J., Wardlaw, J., Wright, M., Boomsma, D.I., Kahn, R., de Geus, E.J.C., Williamson, D.E., Hariri, A., van 't Ent, D., Bastin, M.E., McIntosh, A., Deary, I.J., Hulshoff pol, H.E., Blangero, J., Thompson, P.M., Glahn, D.C., Van Essen, D.C., 2015. Heritability of fractional anisotropy in human white matter: A comparison of Human Connectome Project and ENIGMA-DTI data. NeuroImage. 111, 300–311.

Poster Presentation Number 51, Session 1, Thursday 18:00 – 19:30

Investigating handedness variability in chimpanzees (*Pan troglodytes*): a meta-analysis of the strength and direction of manual lateralized preferences

Rachel M. Hurwitz[1], Susana Carvalho[1,2,3], Thomas A. Püschel[1]

1 - Institute of Human Sciences, School of Anthropology and Museum Ethnography, University of Oxford, Oxford, UK · 2 - Interdisciplinary Center for Archaeology and Evolution of Human Behaviour (ICArEHB) FCHS, University of Algarve, Campus de Gambelas, Faro, Portugal · 3 - Department of Science, Gorongosa National Park, Mozambique

Modern humans show an extreme degree of manual lateralization, both in terms of strength and direction at the population level. Cross-culturally, around 85-95% of individuals report being right-handed, which is a potential evolutionary singularity among both extant and extinct primates [1]. When and why humans evolved such a marked bias remains unclear, though numerous hypotheses have been put forward to explain this phenomenon. There is some evidence that the degree of directional bias has been fixed in human populations since the Neolithic and may have even been present in the *Homo* lineage before the emergence of *Homo sapiens* [2]. Numerous studies suggest that our closest living relative, the chimpanzee (*Pan troglodytes*), displays individual lateral preferences as a result of various life history factors, and particularly when engaging in complex behaviors such as the use of tools [3]. However, it is still debated whether chimpanzees show population- or group-level biases toward one hand, and very few large-scale studies have tested this [4]. Here, we present a new, comprehensive meta-analysis of chimpanzee handedness to measure if there is consistent behavioral evidence of dexterous lateralization in chimpanzees. Using both wild and captive data, we carried out two analyses, one using data obtained from the 'tube task,' a standard experimental paradigm used to determine hand preferences in primates, and a second one using other alternative tests of handedness preference. We aimed to assess whether chimpanzees show population-level handedness terms of direction via the mean handedness index (MHI) and strength via the mean absolute handedness index (MABSHI). When relevant data was available, we analysed the MHI and MABSHI as a response of various covariates hypothesized to impact lateralized behaviours in apes including sex, age, captive versus wild rearing, subspecies, and community of origin. Multi-level random-effects meta-analyses were conducted to address sources of non-independence in experimental data and to better control for publication bias. Our results demonstrate the importance of accounting for publication heterogeneity, as well as ontogeny when studying handedness in chimpanzees. Importantly, understanding whether the genus *Pan*, who last shared a common ancestor with humans around 7-13 mya [5], show individual or population-level handedness can guide hypotheses regarding when our lineage evolved its idiosyncratic right-hand preference. Furthermore, being able to trace the origins of laterality at the behavioural level may influence future research into markers of laterality in the fossil record. Our results shed light on the evolutionary trajectory of manual lateralization in chimpanzees and equally can inform the timing and mechanisms underlying the evolution of this trait, which, in turn, may help explain the marked rightward bias observed in modern humans.

RMH was supported by the Clarendon Fund Scholarship and the Oxford-Angus McLeod, St John's College Graduate Scholarship. We thank all the authors for the availability of data sets that have been used to conduct this research.

References: [1] Fitch, W.T., Braccini, S.N., 2013. Primate laterality and the biology and evolution of human handedness: a review and synthesis. Annals of the New York Academy of Sciences. 1288, 70–85. [2] Lozano, M., Estalrrich, A., Bondioli, L., Fiore, I., Bermúdez de Castro, J., Arsuaga, J.L., Carbonell, E., Rosas, A., Frayer, D.W., 2017. Right-handed fossil humans. Evolutionary Anthropology: Issues, News, and Reviews. 26, 313–324. [3] Humle, T., Matsuzawa, T., 2008. Laterality in hand use across four tool-use behaviors among the wild chimpanzees of Bossou, Guinea, West Africa. American Journal of Primatology. 71, 40–48. [4] Hopkins, W.D., Phillips, K.A., Bania, A., Calcutt, S.E., Gardner, M., Russell, J., Schaeffer, J., Lonsdorf, E.V., Ross, S.R., Schapiro, S.J., 2011. Hand preferences for coordinated bimanual actions in 777 great apes: Implications for the evolution of handedness in Hominins. Journal of Human Evolution. 60, 605–611. [5] Langergraber, K.E., Prüfer, K., Rowney, C., Boesch, C., Crockford, C., Fawcett, K., Inoue, E., Inoue-Muruyama, M., Mitani, J.C., Muller, M.N., Robbins, M.M., Schubert, G., Stoinski, T.S., Viola, B., Watts, D., Wittig, R.M., Wrangham, R.W., Zuberbühler, K., Pääbo, S., Vigilant, L., 2012. Generation times in wild chimpanzees and gorillas suggest earlier divergence times in great ape and human evolution. Proceedings of the National Academy of Sciences. 109, 15716–15721.

Poster Presentation Number 52, Session 1, Thursday 18:00 – 19:30

Morphometric analysis of the enamel-dentine junction and occlusal crown morphology of the mandibular and maxillary deciduous molars of *Homo naledi*

Mykolas D. Imbrasas[1], Shara E. Bailey[1,2], Lucas K. Delezene[3,4], Matthew M. Skinner[5]

1 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 2 - Department of Anthropology, Center for the Study of Human Origins, New York University, NY, USA · 3 - Department of Anthropology, University of Arkansas, Fayetteville, AR, USA · 4 - Centre for the Exploration of the Deep Human Journey, University of the Witwatersrand, , South Africa · 5 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

Dental elements constitute a significant portion of *Homo naledi* fossil remains [1]. Analyses of the enamel-dentine junction (EDJ) [1-2] morphology, as well as of crown and root non-metric traits of the permanent dentition [3] have revealed a mosaic of primitive and derived features. Recently, a study of non-metric traits of the deciduous dentition [3] and a morphometric analysis of the occlusal outline shape of the maxillary and mandibular deciduous molars [4] have shown that this primitive and derived trait mosaic is also present in the deciduous dentition.

In this study we expand on prior research by using micro-CT scans to analyze the EDJ morphology of deciduous molars (DM) of *H. naledi* (n=5) and other hominins (*Australopithecus*=5, *H. erectus*=2, *H. sapiens*=45, *H. neanderthalensis*=30, *Paranthropus*=15) using 3D geometric morphometrics (GM). We also conducted a combined fissure and outline shape 2D GM analysis of the outer enamel surface, which allowed for larger sample sizes to be compared (*Australopithecus*=17, *H. erectus*=3, *H. neanderthalensis*=35, *H. naledi*=6, *H. sapiens*=42, *Paranthropus*=37). This combined method has been shown to be better at distinguishing between groups than outline shape alone in permanent molars [5].

The fissure patterns and the occlusal outline shape of the *H. naledi* DM1 more closely resemble those of *A. afarensis*. However, the EDJ morphology aligns it more closely with *P. robustus*, due to its thick distal marginal ridge and relatively long occlusal basin. It resembles both taxa in its low dentine body height and lack of a tuberculum molare. The DM2s exhibit a different pattern. They possess a quadrangular occlusal outline and a fissure pattern that is derived towards later *Homo*. The DM2 EDJ morphology exhibits similarities to *A. africanus*, particularly the pinched cervix and occlusal basin shape, while the dentine body height closely resembles that of *H. erectus*.

Both the DM1 and DM2 have a pinched occlusal outline, which most closely resembles that of *Paranthropus*, but are differentiated by having narrower talonids. The specimens most similar to the *H. naledi* DM1 and DM2 are the deciduous teeth from the Omo Basin, Ethiopia, currently classified as *Paranthropus*. These teeth exhibit a similar occlusal outline and fissure pattern, but are larger and have a slightly wider trigonid than in *H. naledi*. At the EDJ, the DM1 features are most similar to *P. robustus*. These include a relatively thick distal marginal ridge, the relative position of the entoconid to the hypoconid, and overall cervix shape. The DM1 differs from that of *P. robustus* in its distally-positioned metaconid relative to the protoconid, in its narrow mesial occlusal basin, and in its more pronounced tuberculum molare. The EDJ of the DM2 also shares similarities with *P. robustus* but is distinct in exhibiting a more developed tuberculum molare and a narrower, elongated occlusal basin. The elongated occlusal basin also distinguishes the *H. naledi* DM2 from all other taxa in the sample. Both mandibular deciduous molars exhibit a slightly taller dentine body height compared to *Paranthropus* and *Australopithecus* but not to the same degree as seen in the DM2s.

The results of the current study confirm that the deciduous molars of *H. naledi* possess a mosaic of primitive and derived features, as well as some unique ones. These results, as well as the intermediate dentine body height, especially in the DM2s, are consistent with the pattern observed in the morphology of the EDJ of the mandibular premolars [2]. Beyond confirming results of a previous study [3], the inclusion of fissures in the analyses did not provide additional information. Given that the *H. naledi* deciduous mandibular molars sample a single individual, additional deciduous dental material is needed to test whether or not the patterns observed here characterize the species as a whole.

We thank Lee Berger for access to the *Homo naledi* deciduous dental material. Comparative material was also kindly provided by University of Witwatersrand, , Tel Aviv University, Rockefeller Museum Jersualem, Croation Natural History Museum, Musée de lHomme Paris, National Museum of Tanzania, University Liege, Nationa Prehistory Museum les Eyzies, Royal Belgian Institute of Natural Sciences, Ditsong National Museum of Natural History, University of Leipzig Anatomical Collection, Museum Angouleme, Bologna University, National Museums of Kenya, National Museum of Tanzania, and the Ethiopian Authority for Research and Conservation of Cultural Heritage. Support for this project was also provided by Jean-Jacques Hublin, Zeresenay Alemseged, Fred Spoor, Bernard Zipfel, Emma Mbua, and Agness Gidna. This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 819960) and the Max Planck Society.

References: [1] Berger, L.R., Hawks, J., De Ruiter, D.J., Churchill, S.E., Schmid, P., Delezene, L.K., Kivell, T.L., Garvin, H.M., Williams, S.A., DeSilva, J.M., Skinner, M.M., Musiba, C.M., Cameron, N., Holliday, T.W., Harcourt-Smith, W., Ackermann, R.R., Bastir, M., Bogin, B., Bolter, D., Brophy, J., Cofran, Z.D., Congdon, K.A., Deane, A.S., Dembo, M., Drapeau, M., Elliott, M.C., Feuerriegel, E.M., Garcia-Martinez, D., Green, D.J., Gurtov, A., Irish, J.D., Kruger, A., Laird, M.F., Marchi, D., Meyer, M.R., Nalla, S., Negash, E.W., Orr, C.M., Radovcic, D., Schroeder, L., Scott, J.E., Throckmorton, Z., Tocheri, M.W., VanSickle, C., Walker, C.S., Wei, P., Zipfel, B., 2015. *Homo naledi*, a new species of the genus Homo from the Dinaledi Chamber, South Africa. eLife. 4, e09560 [2] Davies, T.W., Delezene, L.K., Gunz, P., Hublin, J.-J., Berger, L.R., Gidna, A., Skinner, M.M., 2020. Distinct mandibular premolar crown morphology in *Homo naledi* and its implications for the evolution of Homo species in southern Africa. Scientific Reports. 10, 13196. [3] Bailey, S.E., Brophy, J.K., Moggi-Cecchi, J., Delezene, L.K., 2019. The deciduous dentition of *Homo naledi*: A comparative study. Journal of Human Evolution. 136, 102655. [4] Brophy, J.K., Moggi-Cecchi, J., Matthews, G.J., Bailey, S.E., 2020. Comparative morphometric analyses of the deciduous molars of *Homo naledi* from the Dinaledi Chamber, South Africa. American Journal of Physical Anthropology. 174, 299–314. [5] Imbrasas, M.D., Skinner, M.M., 2022. Morphometric analysis of the mandibular and maxillary molar sample from Lomekwi, Kenya. PaleoAnthropology. 2022.

Poster Presentation Number 53, Session 1, Thursday 18:00 – 19:30

Linking climate and settlement patterns during MIS 3 and 2 in the Inner Asian Mountain Corridor: data from Maibulaq and Aqtogai Cave

Radu Iovita[1,2], Tobias Sprafke[3,4], Abay Namen[2,5], Aristeidis Varis[2], Emily Coco[1,6], Susanne Lindauer[7], Dimitri Vandenberghe[8], Jan-Pieter Buylaert[9], Johan DeGrave[8], Stefan Meng[10], Stefania Milano[11,12], Miriam Belmaker[13], Werner H. Schoch[14], Lisa Schunk[15,16], Zhaken Taimagambetov[17]

1 - Center for the Study of Human Origins, Department of Anthropology, New York University, New York, USA · 2 - Department of Geosciences, University of Tübingen, Tübingen, Germany · 3 - School of Agricultural, Forest and Food Sciences (HAFL), Bern University of Applied Sciences (BFH), Zollikofen, Switzerland · 4 - Institute of Geography, University of Bern, Bern, Switzerland · 5 - Department of Sociology and Anthropology, School of Sciences and Humanities, Nazarbayev University, Kazakhstan · 6 - Department of Anthropology, Yale University, New Haven CT, USA · 7 - Curt-Engelhorn-Zentrum für Archäometrie, Mannheim, Germany · 8 - Department of Geology, Faculty of Sciences, University of Ghent, Ghent, Belgium · 9 - Department of Physics, Technical University of Denmark (DTU), Roskilde, Denmark · 10 - University of Greifswald, Greifswald, Germany · 11 - Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 12 - Department of Evolutionary Ecology, Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany · 13 - Department of Anthropology, University of Tulsa, Tulsa, OK, USA · 14 - Laboratory for Ancient Wood Research, Langnau, Switzerland · 15 - MONREPOS Archaeological Research Centre and Museum for Human Behavioural Evolution, Leibniz-Zentrum für Archäologie, Neuwied, Germany · 16 - Department of Archaeology, University of Cambridge, UK · 17 - National Museum of the Republic of Kazakhstan, Astana, Kazakhstan

The magnitude of the impact that cold periods of the last glacial cycle had on human populations and their behavior is uncertain, because local conditions may differ from the global climate. Central Asia, which presents extreme geographic differences and lies on the threshold of aridity is one of the best laboratories for studying this relationship, because the magnitude of the effect is amplified. More specifically, the Tian Shan and Qaratau piedmonts are hypothesized to have had milder and wetter micro-climates than steppes and thus constituted refugia [1]. Significant parts of these piedmonts are also blanketed by large accumulations of loess, offering excellent archives for preserving the comings and goings of humans in the landscape on a long time scale. Here we present data on human occupation from two Paleolithic archaeological sites in southern Kazakhstan, a cave in the Qaratau (Aqtogai) and a multi-layered open-air site in the Tian Shan piedmont (Maibulaq). We summarize and combine published data [2-4] with new chronologies, microstratigraphic information, and local climate proxies from new high-resolution and -recovery excavations to correlate human occupation with both local and global climates.

We show that Maibulaq was likely occupied during cold and arid periods with high dust flux during the period from ca. 40-25 ka, including Heinrich events 4 and 3 and the beginning of the Last Glacial Maximum (LGM). Where people went during the warmer and wetter episodes is unclear, but it is possible that they occupied sites at higher altitudes, over 2000 m, which have not yet been surveyed. Alternatively, according to the Beeton et al. [1] model, they could have occupied the so far poorly known steppe zone. At the beginning of the LGM, the site was finally abandoned, like all other sites currently known from this part of arid Central Asia. In contrast to the Maibulaq data, new excavations at Aqtogai Cave document human occupation during the coldest phases of the LGM and beyond, suggesting that isolated pockets within the piedmonts may have offered better protections than others. Future research will focus on examining the exact local conditions that enabled human settlement in the Qaratau and use it to investigate areas with similar conditions to further test the refugium hypothesis.

Funding for the 2017 excavation and most of the analyses at Maibulaq was provided by the L.S.B. Leakey Foundation. RI thanks the Leibniz Zentrum für Archäologie (LEIZA, formerly RGZM) for supporting the 2013-2015 field and laboratory research seasons. This research also received support from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (grant agreement n° 714842; PALAEOSILKROAD project).

References: [1] Beeton, T.A., Glantz, M.M., Trainer, A.K., Temirbekov, S.S., Reich, R.M., 2014. The fundamental hominin niche in late Pleistocene Central Asia: a preliminary refugium model. Journal of Biogeography. 41, 95–110. [2] Fitzsimmons, K.E., Iovita, R., Sprafke, T., Glantz, M., Talamo, S., Horton, K., Beeton, T., Alipova, S., Bekseitov, G., Ospanov, Y., Deom, J.-M., Sala, R., Taimagambetov, Z., 2017. A chronological framework connecting the early Upper Palaeolithic across the Central Asian piedmont. Journal of Human Evolution/Journal of Human Evolution. 113, 107–126. [3] Fitzsimmons, K.E., Sprafke, T., Zielhofer, C., Günter, C., Deom, J.-M., Sala, R., Iovita, R., 2018. Loess accumulation in the Tian Shan piedmont: Implications for palaeoenvironmental change in arid Central Asia. Quaternary International. 469, 30–43. [4] Sprafke, T., Fitzsimmons, K.E., Grützner, C., Elliot, A., Marquer, L., Nigmatova, S., 2018. Reevaluation of Late Pleistocene loess profiles at Remizovka (Kazakhstan) indicates the significance of topography in evaluating terrestrial paleoclimate records. Quaternary Research. 89, 674–690.

Poster Presentation Number 54, Session 1, Thursday 18:00 – 19:30

Raw material procurement strategies during the Middle Paleolithic, early Upper Paleolithic and Epigravettian in the cave Ždrilo

Ana Jagić[1], Zlatko Perhoč[2]

1 - Department of Archaeology, University of Zadar, Croatia · 2 - Independent researcher

This paper presents preliminary results of petrographic analysis of lithic raw material with the aim of defining its acquisition strategies by Paleolithic hunter-gathering communities using the example of findings from the Ždrilo cave (Dalmatia, Croatia). Three Paleolithic phases of settlement of the Ždrilo have been confirmed by different chronological methods, the earliest of which dates back to the Middle Paleolithic. The middle phase belongs to the early Upper Paleolithic, while the last traces of Paleolithic hunter-gathering communities in Ždrilo are marked by the appearance of a lithic assemblage with characteristics of the Epigravettian culture. The last was additionally confirmed by the analysis of tephra layer, which was determined as Neapolitan Yellow Tuff. The preliminary petrographic macroscopic analysis carried out showed that Mousterian communities for the production of lithic objects fully used local raw materials that were easily available near the cave in a radius of 20 km. It was of average quality, which also affected variations in typological and technological categories. The pattern of procurement of raw materials during the early Upper Paleolithic was until now unknown in Dalmatia, and Ždrilo is the first certain locality that we can date to this period. The analysis determined predominance of the exploitation of local raw materials with a smaller group of cherts that were gathered at larger, regional distances (20-50 km). During the Epigravettian we have few transregional pieces (with deposits located at distances greater than 50 km) from the area of the western Adriatic coast appeared. Regardless of the mentioned differences, frequent exploitation of Cretaceous chert from rudist limestones is a feature of all phases in Ždrilo. The closest known outcrops of rudist cherts to Ždrilo are located in the Trogir area, a deposit from which the communities once collected raw materials, and the closest and also the only outcrop is located on Dugi otok. In addition to different types of chert, communities from Ždrilo also used radiolarites and tuffs from local and regional distances. Each of the listed raw materials is unique and by conducting various analyses it is possible to precisely determine its origin, which opens up possibilities for the interpretation of potential procurement routes, as well as the movement of communities.

Poster Presentation Number 55, Session 1, Thursday 18:00 – 19:30

Middle Stone Age raw material selection in the Southern Kalahari Desert, South Africa: does homogeneity indicate superior lithic quality?

Bharti Jangra[1], Alexander Blackwood[2], Precious Chiwara-Maenzanise[2], Jillian Huntley[3], Adam Brumm[1], Robyn Pickering[2,4], Benjamin Schoville[5], Jayne Wilkins[1]

1 - Australian Research Centre for Human Evolution, Griffith University, Australia · 2 - Department of Geological Sciences, University of Cape Town, South Africa · 3 - Griffith Centre for Social and Cultural Research, Griffith University, Australia · 4 - Human Evolution Research Institute, University of Cape Town, South Africa · 5 - School of Social Science, University of Southern Queensland, Australia

The quality of lithic raw materials played a pivotal role in ensuring their efficiency, durability, and functionality for stone tool production. While significant strides have been made in understanding its importance, it is still unknown how varying material qualities influenced technological change during the Middle Stone Age (MSA). It is believed that homogenous and isotropic rocks are good quality raw material, providing better control of conchoidal fracture, whereas rock with cleavage planes or inclusions are less suitable, as they it difficult to get desired outcome of knapping [1-2]. Usually, the utilization of 'less suitable' raw material in tool making is considered as adaptive strategy due to the scarcity of 'better quality' raw material. Here we discuss the raw material variation and selectivity by early humans at the site of Ga-Mohana Hill North Rockshelter (GHN) in the southern Kalahari Desert, uncovering insights from two MSA levels dated to ~105,000 and ~30,000 years old [3]. The raw materials used at GHN comprise Banded Ironstone Formation (BIF), black chert, tuff, volcanic rocks, and quartz. Analysis of the lithic assemblage shows that the frequency of banded varieties of BIF and black chert is higher than the homogenous varieties. Both types of BIF come from the same nearby source near the rockshelter, whereas banded varieties of black chert are available in the vicinity, contrasting with the homogeneous variety, which is found 2 km away from the site. Despite the proximity of homogenous sources, it appears banded varieties of both BIF and black chert are often given preference in tool production, aligning with the local availability. In the interior region of southern Africa, stone artifacts made on BIF are quite abundant in the archaeological record, but little is known about the raw material choices and potential shifts in selectivity with technological changes in this region [4]. This study explores how raw material availability and quality were prioritized by early humans, highlighting the potential significance for broader patterns of decision-making processes in the MSA.

References: [1] Inizan, M.L., Reduron-Ballinger, M., Roche, H. and Tixier, J., 1999. Technology and Terminology of knapped stone. Cercle de Recherches et d'Etudes Préhistoriques. [2] Wilson, L., 2007. Understanding prehistoric lithic raw material selection: Application of a Gravity Model. Journal of Archaeological Method and Theory. 14, 388–411. [3] Wilkins, J., Schoville, B.J., Brown, K.S., Gliganic, L., Meyer, M.C., Loftus, E., Pickering, R., Collins, B., Blackwood, A.F., Makalima, S., Hatton, A., Maape, S., 2020. Fabric Analysis and Chronology at Ga-Mohana Hill North Rockshelter, Southern Kalahari Basin: Evidence for in situ, stratified Middle and Later Stone Age deposits. Journal of Paleolithic Archaeology. 3, 336–361. [4] Wilkins, J., 2017. Middle Pleistocene lithic raw material foraging strategies at Kathu Pan 1, Northern Cape, South Africa. Journal of Archaeological Science: Reports. 11, 169–188.

Poster Presentation Number 56, Session 1, Thursday 18:00 – 19:30

Ask ROAD – a new tool for retrieving data from the ROCEEH Out of Africa Database (ROAD)

Andrew W. Kandel[1], Miriam N. Haidle[1,2], Volker Hochschild[1,3], Zara Kanaeva[1], Nicholas J. Conard[1,2,4]

1 - The Role of Culture in Early Expansions of Humans (ROCEEH), Heidelberg Academy of Sciences and Humanities at the University of Tübingen, Tübingen, Germany · 2 - Institute of Early Prehistory and Quaternary Ecology, Department of Geosciences University of Tübingen, Tübingen, Germany · 3 - Department of Geosciences, Institute of Geography, University of Tübingen, Tübingen, Germany · 4 - Senckenberg Centre for Human Evolution and Palaeoenvironment at the University of Tübingen, Tübingen, Germany

The ROCEEH Out of Africa Database (ROAD) includes the largest collection of archaeological sites spanning Africa, Asia and Europe dated between 3,000,000 and 20,000 years ago [1]. When the ROCEEH project began in 2008 (https://www.hadw-bw.de/en/research/research-center/roceeh/home), one of its goals was to create an open-access, online database that would help researchers answer large-scale questions about early human expansions. Since then, ROCEEH has spent 16 years aggregating data from fields related to human evolution including the disciplines of archaeology, paleoanthropology, paleontology and paleobotany. ROAD is a relational database implemented with a PostgreSQL database management system. In addition, ROAD contains spatial information linked within a Geodata Infrastructure that publishes and distributes spatial data through web services and interactive applications.

This poster presents a new tool called Ask ROAD that we developed to help users retrieve data from ROAD on their own. First, we review how ROCEEH provides data to its users. Then, we focus on this user-friendly interface, which embodies the project's philosophy to make the data we collect as FAIR (Findable, Accessible, Interoperable, Reusable) as possible.

Until now, a user could perform queries in ROADWeb in several ways: 1) simple filters on one table provide basic results; 2) an SQL query tool allows the joining of several tables; 3) a SPARQL endpoint is also available; 4) finally, we collaborate intensively with research partners to create bespoke queries. Results can be viewed in ROADWeb or accessed through a URL, and downloaded in several interoperable data formats such as csv, html, xml, and json.

Our experience working with users motivated us to create Ask ROAD, because many of the most frequent queries shared similar structures. Users often wanted to know about a specific category of find (e.g. lithics, hominins, fauna, plants) for a specified geographic region or country (e.g. Asia, East Africa, Italy) over a certain time range. Users especially wanted to find assemblages with their specified criteria that come from the same layer. In Ask ROAD, we instrumentalized this approach so users could determine their own requirements. Furthermore, a log-in is not required, and knowledge of SQL programming language or the database structure is not necessary.

The result is Ask ROAD, an intuitive interface that works in a scaffolded way following five streamlined steps: 1) select localities with specific geographic region and site type; 2) select assemblages of specific type and timeframe; 3) refine search for the assemblages selected in Step 2; 4) merge or intersect selected assemblages; and 5) conduct more detailed searches of the assemblages. After each step, a table of results pops up, which users can download in their preferred format. A user can generate a list of references after the first step, and select which attributes to display at any time.

We plan to establish another gateway to ROAD to streamline the analytical process in statistical programming tools like R. We encourage you to visit ROAD (https://www.roceeh.uni-tuebingen.de/roadweb/) and are glad to provide expanded access to anyone interested. Discover for yourself what ROAD can do!

References: [1] Kandel, A.W., Sommer, C., Kanaeva, Z., Bolus, M., Bruch, A.A., Groth, C., Haidle, M.N., Hertler, C., Heß, J., Malina, M., Märker, M., Hochschild, V., Mosbrugger, V., Schrenk, F., Conard, N.J., 2023. The ROCEEH Out of Africa Database (ROAD): A large-scale research database serves as an indispensable tool for human evolutionary studies. PLOS ONE. 18, e0289513.

Poster Presentation Number 57, Session 1, Thursday 18:00 – 19:30

Reimagining Palaeolithic lifeways: optimising ZooMS methods for species identification of bone

Amanpreet Kang[1], Bharath Anila Bhuvanendran Nair[1], Matthew Collins[1,2]

1 - McDonald Institute for Archaeological Research, University of Cambridge, United Kingdom · 2 - Globe Institute, University of Copenhagen, Copenhagen, Denmark

Worked bone artefacts are an important but elusive part of the Middle-Upper Palaeolithic record. We know very little about the faunal species they are made from due to alteration during manufacture. Previous research could only conduct species identification on worked bone artefacts that have undergone minimal alteration. The reality is that most bone artefacts have been subject to a substantial level of anthropogenic surface modification. As a result, the source material of such artefacts cannot be identified as morphological observations are unable to assist in the identification of the animal from which the artefact was made. Recent studies have utilised Zooarchaeology by Mass Spectrometry (ZooMS) to address this limitation. Although sample preparation for ZooMS is traditionally destructive, recent developments have produced alternative extraction techniques for collagen recovery. Some include (but are not limited to) the eraser extraction method [1], microgrit strips [2], dermatology skin strips [3], and the sealed bag method [4]. To gain a better understanding of collagen recovery of each, we compared some of these with a new technique using nano tape, a type of tape that mimics the foot of a gecko. Here we present the results which demonstrate that the nano tape has great potential to be used for collagen recovery. This is highly dependent on the nature of preservation of the bone being sampled. Different faunal material was therefore chosen to account for factors such as climate and archaeological context. Herein, we quantify the number of peptides recovered and the overall protein sequence coverage to test the efficiency of the extraction methods. This new method gives researchers another option for future sampling of rare archaeological material such as bone artefacts, and thus helps to address the limitations of destructive ZooMS analysis. Furthermore, it can contribute to the dialogue concerning bone tool manufacture and the choice of material behind such rare objects. The application of this new technique assists in advancing our understanding of resource acquisition and the means of procurement during the Middle-Upper Palaeolithic. Ultimately, it leads to an enriched understanding of bone tool manufacture and the exploitation of animal resources during a period where Homo sapiens came to thrive as the only hominin species in Europe.

This work was supported by the Cambridge Australia Newnham Scholarship and the Cambridge Philosophical Society.

References: [1] Fiddyment, S., Holsinger, B., Ruzzier, C., Devine, A., Binois, A., Albarella, U., Fischer, R., Nichols, E., Curtis, A., Cheese, E., Teasdale, M.D., Checkley-Scott, C., Milner, S.J., Rudy, K.M., Johnson, E.J., Vnouček, J., Garrison, M., McGrory, S., Bradley, D.G., Collins, M.J., 2015. Animal origin of 13th-century uterine vellum revealed using noninvasive peptide fingerprinting. Proceedings of the National Academy of Sciences. 112, 15066–15071. [2] Kirby, D.P., Manick, A., Newman, R., 2019. Minimally invasive sampling of surface coatings for protein identification by peptide mass fingerprinting: A case study with photographs. Journal of the American Institute for Conservation. 59, 235–245. [3] Multari, D.H., Ravishankar, P., Sullivan, G.J., Power, R.K., Lord, C., Fraser, J.A., Haynes, P.A., 2022. Development of a novel minimally invasive sampling and analysis technique using skin sampling tape strips for bioarchaeological proteomics. Journal of Archaeological Science. 139, 105548. [4] McGrath, K., Rowsell, K., Gates St-Pierre, C., Tedder, A., Foody, G., Roberts, C., Speller, C., Collins, M., 2019. Identifying archaeological bone via non-destructive ZooMS and the materiality of symbolic expression: Examples from Iroquoian bone points. Scientific Reports. 9, 11027.

Pecha Kucha Presentation, Session 7, Friday 13:30 – 15:00

The biomechanical nature of the human chin

Brian A. Keeling[1,2], Mercedes Conde-Valverde[1,2], Alessandro Urciuoli[2,3,4,5], Julia Diez-Valero[2], Rolf Quam[1,2,6,7]

1 - Department of Anthropology, Binghamton University (SUNY), Binghamton, NY,USA · 2 - Universidad de Alcalá, Cátedra de Otoacústica Evolutiva y Paleoantropología (HM Hospitales-UAH), Departamento de Ciencias de la Vida, Madrid, Spain · 3 - Universitat Autònoma de Barcelona, Campus de la UAB, Barcelona, Spain · 4 - Division of Palaeoanthropology, Senckenberg Research Institute and Natural History Museum Frankfurt, Frankfurt am Main, Germany · 5 - Institut Català de Paleontologia Miquel Crusafont, Universitat Autònoma de Barcelona, Edifici ICTA-ICP, c/ Columnes s/n, Campus de la UAB, Barcelona,Spain · 6- Centro de Investigación UCM-ISCIII sobre la Evolución y Comportamiento Humanos, Madrid, Spain · 7 - Division of Anthropology, American Museum of Natural History, New York, USA

The human chin is considered one of the most distinctive, and evolutionarily derived features of *Homo sapiens*. The potential functional significance of the chin has long been debated in paleoanthropology. In this study, we investigated the biomechanical properties of the human chin and mandibular corpus using a novel 3D cross-sectional geometric morphometric approach on a sample consisting of 119 recent *Homo sapiens* from Europe (n=11) and Africa (n=108). This approach involved taking five 2D cross-sectional slices in 3D space at three key para/masticatory regions of the mandibular corpus: the symphysis, left and right junction between the third and fourth premolars and between the first and second molars. A total of 600 3D semilandmarks were taken on the external and internal cortical bone to quantify corpus shape and cortical bone thickness at these functionally relevant regions. Standardized biomechanical properties (i.e., cortical thickness, orientation, bending resistances) were computed based on the 2D cross-sections. We relied on advanced statistical techniques for tests of correlation, covariance and prediction, such as Variable Importance Projections (VIP) for variable selection, correlograms for multivariate correlations, partial least squares regressions for covariance, and multivariate linear and non-linear regressions for prediction.

The results demonstrate that the symphysis, chin, and genial tubercle strongly and significantly ($p<0.001$) covary with the rest of the mandibular corpus (RV=0.75; 0.68; 0.70) and differentially covaries with the left (RV=0.71; 0.63; 0.69) and right (RV=0.94; 0.87; 0.9) sides. Individuals with a prominent chin have an infero-buccally projected basal corpus, cortical bone thickening at the supero-lingual premolar junction and supero-buccal molar junction, and reduced genial tubercle. Individuals lacking a prominent chin have taller mandibles with wider corpus bases, as well as a thick basal corpus and genial tubercle. VIP selection of cortical thickness points also closely support trends visualized through this covariance pattern. This primary shape covariance pattern was found to also be partially influenced ($r^2=0.19$, $p<0.001$) by allometry, with larger individuals lacking a prominent chin. However, neither mandibular shape nor the chin was found to be significantly correlated with sex ($r^2=0.01$), age ($r^2=0.0075$), weight ($r^2=0.03$), or height ($r^2=0.04$). Additionally, we have found a significant fluctuating asymmetry in the mandibular corpus ($r^2=0.28$, $p<0.001$) where individuals with prominent chins have buccally projected right mandibular corpora and anteriorly placed premolars and molars on the left side.

Furthermore, we have found significant, strong correlations between biomechanical variables in each of the targeted regions of the mandibular corpus. Primarily, second modulus of area (Zx) and second moment of area, (Ix), or generally superior-inferior bending resistances, polar second moment of area (J), or torsional resistances, in the symphysis are highly correlated ($r^2=0.79$-0.90) with every cross-section. Additionally, between the premolars and molars, the maximum length and orientation of these cross-sections are also highly correlated ($r^2>0.8$). Furthermore, linear regressions on relevant biomechanical variables of the symphysis on posterior corpus shape was moderately predictive ($r^2=0.54$, $p<0.001$) as well as the other way around ($r^2=0.54$, $p<0.001$).

When evaluating the importance of vertical and torsional bending resistances, the orientation and distribution of cortical bone along the corpus, asymmetry, and allometric effects to total shape, our results demonstrate that the chin is a biomechanical structure which is highly integrated within the mandibular corpus, likely to resist vertical and torsional shearing which is likely dependent on differential preference of para/masticatory practices of the mandible.

We would like to express our gratitude to several institutions which had granted us access to micro-CT scans of recent human mandibles to carry out this study. We thank the University of Pretoria, Sefako Makgatho Health Sciences University, Dr. Ericka L' Abbé and Dr. Charlotte Theye as well as the entire Bakeng se Afrika digital skeletal repository team. Additionally, we would like to thank Dr. Matt Skinner and University of Kent. This study is in part funded through Fulbright Spain, Binghamton University, and forms part of Project PID2021-122355NB-C31 supported by MCIN/AEI/10.13039/501100011033/FEDER, UE of the Government of Spain.

Poster Presentation Number 58, Session 1, Thursday 18:00 – 19:30

Bridging gaps in hominid morphological research: a comparative 3D CT dataset initiative

Stine Keibel Blom[1], Christy Anna Hipsley[1], Guojie Zhang[1,2]

1 - Ecology & Evolution, Department of Biology, University of Copenhagen, DK · 2 - Center for Evolutionary & Organismal Biology, School of Medicine, Zhejiang University, CN

We introduce the formation of a novel, comprehensive dataset of 3D X-ray computed tomography (CT) hominid skeletal morphology, encompassing scapulae, manual, and pedal structures from chimpanzees, gorillas, and orangutans. To date, this dataset comprises CT scans of skeletal elements from 27 hands, 27 feet, and 39 shoulder blades, with plans for future expansion. Specimens were obtained from natural history museum collections in the USA and Europe and subjected to systematic CT scanning protocols at high resolution (<0.2 mm voxel size). Our initiative aims to fill outstanding gaps in hominid phenotypic sampling, revealed by my literature survey of 493 papers comparing morphology of two or more extant hominid species (*Gorilla* sp., *Pan* sp., *Pongo* sp., and *Homo sapiens*). These papers span nearly 50 years (1976 to 2022) of hominid comparative morphological research, revealing a systematic bias in two-thirds of all analyses towards studies of solid tissues, predominantly focused on the craniofacial and appendicular skeletons. In contrast, only a third of papers focused on soft tissues, such as muscle, ligaments, or fibrous tissues. Studies of larger elements like skulls or long bones tended to have limited sample sizes of few individuals, while those focused on repeated elements such as vertebrae or teeth had many more, reaching into the hundreds or even a thousand. Comparative analyses of hands and feet tended to focus on a single element, like the first metacarpal, rather than the integrated or articulated structure [1]. While these studies have provided crucial foundations for bioanthropological research, they have been affected by historical factors such as restricted access to endangered or rare specimens and the technology to sample their internal morphology non-invasively, limiting their ability to provide wider insights into interspecific relationships between ourselves and our closest living relatives. To facilitate these efforts, we intend to make our dataset publicly available through Morphosource.org, to promote broader access to hominid morphological data, increase international collaborations, and better preserve the physical specimens through decreased handling. These issues have long been widely recognized in biological anthropology [2], making digitization efforts a worthy endeavor for future research, for example, integrating phenotypic variables with genomic data. As part of my PhD on the phenotypic signatures of incomplete lineage sorting in hominids, I will use this dataset to estimate phylogenetic signals of skeletal elements, using advanced morphometric methods in addition to traditional linear measurements, volumes, and topographical assessments. We anticipate that this dataset will be highly beneficial not only for anthropological and evolutionary research, but also in teaching, science communication, methods development, and sharing with people globally, including the regions from which these specimens originate. Join us in embracing this paradigm shift towards more open and collaborative hominid morphological research and contact us if you are interested in contributing data.

I sincerely thank Darrin Lunde, Megan Vierra, and Teresa Hsu from the Smithsonian National Museum of Natural History (NMNH), Marisa Surovy, Eleanor Hoeger, and Lauren Caspers from the American Museum of Natural History (AMNH), and Daniel Klingberg Johansson and Peter Rask Møller from the Natural History Museum of Denmark (NHMD) for access and assistance in the hominid collections. Sina Baier-Stegmaier from the Technical University of Denmark (DTU), and Justin Gladman from the Shared Materials Instrumentation Facility (SMiF) for CT scanning of the material. Doug Boyer from Duke University for assistance in publishing the scans. Christy Hipsley and Guojie Zhang for being co-authors, supervisors, and supporters. This project is funded by Villum Foundation.

References: [1] Blom, S.K., Hipsley, C.A., Zhang, G., in preparation. A trait-based approach towards identifying the impacts of incomplete lineage sorting on hominid morphology. University of Copenhagen. [2] Mulligan, C.J., Boyer, D.M., Turner, T.R., Delson, E., Leonard, W.R., 2022. Data sharing in biological anthropology. American Journal of Biological Anthropology. 178, 26-53.

Pecha Kucha Presentation, Session 2, Thursday 11:20 – 12:50

The ecocultural niche of the European Acheulean

Alastair Key[1], Stephen J. Lycett[2], Andrea Manica[3], Michela Leonardi[3,4]

1 - Department of Archaeology, University of Cambridge, United Kingdom · 2 - Department of Anthropology, University at Buffalo (SUNY), Amherst, New York, USA · 3 - Department of Zoology, University of Cambridge, United Kingdom · 4 - Natural History Museum, London, United Kingdom

The Acheulean is the most spatially and temporally vast stone tool industry ever produced by early humans, persisting for more than 1.6 million years across three continents. Bifacially-flaked core tools – which technologically define the tradition – are, however, sometimes regionally and periodically absent. Substantial debate has persisted for decades in Africa, Europe and Asia about why bifacial tools are present and absent in different regions at specific times. This includes demographic, cultural, raw material and other considerations. All of which have been investigated in varying degrees of depth. Biface presence is, however, also broadly associated with, but rarely formally tested against, environmental conditions. Here, we reconstruct the ecocultural niche of European Acheulean populations between 726 and 130 ka. We performed ecocultural niche modelling using a comprehensive sample of European sites, and a set palaeoclimatic and palaeoenvironmental time series of the continent for the whole period considered. We were then able to reconstruct the Acheulean distribution in Europe through the cycles of climate changes observed between MIS 18 and MIS 5. This allowed us to identify its geographic boundaries, their variation through time along with the climatic variables that drove the distribution itself. Our analyses also show clear associations between Acheulean presence and specific environments, especially warm forests. A clear and strong association is also identified between Acheulean presence and regions now covering southern Europe, including Iberia and Italy. We consider these data in light of their implications for understanding hominin behaviour in Europe during the Middle Pleistocene. This includes periods of absence and presence, factors that may have motivated the movement of populations around the continent, the survival of Acheulean populations in varied ecological settings, and the potential routes for Acheulean cultural information to enter and leave Europe.

Poster Presentation Number 59, Session 1, Thursday 18:00 – 19:30

Form or function? An experimental study on the role of fillers in Stone Age compound adhesives

Paul Kozowyk[1], Geeske Langejans[1,2]

1 - Department of Materials Science and Engineering; Delft University of Technology · 2 - Palaeo-Research Institute; University of Johannesburg

Middle Stone Age archaeological discoveries of hematite rich red earth pigments, collectively referred to as 'red ochre,' have fuelled discussions about the origins of complex cognition, abstraction, and symbolic behaviour within our species. A distinction is often made between utilitarian and non-utilitarian roles based on the context of the ochre pieces discovered. For example, mixtures of ochre and milk are considered paint, and engraved ochre nodules have no clear utilitarian function [1-2]. On the other hand, experimental and archaeological evidence indicates that ochre has several functional roles in different areas. Fine grained, hematite-rich ochres may have been preferentially selected for as colouring pigments, yet also have benefits as a UV blocker and for treating animal hides [3-4]. Red ochre was also used as a filler in Stone Age hafting adhesives and improves adhesive performance. Yet, comparisons with different types of fillers and different material properties in this role is limited. Separating utilitarian from non-utilitarian use in adhesives depends on a wide range of variables. The mineral content and grain size of the filler, the type of resin or gum used in the adhesive, and the function of the tool may all result in distinct characteristics that may or may not be beneficial. To determine if ochre was added for utilitarian purposes, it must exhibit clear material advantages over other widely available fillers. For example, previous field experiments indicate improved workability and hydrophobicity of ochre loaded gum adhesives [5]. To quantify these observations, we tested a range of fillers, including ochre with high and low hematite contents, clay, and charcoal powders in acacia gum. We use rheological and contact angle measurements to assess the working properties and hydrophobicity of compound gum-filler adhesives. In all cases, fillers improved the performance over single-component adhesives. We found no significant differences between the low hematite concentration ochre and kaolin or charcoal. However, the ochre with a high hematite concentration improved the working properties and hydrophobicity of the adhesive more than any other filler. These results indicate the importance of quantifying hematite concentrations in hafting residues found on stone tools. This will show whether the patterns seen in ochre selection, procurement, and processing are also present in adhesive manufacturing.

This research was supported as part of the Ancient Adhesives project, funded by the European Research Council under the European Union's Horizon 2020 research and innovation programme grant agreement No. 804151. We thank Roy Awater, Jelmer Postma, Rivka Chasan, Johannes Poulis, and Ruud Hendrix for their input and assistance in conducting the research.

References: [1] Henshilwood, C.S., d'Errico, F., Watts, I., 2009. Engraved ochres from the Middle Stone Age levels at Blombos Cave, South Africa. Journal of Human Evolution 57, 27-47. [2] Villa, P., Pollarolo, L., Degano, I., Birolo, L., Pasero, M., Biagioni, C., Douka, K., Vinciguerra, R., Lucejko, J.J., Wadley, L., 2015. A Milk and ochre paint mixture used 49,000 years ago at Sibudu, South Africa. PLOS ONE. 10, e0131273. [3] Rifkin, R.F., 2011. Assessing the efficacy of red ochre as a prehistoric hide tanning ingredient. Journal of African Archaeology 9, 131-158. [4] Rifkin, R.F., 2015. Ethnographic insight into the prehistoric significance of red ochre. The Digging Stick. 32, 7-10. [5] Wadley, L., 2005. Putting ochre to the test: replication studies of adhesives that may have been used for hafting tools in the Middle Stone Age. Journal of Human Evolution. 49, 587-601.

Poster Presentation Number 60, Session 2, Friday 17:00 – 18:30

Endocast anatomy of non-human primates in the context of ecology and social systems

Anna Maria Kubicka[1,2], Antoine Balzeau[2,3]

1 - Department of Zoology, Poznań University of Life Sciences in Poznań, Poland · 2 - PaleoFED team, UMR 7194, CNRS, Département Homme et Environnement, Muséum national d'Histoire naturelle. Musée de l'Homme, Paris, France · 3 - Department of African Zoology, Royal Museum for Central Africa, Tervuren, Belgium

The brain size and asymmetry are diverse within the Primate order. The latest study shows that the primate brain size can be predicted by diet and not social complexity calling into question the social brain hypothesis [1]. However, neurological research shows that not size but brain asymmetry is a good marker of cognitive abilities [2]. That is why, the main aim of this research is to retest the social hypothesis by focusing on the brain asymmetry in a large number of non-human primate species. We suspect that non-human primates that create complex social groups in terms of hierarchy and interpersonal contacts should exhibit more sophisticated cognitive abilities that will be expressed in more pronounced differences between hemispheres. The brain never fossilizes; however, it leaves imprints of the intracranial blood vessels, cranial nerves, and braincase sutures on the internal surface of the skull, namely the endocast. Therefore, this research focuses on the endocast of over 120 non-human primate species.

The material includes computed-tomography scans of 900 skulls with preserved brain case and cranial base of 120 non-human primate species. The collected species belong to almost all primate families therefore they are a good representation of the diversity of the Primate order. For each CT scan, a three-dimensional skull model was performed using Avizo software. Next, reconstructions of endocasts and their volumes were prepared using the Arothron R package. The last step was the digitization of landmarks and semilandmarks on the endocasts using 3D Slicer software. The following biological and ecological information for each non-human primate species has been collected: diet (e.g. herbivores, frugivores, insectivores, omnivores), activity (day, night), social group type (e.g. solitary primate systems, pair-bonded systems, one-male-multi-female systems, one-female-multi-male systems), the average size of the group.

All 3D models of skulls and endocast are prepared; however, the statistical analysis of the proposed study is still ongoing. A multivariate regression will be used to investigate the association between the asymmetry of the endocast shape (landmark and semilandmarks coordinates) and biological and ecological features. Moreover, linear models will be performed to analyze the correlation between the asymmetry of the hemisphere volumes and biological and ecological variables.

The results will show whether the primate species living in more complex social groups are characterized by greater endocast asymmetry. In addition, the research will show if the endocast anatomy in primates is related to any specific ecological and biological features.

References: [1] DeCasien, A.R., Williams, S.A., Higham, J.P., 2017. Primate brain size is predicted by diet but not sociality. Nature Ecology & Evolution. 1, 1–7. [2] Corballis, M.C., 2009. The evolution and genetics of cerebral asymmetry. Philosophical Transactions - Royal Society. Biological Sciences.. 364, 867–879.

Poster Presentation Number 61, Session 2, Friday 17:00 – 18:30

How diverse are bifaces: the results of the technico-functional study of bifaces of La Grande Vallée

Svetlana Kulehsova[1,2], Jean Airvaux[3], David Hérisson[2], Eric Boëda[2]

1 - Center for Language Evolution Studies, Nicolaus Copernicus University in Toruń, Toruń, Poland · 2 - ArScAn-Équipe AnTET (UMR 7041), CNRS, Université Paris Nanterre, Nanterre, France · 3 - Independant Researcher, 76, route de Bouresse, Mazerolles 86320, Lussac-Les-Châteaux, France

The biface stands as the most emblematic tool of the Lower Palaeolithic. Because of their distinctive morphology, which has gained them fame, analyses of bifaces often focus on their form or symmetry [e.g., 1-2]. However, by concentrating so much on their form, we risk missing their diversity as tools expressed through their structure.

In this poster, we discuss how we can account for the diversity within seemingly uniform tools, such as bifaces, through the technico-functional method. The technico-functional method [3-4] consists of reconstructing the chaînes opératoires of lithic tools, examining them by identifying active and prehensile parts, and finally classifying them based on their internal structure. The aim is to understand the object that lacks an equivalent in our contemporary world, and whose memory has been lost by inferring the technical intentions of prehistoric humans from the resulting technical criteria that were set on a blank. This gives us access to the functional and productional diversity of the toolkit and the needs of prehistoric people. In this poster, we present the results of the technico-functional analysis of the bifaces of La Grande Vallée, Colombiers, Vienne, France. The site of La Grande Vallée presents bifaces, retouched blanks and flakes. The dates for the in-situ archaeological levels of the site of La Grande Vallée range between MIS 13-11 [5]. We start the analysis by identifying different active parts (cutting edges, grinds, and their combinations) and prehensile parts, and finally, we group tools based on their structure and synergy between active and prehensile parts. We show that despite the apparent disparity in the morphology of the bifaces of La Grande Vallée, there are clear production goals with coherent sets of criteria that complement each other. We can thus talk about a real toolbox. The distinction between different types of tools in a biface toolkit challenges the idea of the homogeneity of this type of tool.

References: [1] Méndez-Quintas, E., 2022. Testing the Bordes method on handaxes: A geometric morphometric approach. Journal of Archaeological Science: Reports. 45, 103563. [2] Shipton, C., Groucutt, H.S., Scerri, E., Petraglia, M.D., 2023. Uniformity and Diversity in Handaxe Shape at the End of the Acheulean in Southwest Asia. Lithic Technology. 48, 364–377. [3] Boëda, Éric. 2013. Techno-Logique & Technologie: une Paléo-Histoire des Objets Lithiques Tranchants. 1 vol. Préhistoire au présent. Prigonrieux: @rchéo-éditions. [4] Lepot, Michel. 1993. Approche techno-fonctionnelle de l'outillage lithique moustérien: essai de classification des parties actives en termes d'efficacité technique. Application à la couche M2e sagittale du Grand Abri de la Ferrassie (fouille Henri Delporte). Université de Paris X, Nanterre. [5] Hérisson, D., Airvaux, J., Lenoble, A., Richter, D., Claud, E., Primault, J., 2016. Between the northern and southern regions of Western Europe: The Acheulean site of La Grande Vallée (Colombiers, Vienne, France). Quaternary International. 411, 108–131.

Poster Presentation Number 62, Session 2, Friday 17:00 – 18:30

Unveiling the impact of frost on stone tools: a review of published freeze-thaw experiments and their impact on displacement and use-wear traces

Areti Leventi[1], Mickael Baillet[1,2], Marie Soressi[1]

1 - Leiden University, The Netherlands · 2 - Zhejiang University, China

Freeze-thaw cycles commonly affected Pleistocene archaeological sites in central and northern Eurasia. During the freeze-thaw cycles, ice lenses are formed between the sedimentary particles resulting to sediment expansion and contraction, deformation of stratigraphic layers and artefact displacement [1].

Stone tools from Pleistocene deposits often display significant microscopic alterations across their surfaces and ridges. Use- wear traces are sometimes so altered that polish and striations from use either disappear or are obscured by post-depositional wear [2]. Additionally, post-depositional wear can resemble use-wear traces associated with cutting or scraping animal materials (e.g. meat or hide), or wood working activities [2-4]. It still remains unclear which specific post-depositional phenomena are responsible for these alterations and use-wear modifications. Frost and freeze-thaw cycles are among the natural processes that could be responsible for these modifications. But our comprehension of how freeze-thaw cycles can affect the position and surfaces of lithic artefacts, particularly the microscopic use-wear traces of their edges, is limited.

Here, we review the results of published experiments that investigated material displacement and use-wear alterations caused by freeze-thaw cycles in natural environments (in vivo) and in laboratory conditions (in vitro). Thirteen experimental studies were conducted by geologists and/or archaeologists since the 1960s' exploring freeze-thaw impact on movement and preservation of objects. From the six studies with a micro-wear perspective, the results displayed few minor modifications in use-wear traces and post-depositional polish on the surfaces and dorsal ridges of stone tools (e.g. [4]). However, the number of freeze-thaw cycles in these studies is limited and not comparable to the number of freeze-thaw cycles that occurred in Pleistocene deposits. Consequently, regarding artefacts from Pleistocene contexts, the impact of freeze-thaw on use-wear modifications and its influence on functional interpretation are likely underestimated. Moreover, it is argued that smaller or less dense objects may move toward the surface, but these observations were made in natural contexts with co-occurring post-depositional phenomena, making it difficult to associate the exact phenomena with the origins of object movement [5]. Therefore, it has not been systematically demonstrated whether the dimensions or elongation of different types of artefacts affect their final deposition or displacement when subjected to freeze-thaw cycles.

Based on our review, we conclude that long-term freeze-thaw experiments under controlled conditions are necessary to gain a better understanding of how freeze-thaw cycles affect the movement of artefacts and alter the microscopic use-wear traces on their surfaces. Conducting more systematic experiments in conjunction with micro-wear analysis can offer deeper insights into surface modifications and the taphonomy of artifacts, while also complementing geoarchaeological research on site formation processes.

This research is funded by the Dutch Research council (NWO) 'Neandertal Legacy' grant (VI.C.191.070) awarded to M. Soressi.

References: [1] 1. Karkanas, P., Goldberg, P., 2019. Reconstructing Archaeological Sites: Understanding the Geoarchaeological Matrix. John Wiley & Sons Ltd. [2] Sala, I.L., 1996. A study of microscopic polish on Flint implements. British Archaeological Reports Oxford Limited. [3] Caspar, J.P., Masson, B., Vallin, L., 2009. Taphonomie des ensembles lithiques du Paléolithique moyen en context loessique: l'aproche expérimentale. Les Nouvelles de l'archaéologie. 118, 2-20. [4] Michel, M., Cnuts, D., Rots, V., 2019. Freezing-in-sight: the effect of frost cycles on use-wear and residues on flint tools, Archaeological and Anthropological Sciences. 11, 5423–5443. [5] Texier, J.P., Bertran, P., Coutard, J.P., Francou, B., Gabert, P., Guadelli, J.L., Ozouf, J.C., Plisson, H., Raynal, J.P., Vivent, D., 1998. TRANSIT, an experimental archaeological program in periglacial environment: problem, methodology, first results. Geoarchaeology. 13, 433–473.

Poster Presentation Number 63, Session 2, Friday 17:00 – 18:30

Homo Out of Africa I - grassland or forest?

Liping Liu[1,2,4], Abigail Parker[3], Tegan Foister[1], Anu kaakinen[1], Indre Žliobaitė[3], Miikka Tallavaara[1]

1 – Department of Geoscience and Geography, University of Helsinki, Finland · 2 – Department of paleobiology, the Swedish museum of Natural History · 3 – Bolin Center for climate Research, Stockholm University · 4 – Department of Computer Science, University of Helsinki

The initial dispersal of human out of Africa in the beginning of Pleistocene has been well known as "Out of Africa I" [1]. *Homo erectus/ergaster*, the first human migrated from Africa into Eurasia has been commonly reconstructed as living in relatively open grassland. For many years, it is widely subscribed that early Homo migrated out of Africa following the expansion of open 'savannah' or grassland habitat [2].

However, this classic savannah scenario has been challenged recently, especially by evidence in Eurasia [3]. Foister et al. [4] recently synthesized the habitat reconstructions drawing from scientific publications between 2000 and 2021. Their analysis indicates that while savannah/grassland biomes were common for early Pleistocene humans, these humans were not restricted to open environments; reconstructed habitats range from forests to open grasslands.

To further investigate the habitats of early Homo, we here use community-level dental traits of large mammalian herbivores 5] to estimate temperature and precipitation conditions at fossil sites where Homo has been found with those where Homo is absent in China across the Pleistocene. Temperature and precipitation are associated with vegetation structure; from them, it is possible to estimate net primary productivity (NPP), which characterizes the habitats that Homo and other mammals live in.

Our results indicate that early Pleistocene Homo in China occupied a narrower climate zone compared to Late Middle Pleistocene and Late Pleistocene Homo. Early humans were largely absent from localities with extreme climatic conditions—both in regions with high temperature and precipitation, such as southeast China (corresponding to subtropical rainforest), and in areas with low temperatures or precipitation, such as northern and western China (with cold or open habitats). Although several Early Pleistocene archaeological sites are located in steppe regions with low temperatures and precipitation, we argue that these sites were on the periphery of early human occupation and represented marginal habitats. The core habitat for early humans was characterized by moderate temperature and precipitation, akin to the subtropical and temperate open forests in China. Therefore, our findings do not strongly support the savannah hypothesis.

We thank the financial support by grants from the Research Council of Finland (341620, 341622, 341623).

References: [1] Dennell, R.W., 2010. The colonization of "Savannahstan": Issues of timing(s) and patterns of dispersal across Asia in the Late Pliocene and Early Pleistocene. Vertebrate Paleobiology and Paleoanthropology. 7–30. [2] Agustí, J., Lordkipanidze, D., 2019. An alternative scenario for the first human dispersal out of Africa. L'Anthropologie. 123, 682–687. [3] Foister, T.I.F., Žliobaitė, I., Wilson, O.E., Fortelius, M., Tallavaara, M., 2023. *Homo heterogenus*: Variability in early Pleistocene *Homo* environments. Evolutionary Anthropology: Issues, News, and Reviews. 32, 373–385. [4] Liu, L., Galbrun, E., Tang, H., Kaakinen, A., Zhang, Zhongshi, Zhang, Zijian, Žliobaitė, I., 2023. The emergence of modern zoogeographic regions in Asia examined through climate–dental trait association patterns. Nature Communications. 14, 8194.

Podium Presentation, Session 9, Saturday 9:00–10:40

Arboreal bipedalism in captive chimpanzees: new experimental setup and initial results

Victoria A. Lockwood[1], François Druelle[2,3,4], Mathieu Domalain[5], Alicia Blasi-Toccacceli[1,6], Jean Pascal Guéry[7], Guillaume Daver[1]

1 - PALEVOPRIM: Laboratoire de Paléontologie, Evolution, Paléoécosystèmes et Paléoprimatologie, Université de Poitiers, CNRS, Poitiers, France · 2 - Histoire Naturelle de l'Homme Préhistorique, UMR 7194, CNRS-MNHN-UPVD, Paris, France · 3 - Primatology Station of the CNRS, UAR 846, Rousset, France · 4 - Functional Morphology Laboratory, University of Antwerp, Campus Drie Eiken (Building D), Antwerp, Belgium · 5 -Institut Pprime, Université de Poitiers, CNRS UPR 3346, France · 6 - Department of Anatomy, Midwestern University, Glendale, AZ, USA · 7 - Zoological Park La Vallée des Singes, Romagne, France

Questions on bipedalism and its origins form a cornerstone of the study of human evolution. Arboreal bipedal locomotion and posture have been suggested as a key component of the evolution of hominin bipedalism [1-5]. Given their close phylogenetic relationship with modern humans, chimpanzees (*Pan troglodytes*), are a study species of particular interest for investigating hominin locomotor evolution. However, whilst the latter have been observed to engage in arboreal bipedal behaviors there are limited gait and biomechanical data on these behaviors for chimpanzees in comparison to terrestrial bipedalism. Observations of arboreal bipedal locomotion in free ranging primates are complicated by visibility issues and the rarity of arboreal bipedalism. We developed an experimental set up that permits consistent observations of arboreal bipedalism in captive hominoids and the collection of data for gait and kinematic analyses of chimpanzee arboreal bipedalism in addition to hand and foot contact information. Here we present the experimental set up and an overview of the observed variation within arboreal bipedal locomotion alongside initial hand contact results. A simulated arboreal foraging scenario using PVC tubes dispensing a high value food reward was presented to the chimpanzee community (n=6 [adults, 3 females, 3 males]) at the zoological park of La Vallée des Singes, Romagne, France. The chimpanzees' voluntarily engagement with the equipment was recorded via five synchronized GoPro cameras (n=60 locomotor observations). Individual ID, specific variation of arboreal bipedal locomotion and postures, and hand contact data were extracted. Multiple distinct variations of arboreal bipedal locomotion were observed: forward facing, and sideways steps. In forward facing arboreal bipedalism the median plane of the body is positioned facing the direction of travel and the foot of the leading hindlimb is placed directly in front of the foot of the trailing hindlimb. In sideways step arboreal bipedalism, the median plane of the body is perpendicular to the direction of travel and the feet are positioned next to each other but do not cross over each other during the step. Sliding, using a combination of bipedal posture with forelimb suspension, was observed in one male only. The frequency of use of each of these styles varied between individuals. The males engaged with the experimental setup at the lowest frequency, followed by the older female, and then the younger females. Hand contacts between the first and final bipedal postures in bipedal locomotor sequences (n=55 sequences) were used to calculate a handedness index for walnut and support contacts. Manipulating the walnut along the PVC tube had a significant right-hand preference ($z=-4.86$, $p<0.001$, $r=0.675$), whereas there was a significant left-hand preference for support contacts ($z=-4.61$, $p<0.001$, $r=-0.639$). Overall, these initial results highlight the wide range of variation encompassed by the locomotion category 'arboreal bipedalism' and suggest that potential morphological correlates for distinct variations of arboreal bipedalism should be investigated in greater detail. Forthcoming gait parameter and kinematic data will help discriminate the biomechanical contexts of the observed variation in bipedal locomotion. The behavioral variation documented by this pilot study provides a new facet through which to assess the bipedal capabilities of the earliest hominins.

We would like to thank the following people for facilitating the study of the chimpanzees from La Vallée des Singes: Pierre Brandibas and all the caregivers for the chimpanzees, F. Guy, J.R. Boisserie, O. Chavasseau, and G. Merceron, as well as the University of Poitiers. Funding was provided by the Région Nouvelle Aquitaine (AAPR 2020-2020-8624210), the International Research Network 'Bipedal Equilibrium' (CNRS-INEE GDRI0870) and theANR HOMTECH (ANR-17-CE27-0005-02).

References: [1] Stamos, P.A., Alemseged, Z., 2023. Hominin locomotion and evolution in the Late Miocene to Late Pliocene. Journal of Human Evolution. 178, 103332. [2] Daver, G., Guy, F., Mackaye, H.T., Likius, A., Boisserie, J.-R., Moussa, A., Pallas, L., Vignaud, P., Clarisse, N.D., 2022. Postcranial evidence of late Miocene hominin bipedalism in Chad. Nature. 609, 94–100. [3] Lovejoy, C.O., Suwa, G., Spurlock, L., Asfaw, B., White, T.D., 2009. The pelvis and femur of *Ardipithecus ramidus*: The emergence of upright walking. Science. 326, 71. [4] Richmond, B.G., Jungers, W.L., 2008. *Orrorin tugenensis* femoral morphology and the evolution of hominin bipedalism. Science. 319, 1662–1665. [5] Thorpe, S.K.S., Holder, R.L., Crompton, R.H., 2007. Origin of human bipedalism as an adaptation for locomotion on flexible branches. Science. 316, 1328–1331.

Pecha Kucha Presentation, Session 2, Thursday 11:20 – 12:50

Quantifying differences in primates technology with 3D shape analysis

Miguel López-Cano[1,2], Tomos Proffitt[3], Markus Bastir[1], Tiago Falótico[4,5], Ignacio de la Torre[6]

1 - Departamento de Paleobiología, Museo Nacional de Ciencias Naturales, Spanish National Research Council-CSIC, Madrid, Spain · 2 - Unidad de Antropología, Facultad de Ciencias Biológicas, Universidad Complutense of Madrid, Spain · 3 - Interdisciplinary Center for Archaeology and Evolution of Human Behaviour (ICArEHB), Universidade do Algarve, Faro, Portugal · 4 - Neotropical Primates Research Group, São Paulo, SP, Brazil · 5 - Technological Primates Research Group, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 6 - Instituto de Historia, Spanish National Research Council-CSIC, Madrid, Spain

The production of sharp-edged stone flakes pieces is our primary evidence for the emergence of technology in our lineage [1]. Nevertheless, recent discoveries have shown that bearded capuchins and long-tailed macaques (*Sapajus libidinosus* and *Macaca fascicularis*) can unintentionally produce high frequencies of sharp-edged flake assemblages as a by-product of various percussive behaviour [2-3]. It has been shown that these flakes fall within the range of variation for shape, size and technological attributes commonly used to describe intentional hominin stone flakes [3-4].

Here we directly compare the 3D shape properties of unintentionally produced capuchin flakes from Serra da Capivara National Park (Brazil, n=23) with a sample of Oldowan flakes from Olduvai Gorge (Tanzania, n=179) using 3D Geometric Morphometrics (3DGM). The digitized flakes were manually measured using Viewbox 4.0 software and a template comprising 3 fixed platform landmarks (point of percussion and the lateral extremities of the platform defining platform width), 4 curves (the flake edge and 3 segments on the platform) and 3 surfaces patches of 404 surface semilandmarks (platform, dorsal and ventral facets). The 3D coordinates were subjected to a generalized Procrustes superimposition (GPA) and semi-landmarks were slid and re-slid to the Procrustes sample average. Shape data were explored by PCA. In addition, we grouped flakes by their origin and raw material, subsequently conducted an ANOVA to test for statistical differences between them.

Our findings indicate that capuchin stone-on-stone (SoS) flakes statistically diverge ($p<0.05$) from those knapped by early hominins if taking into account PC3 scores. PC3, which explains 10.4% of the total variance, highlights attributes such as flake dorso-ventral width and platform length and depth as crucial for distinguishing intentional from untentional knapping techniques. Along PC3, capuchin flakes are characterized by reduced platforms, no step terminations and an increased dorso-ventral width, which may be a consequence of the low level of reduction exhibited by this species during SoS behaviour, but also the raw material [3].

Our study indicates, for the first time and with a sufficient comparative archaeological sample, that there are shape differences between intentional/unintentional flakes and that 3DGM might be a useful tool to contribute for identifying potential differences between intentional hominin, unintentional and natural percussive artefacts. Moreover, 3DGM applied to stone tools research might also elucidate intentionality at the emergence of hominin technology.

This research was supported by PID2020-115854GB-I00/MCIN/AEI/10.13039/501100011033 and an ERC-Advanced Grant (Horizon 2020, BICAEHFID grant agreement No. 832980).

References: [1] Isaac, G.L., 1977. Early stone tools: an adaptive threshold. In: Sieveking, G.D.G., Longworth, I.H., Wilson, K.E. (Eds.), Problems in Economic Prehistory and Social Archaeology. Duckworth, London, pp. 39-47. [2] Proffitt, T., Reeves, J.S., Braun, D.R., Malaivijitnond, S., Luncz, L.V., 2023. Wild macaques challenge the origin of intentional tool production. Science Advances. 9, eade8159. [3] Proffitt, T., Luncz, L.V., Falótico, T., Ottoni, E.B., de la Torre, I., Haslam, M., 2016. Wild monkeys flake stone tools. Nature. 539, 85–88. [4] Proffitt, T., Reeves, J.S., Falótico, T., Arroyo, A., Torre, I. de la, Ottoni, E.B., Luncz, L.V., 2023. Identifying intentional flake production at the dawn of technology: A technological and 3D geometric morphometric study. Journal of Archaeological Science. 152, 105740.

Poster Presentation Number 64, Session 2, Friday 17:00 – 18:30

The conservation of Shanidar Z at a glance

Lucía López-Polín[1,2], Emma Pomeroy[3], Katerina Theodoraki[3], James Holman[4], Chris Hunt[5], Paul Bennett[4], Tim Reynolds[6], Jessica Twyman[4], Graeme Barker[3]

1 - Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Spain · 2 - Universitat Rovira i Virgili, Spain · 3 - University of Cambridge, UK · 4 - Canterbury Archaeological Trust, UK · 5 - Liverpool John Moores University, UK · 6 – Birkbeck, Univeristy of London, UK

Shanidar Cave (Iraqi Kurdistan) was excavated in two phases. In the first stage (1951-1960), the team led by Ralph Solecki recovered 10 Neanderthal individuals [1-2]. They have been assigned to two periods: Shanidar 1, 3, and 5 to 46-50 ka, and Shanidar 2, 4, 6, 7, 8, 9, and 10, to around 75 ka. In 2015, excavations were resumed by a new team, and new Neanderthal remains were recovered, including some belonging to Shanidar 5 [3], an individual currently named Shanidar Z [4], and further adult elements presented at the 2023 ESHE meeting.

Here we give the first report on the conservation of Shanidar Z, the largely complete upper body of an adult recovered in 2018-2019 [4]. The Shanidar Z remains were directly adjacent to the block of sediment that Solecki's team lifted to recover Shanidar 4, probably truncating Shanidar Z in the process. The skull of Z was superimposed on the left upper limb and the thoracic elements. Though severely distorted and flattened, the skull was recognisable. Underneath, the bones of the upper left limb were delicate, but more visible and less crushed. Below, the ribs and spine were articulated, with some ribs slightly displaced, but all the bones extremely crushed and friable.

After careful excavation and consolidation with Paraloid B72 in situ, the bones were lifted in numerous small blocks with some of the sediment. Only a few hand elements were lifted individually. The blocks were wrapped in aluminium foil. Once at the University of Cambridge facilities on loan from the General Directorate of Antiquities & Heritage, Iraqi Kurdistan, the blocks were microCT scanned without opening them, and preserved in a cold and stable environment until the physical conservation of the skeleton could begin.

The general steps for the conservation treatment were: 1) collection of the field documentation and visualization of the 3D reconstruction of the bones before opening the packages; 2) photography of the blocks and elements before treatment; 2) microexcavation of the blocks; cleaning, and stabilisation of the recovered fragments; and bonding of fragments contained in the same package; 3) reconstruction of the elements recovered in different blocks; 4) final documentation; 5) packing.

Conservation techniques were similar to those used for another hominin find [5]. In short, the work was carried out with small manual tools (e.g., soft brushes, wooden sticks, scalpels and dental picks) to remove the sedimentary matrix and clean the bones. Consolidation and bonding of fragments was performed with Paraloid B72 dissolved in acetone (5-25%). We also used fibreglass cloth strips impregnated with Paraloid, both to temporarily hold the pieces in place, and as a final bond reinforcement for some of the elements. The final packing of the bones used clean polyethylene plastic bags, foam blocks and boxes, adapted to each element.

After this conservation treatment, the Shanidar Z bones are clean, stable and prepared. Most upper limb elements are well reconstructed, but additional reconstruction work may improve some of the elements, particularly the highly fragmented thoracic bones. The skull is reshaped, but the lack of physical contact among some cranial elements does not allow a complete physical reconstruction, so virtual reconstruction is also underway.

The conservation took over a year. The main challenges were the bones' significant fragmentation and friability. Hundreds of tiny pieces needed to be cleaned and consolidated before attempting the reconstruction. That posed a challenge resolved by exhaustive documentation to keep track of the fragments. This documentation, crucial to the conservation work, will also be a useful legacy for future research on these remains.

We thank the Kurdistan Regional Government for the original invitation to G.B. to plan new excavations at Shanidar Cave and the Kurdistan General Directorate of Antiquities & Heritage for permission to conduct them. We gratefully acknowledge the John Templeton Foundation for the financial support of conservation work by L.L.P. and K.T., as well as the British Academy, the Leverhulme Trust (Research Grant RPG-2013-105), the McDonald Institute for Archaeological Research (University of Cambridge), the Natural Environment Research Council Oxford Radiocarbon Dating Facility (grant NF/2016/2/14), the Rust Family Foundation, the Society of Antiquaries, and the Wenner-Gren Foundation. L.L.P.'s research is currently funded through the following projects: PID 2021-122355NB-C32 (funded by MCIN/AEI/10.13039/501100011033 and by "ERDF A way of making Europe"), SGR 2021-01239 (Catalan AGAUR) and 2023PFR-URV-01239 (URV), and "María de Maeztu" program for Units of Excellence (CEX 2019-000945-M).

References: [1] Solecki, R.S., 1971: Shanidar. The first flower people, Alfred A. Knopf, New York. [2] Trinkaus, E., 1983: The Shanidar Neanderthals, Academic Press, New York. [3] Pomeroy, E., Mirazón Lahr, M., Crivellaro, F., Farr, L., Reynolds, T., Hunt, C.O., Barker, G., 2017. Newly discovered Neanderthal remains from Shanidar Cave, Iraqi Kurdistan, and their attribution to Shanidar 5. Journal of Human Evolution. 111, 102–118. [4] Pomeroy, E., Bennett, P., Hunt, C.O., Reynolds, T., Farr, L., Frouin, M., Holman, J., Lane, R., French, C., Barker, G., 2020. New Neanderthal remains associated with the 'flower burial' at Shanidar Cave. Antiquity. 94, 11–26. [5] López-Polín, L., Bermúdez de Castro, J.M., Carbonell, E., 2017. The preparation and conservation treatments of the human fossils from Lower Pleistocene unit TD6 (Gran Dolina site, Atapuerca) – The 2003–2009 record. Quaternary International. 433, 251–262.

Pecha Kucha Presentation, Session 2, Thursday 11:20 – 12:50

Novel, physically non-destructive AMS radiocarbon dating of fossil bone

Katharina Luftensteiner[1], Laura van der Sluis[1,2], Maddalena Giannì[1], Katerina Douka[1,2], Thomas W. Stafford, Jr.[3], Tom Higham[1,2]

1 - Department of Evolutionary Anthropology, University of Vienna, University Biology Building, Vienna, Austria · 2 - Human Evolution and Archaeological Science (HEAS) Network, Vienna, Austria · 3 - Stafford Research LLC, Albuquerque, NM 87111, USA

Radiocarbon dating is a key dating method in archeological sciences and Palaeolithic chronology building. In mammalian bone, Type I collagen is used for high-accuracy, high-resolution ^{14}C measurements. Over time, protocols for collagen extraction have continuously improved to maximize the removal of contaminants. These steps are of great importance to ensure accurate interpretations of archaeological chronologies.

Obtaining collagen from faunal remains and bone artefacts involves removing part of the specimen, with varying degrees of destruction. While efforts are made to avoid damaging areas of archaeological and taxonomic significance, such as cut marks, evidence of diseases and trauma, and osteological features, the process inevitably alters the object's original morphology. Unlike innovative, non-destructive methods employed in ancient genomics [1] and palaeoproteomics [2], no analogous, non-destructive process has been developed for bone ^{14}C dating.

We have experimentally tested a non-destructive collagen extraction method that eliminates cutting or drilling of bones, teeth or ivory. It involves an initial heating step of whole objects in a solvent designed to bring collagenous-derived material into solution. Collagen is extracted as aqueous gelatin that has a collagenous or collagen-derived amino acid spectrum, and C:N and $\delta^{13}C$ and $\delta^{15}N$ values similar to collagen isolated by conventional methods from a >50,000 ^{14}C year-old bone.

We sampled previously dated European Bronze Age and Upper Paleolithic bone, and Denisova Cave animal bone to test the accuracy of this non-destructive method. Our experiments demonstrate that collagen with a Type-1 collagen amino acid spectrum can be extracted from fossil bones by this technique non-destructively, and that ^{14}C dates and isotopic data are identical to those from conventional collagen isolation methods which use destructive sampling and routine purification methods.

References: [1] Essel, E., Zavala, E.I., Schulz-Kornas, E., Kozlikin, M.B., Fewlass, H., Vernot, B., Shunkov, M.V., Derevianko, A.P., Douka, K., Barnes, I., Soulier, M.-C., Schmidt, A., Szymanski, M., Tsanova, T., Sirakov, N., Endarova, E., McPherron, S.P., Hublin, J.-J., Kelso, J., Pääbo, S., Hajdinjak, M., Soressi, M., Meyer, M., 2023. Ancient human DNA recovered from a Palaeolithic pendant. Nature. 618, 328–332. [2] Fiddyment, S., Holsinger, B., Ruzzier, C., Devine, A., Binois, A., Albarella, U., Fischer, R., Nichols, E., Curtis, A., Cheese, E., Teasdale, M.D., Checkley-Scott, C., Milner, S.J., Rudy, K.M., Johnson, E.J., Vnouček, J., Garrison, M., McGrory, S., Bradley, D.G., Collins, M.J., 2015. Animal origin of 13th-century uterine vellum revealed using noninvasive peptide fingerprinting. Proceedings of the National Academy of Sciences. 112, 15066–15071.

Poster Presentation Number 65, Session 2, Friday 17:00 – 18:30

Knee joint loading diversity in South African hominins as evidenced by the trabecular structure of the distal femur

Andrea Lukova[1], Marine Cazenave[1,2,3], Christopher J. Dunmore[4], Sebastian Bachmann[5], Matthew M. Skinner[1]

1 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 2 - Division of Anthropology, American Museum of Natural History, New York, USA · 3 - Department of Anatomy, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa · 4 - Skeletal Biology Research Centre, School of Anthropology and Conservation, University of Kent, Canterbury, UK · 5 - Institute of Lightweight Design and Structural Biomechanics, TU Wien, Wien, Austria

A valgus knee has consistently been considered as evidence for bipedalism in *Australopithecus,* indicating an extended knee posture. This knee characteristic has been central to debates surrounding the potential retention of climbing abilities in the locomotor repertoire of *A. afarensis* [1]. Distinctions can be observed in the distal femoral morphology among australopiths, such as varying degrees of anterior projection of the lateral patellar lip, as well as differences from *Homo*, including the anterior expansion of the patellar surface [2]. Relying solely on the external morphology of the knee epiphyses may have limitations in discerning subtle differences in knee biomechanics among hominins with diverse locomotor repertoires. Examining the variation in the trabecular bone may offer additional insights into the biomechanical differences of the fossil hominin knees.

We analyse the internal morphology of StW 318 and TM 1513 distal femora, attributed to *A. africanus*, and the U.W. 88-63, attributed to *A. sediba.* A comparative sample of *Homo sapiens* (N=15), *Gorilla gorilla* (N=14), *Pan troglodytes verus* (N=15), and *Pongo* spp. (N=9) was used. All specimens were scanned via micro-CT and segmented using medical image analysis (MIA) clustering segmentation [3]. A holistic morphometric analysis (HMA) was used to quantify relative trabecular bone density (rBV/TV) in the distal femoral epiphyses [4]. To statistically compare variation between groups, a canonical holistic morphometric analysis (cHMA) was applied [5]. Variation in the trabecular structure was further compared via principal component analyses (PCA). Each fossil hominin specimen was variably preserved, and analysis was restricted as follows: StW 318 – only the lateral condyle; TM 1513 – whole epiphysis except for the missing medial epicondyle; U.W. 88-63 – region under the patellar surface.

Results of the PCA separate *H. sapiens* by high rBV/TV posteroinferiorly in the femoral condyles, laterally under the patellar surface and higher rBV/TV in the lateral compared to the medial condyle. This distribution pattern reflects higher lateral loading due to extended knee postures. In African apes, high rBV/TV is concentrated posterosuperiorly in the femoral condyles, medially on the patellar surface, and it is higher in the medial compared to the lateral condyle. This distribution pattern reflects higher medial loading due to flexed knee postures. *Pongo* displays a more homogenous rBV/TV distribution, suggesting more diverse postural and locomotor behaviour. All extinct taxa display a unique set of human-like and ape-like characteristics. StW 318 exhibits a trabecular distribution under the patellar surface, in the lateral epicondyle, and in the posteroinferior volumes of the lateral condyle, falling somewhere between *Pan* and *Pongo* in the PCA and suggesting the knee was loaded in flexed postures, but possibly to a lesser extent than in African ape. The distribution beneath the insertion of gastrocnemius muscle resembles that of *H. sapiens,* suggesting a potentially same level of muscular involvement during bipedal walking. TM 1513 shows high rBV/TV in the distal volumes of both femoral condyles, suggesting extended knee postures. The higher rBV/TV values in the medial compared to the lateral condyle are consistent with higher medial knee compartment loading. The rBV/TV concentration beneath the insertions of the gastrocnemius muscle is again more like that of *H. sapiens*. U.W. 88-63 exhibits a trabecular distribution falling close to *Pongo*. High rBV/TV is concentrated more laterally compared to *A. africanus* and African apes under the patellar surface, supporting the functional interpretation of extended knee postures during bipedal locomotion with a degree of knee flexion that differs from *A. africanus* and African apes. These findings underscore the diversity in knee joint loading among South African hominins.

For access to specimens in their collections, we thank the follow ing individuals/institutions: Max Planck Institute for Evolutionary Anthropology (C. Boesch, J-J. Hublin); Museum für Naturkunde – Leibniz Institute for Evolution and Biodiversity Science (F. Mayer, C. Funk); Powell-Cotton Museum (I. Livne); Royal Museum for Central Africa (E. Gilissen); University of Florence (J. Moggi-Cecchi, S. Bortoluzzi); Johann-Friedrich-Blumenback-Institute for Zoology and Anthropology, Georg-August University, Goettingen (B. Grosskopf); Frankfurt Senckenberg Museum (V. Volpato); University of the Witswatersand (L. Berger, B. Zipfel); Science Academy of the Czech Republic (J. Svoboda). We thank the Editor-in-Chief, J. Saers and one anonymous reviewer for these constructive comments that greatly improved our manuscript. This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement no. 819960).

References: [1] Stern Jr, J. T., & Susman, R. L. (1983). The locomotor anatomy of Australopithecus afarensis. American Journal of Physical Anthropology, 60(3), 279-317. [2] Ward, C. V. (2013). Postural and locomotor adaptations of Australopithecus species. The paleobiology of Australopithecus, 235-245. [3] Dunmore, C. J., Wollny, G., & Skinner, M. M. (2018). MIA-Clustering: a novel method for segmentation of paleontological material. PeerJ, 6, e4374. [4] Gross, T., Kivell, T. L., Skinner, M. M., Nguyen, N. H., & Pahr, D. H. (2014). A CT-imagebased method for the holistic analysis of cortical and trabecular bone. Pal Elec, 17,33A. [5] Bachmann, S., Dunmore, C.J., Skinner, M.M., Pahr, D.H., Synek, A., 2022. A computational framework for canonical holistic morphometric analysis of trabecular bone. Scientific Reports 12, 1-13.

Poster Presentation Number 66, Session 2, Friday 17:00 – 18:30

New insights from Taung

Gabriele Macho[1], Simon Neubauer[2], Kevin Kuykendall[3], Melissa Berke[4], Phil Hopley[5], Andreas Koutsodendris[6], Laurin Kolb[6], Thibaut Caley[7]

1 - Senckenberg Society for Nature Research, Germany · 2 - Johannes Kepler University Linz, Austria · 3 - University of Sheffield, England · 4 - University of Notre Dam, USA · 5 - Birkbeck, University of London, England · 6 - Ruprecht-Karls-Universität Heidelberg, Germany · 7 - EPOC, UMR-CNRS 5805, Université de Bordeaux, France

The Taung child, the holotype of *Australopithecus africanus*, was discovered in 1924 at the Buxton Limeworks quarry, South Africa [1]. Ultimate acceptance of the specimen was however delayed until the discovery of adult hominins from Sterkfontein and Makapansgat. The latter sites are some 390km and 670km north-east of Taung, whereas no other hominins were discovered from Taung.

The juvenile age of the Taung specimen has made -and continues to make- it difficult for researchers to fully appraise the (dis)similarities of this fossil from other, i.e. biologically mature, hominins from South Africa and elsewhere. Interpretations are further confounded by the lack of provenance of South African hominin fossils, insecure dating of the hominin-bearing karstic deposits [2] and limited palaeoecological information. What constitutes *A. africanus* and how to explain the morphological variation observed among South African hominins has therefore been subject of debate for decades.

The discovery (formal description) of the partial skeleton StW 573 'Little Foot' from Sterkfontein Mb2 potentially puts renewed focus on the Taung child for the following reason: StW 573 has been dated to 3.67±0.16Ma [3]. Although some researchers have raised doubts about this early date, there is general consensus that the specimen is derived from the Pliocene. Both Taung and Makapansgat, unlike the material of *A. africanus* from Sterkfontein Mb4 [2], are dated to the Pliocene too, i.e. between 3.03-2.58 Ma [4]. Moreover, StW 573 and hominins from Makapansgat, have recently been placed into a new species *Australopithecus prometheus* [5], separate from *A. africanus* (Taung). If this interpretation is correct, two hominin species co-existed in South Africa prior to the Plio-Pleistocene transition and thereafter, when environmental conditions were substantially cooler and more arid. Against the backdrop of increased mammalian species turnover ~2.5 Ma this finding is puzzling and calls for a rethink of early hominin biology and adaptations, as well the evolutionary processes governing hominin evolution. With this in mind we took a fresh look at the Taung child, using a multi-disciplinary approach. Specifically, here we report on new palaeoecological data, compare/contrast brain size/shape and investigate dental eruption pattern in the Taung child. Palaeoclimate reconstructions are derived from a variety of archives and serve to indicate the possible timing(s) of East African hominin dispersal(s)/niche expansions into southern Africa.

Our analyses yield a number of unexpected results. First, based on the morphological evidence analysed here, the Taung child cannot unequivocally be associated with fossils from either Sterkfontein or Makapansgat. Second, as regards life history variables, the Taung child exhibits a unique dental developmental pattern not observed in other Plio-Pleistocene hominins. At present it is unclear whether the delayed molar mineralization seen in Taung could be a plastic response to the warmer, more mesic environmental conditions during the Pliocene. Alternatively, it may be the case that Taung exhibits a unique life history strategy, not shared with other hominins. Third, and perhaps most importantly, our palaeoclimatic reconstructions highlight potential windows of opportunity for dispersal(s) or, rather, range expansion of Pliocene hominins from East to South Africa. Hydroclimatic conditions alternated between East and South Africa during the Plio-Pleistocene. It is conceivable that early hominins expanded their ranges (dispersed) some 4 times between 3-3.7 Ma. Such waves of dispersals (range expansions) would have affected population dynamics and gene flow, thereby obscuring species identification among South African Plio-Pleistocene hominins. This may explain why researchers have thus far been unable to agree on the number of hominin taxa present at South African hominin sites.

References: [1] Dart, R., 1925. *Australopithecus africanus*. The Man-Ape of South Africa. Nature. 115, 195-199. [2] Herries, A.I.R., 2022. Chronology of the hominin sites of southern Africa. Oxford Research Encyclopedia of Anthropology. [3] Granger, D.E., Gibbon, R.J., Kuman, K., Clarke, R.J., Bruxelles, L., Caffee, M.W., 2015. New cosmogenic burial ages for Sterkfontein Member 2 *Australopithecus* and Member 5 Oldowan. Nature. 522, 85-88. [4] Hopley, P.J., Herries, A.I.R., Baker, S.E., Kuhn, B.F., Menter, C.G., 2013. Beyond the South African cave paradigm – *Australopithecus africanus* from Plio-Pleistocene paleosol deposits at Taung. American Journal of Physical Anthropology 151:316-324. [5] Clarke, R.J., Kuman, K., 2019. The skull of StW 573, a 3.57 Ma *Australopithecus Prometheus* skeleton from Sterkfontein Caves, South Africa. Journal of Human Evolution. 134, 102634.

Podium Presentation, Session 6, Friday 10:30 – 12:10

Using functional morphology to investigate palaeoenvironments in South Africa's Cradle of Humankind

Megan Malherbe[1], Deano Stynder[2], Robyn Pickering[2], Martin Häusler[1]

1 - University of Zurich · 2 - University of Cape Town

South Africa's Cradle of Humankind contains some of the most important sites of human evolution, representing hominin fossils attributed to at least five species. However, lack of a detailed chronology for the sites has meant that these significant fossils are yet to be placed within a precise climatic or vegetative framework. Previously, ambiguity of the ages of these sites meant that we could not hypothesize about how different species responded to the dramatically changing environments that characterised the Plio-Pleistocene [1]. Now, recent uranium-lead dating has provided radiometric ages for eight of the most vital fossil-bearing sites in the Cradle: Bolt's Farm, Cooper's Cave, Drimolen, Haasgat, Hoogland, Malapa, Sterkfontein and Swartkrans [2]. Thus, the bovid assemblages – crucial indicators of palaeoenvironments and abundant at South African Plio-Pleistocene sites – now have their own time ranges and can be interrogated discretely. The chief consequence of this is that the fauna can now be examined without the hermeneutic constraints that accompany eastern African comparisons, and they can be examined on a regional, Cradle-wide scale.

Our research is the first direct comparison of the bovids and associated environments from these South African sites and those of corresponding time periods in eastern Africa. Using ecomorphological and mesowear analyses, we provide insight on functional adaptations and dietary ecology within six narrow intervals at the Cradle between 3.2 and 1.3 million years ago. Ecomorphology explores the relationship between functional morphology and ecological variables such as preferred habitat. The method defines a relationship between phenotypic characteristics and habitat in extant taxa, then applies that relationship to fossils to interpret habitat preferences of extinct taxa. Mesowear examines the degree of facet development on occlusal surfaces of molar teeth, determined by tooth-on-tooth contact known as attrition, and food-on-tooth contact known as abrasion. Ecomorphology was conducted on fossil bovid distal metapodials (n=85) using a novel 3D geometric morphometric method [3], and mesowear was conducted on fossil bovid molars (n=623) across the abovementioned sites [4]. Our analyses yielded consistent results, demonstrating an agreement between potential (ecomorphology) and actual (mesowear) markers of behavioural ecology. Discriminant function analyses of metapodials from South Africa showed higher variation in habitat adaptation (~50% indicated open/light cover habitat dwelling) than metapodials from Kenya's Koobi Fora Formation (>80% indicated open/light cover habitat dwelling).

Our study has various implications. Firstly, functional morphology did not reveal a clear progression towards more open dominated environments from 3 to 1 million years ago in the Cradle as expected. Instead, more variable habitat conditions are noted across all sites in South Africa. This is in accordance with inferences from the cave site formation and flowstone analysis which indicated fluctuating conditions outside the caves during this period. These results provide further evidence that vegetative transitions during this time were gradual rather than stepwise. Mesowear data, collected for the first time on a Cradle-wide scale, indicated a similar scenario whereby no clear shift towards more grassland dominated environments was observed at ~1. 7 Ma, as previously postulated in studies including just one or two Cradle sites. Lastly, differences in landscape and environment were demonstrated between southern and eastern sites of corresponding ages, with eastern African sites considerably more open. These findings provide no support that climatic changes were associated with hominin evolution [5], thus advancing our understanding of a pivotal period in our prehistory, and illustrating regionally specific modes of climate change during the Plio-Pleistocene across the African continent.

We would like to thank the Ditsong National Museum of Natural History and the Evolutionary Studies Institute at the University of the Witwatersrand for access to their collections. This work was supported by the Swiss Federal Commission for Scholarships, the Swiss Society for Anthropology, and the Western Interior Paleontological Society Karl Hirsch Memorial Grant.

References: [1] Trauth, M.H., Asrat, A., Berner, N., Bibi, F., Foerster, V., Grove, M., Kaboth-Bahr, S., Maslin, M.A., Mudelsee, M., Schäbitz, F., 2021. Northern Hemisphere Glaciation, African climate and human evolution. Quaternary Science Reviews. 268, 107095. [2] Pickering, R., Herries, A.I.R., Woodhead, J.D., Hellstrom, J.C., Green, H.E., Paul, B., Ritzman, T., Strait, D.S., Schoville, B.J., Hancox, P.J., 2018. U–Pb-dated flowstones restrict South African early hominin record to dry climate phases. Nature. 565, 226–229. [3] Malherbe, M., Webb, N., Palisson-Kramer, M., Ndiema, E., Braun, D., Haeusler, M., Forrest, F., In prep. Ecomorphology in Kenya's Koobi Fora Formation: Reconstructing Early Pleistocene hominin palaeoenvironments with 3D geometric morphometric analyses of bovid metapodials. Journal of Human Evolution. [4] Malherbe, M., Haeusler, M., Stynder, D., In prep. Dental mesowear patterns challenge the hypothesis of a 1.7 Ma transition to open grasslands in South Africa's Cradle of Humankind. Palaeogeography, Palaeoclimatology, Palaeoecology. [5] deMenocal, P.B., 2004. African climate change and faunal evolution during the Pliocene–Pleistocene. Earth and Planetary Science Letters. 220, 3–24.

Podium Presentation, Session 11, Saturday 13:50 – 15:30

The Uluzzian of Klissoura cave 1, Greece

Giulia Marciani[1,2], Serena Lombardo[3], Simona Arrighi[1,2], Nicholas Thompson[3], Vangelis Tourloukis[3,4], Stefano Benazzi[1], Katerina Harvati[3,5]

1 - Università di Bologna, Dipartimento di Beni Culturali, via degli Ariani 1, 48121 Ravenna, Italy · 2 - Università di Siena, Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, U. R. Preistoria e Antropologia, 53100 Siena, Italy · 3 - Palaeoanthropology, Institute for Archaeological Sciences and Senckenberg Centre for Human Evolution and Palaeoenvironment, Eberhard Karls University of Tübingen, Tübingen, Germany · 4 - University of Ioannina, School of Philosophy, Department of History and Archaeology, Ioannina, Greece · 5 - DFG Center for Advanced Studies 'Words, Bones, Genes, Tools', University of Tübingen, Tübingen, Germany

The Uluzzian, dated approximately 43,000 to 40,000 years BP, marks one of the earliest *Homo sapiens* dispersals into Europe, with evidence in Italy and Greece. This techno-complex stands out for its cohesive technological behaviour, usage of colourants, and systematic manufacture of bone tools and ornaments, representing a clear departure from the Mousterian techno-complex through innovations in technology, typology, and subsistence strategies [1].

Recent multidisciplinary research in Italy has enhanced our understanding of the Uluzzian, by clarifying patterns of raw material exploitation, production methods, and tool use. This presentation introduces the technological study of the lithics from Klissoura Cave 1, the most significant Uluzzian assemblage discovered outside Italy. Klissoura is located at the entrance of Klissoura Gorge on the western bank of the Berbatiotis River, northeastern Peloponnese. Excavations from 1993 to 2006 revealed a rich anthropogenic sequence from the Middle Paleolithic to the Holocene [2].

The analyzed assemblage from Klissoura layer V comprises 3,014 pieces, predominantly consisting of small fragments, mainly chips and debris, indicating on-site knapping activity. Additionally, the discovery of a hammerstone and an anvil, the latter modified on the base by flaking to create an angular shape, possibly for insertion into a support, suggests specialized tool use. The surfaces of these anvils show clear signs of the bipolar technique, predominantly featuring linear impacts with deep sub-rectangular hollows, like those observed at Castelcivita in Italy [3].

The on-site production primarily targeted flakes (62.6%) and bladelets (12.4%). Three main core types have been identified: parallel planes, orthogonal planes, and semi-circumferential cores. At Klissoura, the intentionality of bladelet production is evident through the exploitation of lateral ridges on blanks, as well as through the management of convexities using technical and crested elongated blanks [4]. The prevalent use of the bipolar technique is a distinguishing feature of the Uluzzian, consistent with findings from other Uluzzian sites in Italy, where both bipolar and direct percussion techniques were employed within the same reduction sequence [3]. At Klissoura, this technological choice has been further intensified. We observed an integrated use of the two reduction techniques in the cores: some cores (6.7%) exhibit the use of direct percussion followed by bipolar percussion on an anvil, while in other cases, freehand direct percussion follows the use of the bipolar technique (2.2%). The dorsal scars on debitage blanks and tools display and confirm this pattern. The retouched tools within the assemblage are predominantly characterized by backed retouch, which facilitates various typological categories such as lunates, backed pieces, backed points, truncations, and becs. Notably, lunates make up a significant portion of the tools (30.2%), accompanied by the presence of end scrapers (4.1%) and a considerable number of side scrapers (18.8%).

The materials from Klissoura are especially significant because they represent the first well-studied documentation of the Uluzzian culture outside Italy, perfectly aligned with its final stage [5]. A key challenge highlighted in our study is the production mode using the bipolar technique, often considered simplistic. However, this technique significantly enhances production efficiency by reducing preparation time while still maintaining control over the output. Compared to the Mousterian approach, it represents a novel way of engaging with raw materials, underscoring a strategic adaptation for faster tool production, pivotal to understanding early human technological and behavioural evolution in Europe.

This research is funded by the European Research Council (ERC-AdG-101019659 "FIRSTSTEPS" awarded to K. Harvati). K. Harvati is also supported by the Deutsche Forschungsgemeinschaft (DFG FOR 2237).

References: [1] Marciani, G., Ronchitelli, A., Arrighi, S., Badino, F., Bortolini, E., Boscato, P., Boschin, F., Crezzini, J., Delpiano, D., Falcucci, A., Figus, C., Lugli, F., Oxilia, G., Romandini, M., Riel-Salvatore, J., Negrino, F., Peresani, M., Spinapolice, E.E., Moroni, A., Benazzi, S., 2020. Lithic techno-complexes in Italy from 50 to 39 thousand years BP: An overview of lithic technological changes across the Middle-Upper Palaeolithic boundary. Quaternary International. 551, 123–149. [2] Kaczanowska, M., Kozłowski, J., Sobczyk, K., 2010. Upper Palaeolithic human occupations and material culture at Klissoura Cave 1. Eurasian Prehistory. 7, 133-285. [3] Arrighi, S., Marciani, G., Rossini, M., Pereira Santos, M.C., Fiorini, A., Martini, I., Aureli, D., Badino, F., Bortolini, E., Figus, C., Lugli, F., Oxilia, G., Romandini, M., Silvestrini, S., Ronchitelli, A., Moroni, A., Benazzi, S., 2020. Between the hammerstone and the anvil: bipolar knapping and other percussive activities in the late Mousterian and the Uluzzian of Grotta di Castelcivita (Italy). Archaeological and Anthropological Sciences. 12, 271. [4] Sitlivy, V., 2016. Technological variability of the Middle-to-Upper Paleolithic transition: Examples from the Balkans and neighboring regions. In: Harvati, K., Roksandic, M., (Eds.), Paleoanthropology of the Balkans and Anatolia: Human evolution and its context. Dordrecht, Springer, pp. 229–265. [5] Moroni, A., Ronchitelli, A., Arrighi, S., Aureli, D., Bailey, Boscato, P., Boschin, F., Capecchi, G., Crezzini, J., Douka, K., Marciani, G., Panetta, D., Ranaldo, F., Ricci, S., Scaramucci, S., Spagnolo, V., Benazzi, S., Gambassini, P., 2018. Grotta del Cavallo (Apulia – Southern Italy). The Uluzzian in the mirror. Journal of Anthropological Sciences 96, 1–36.

Podium Presentation, Session 4, Thursday 16:20 – 18:00

The invasive potential of *Homo sapiens* at their arrival to Europe

Ana B. Marín-Arroyo[1], Marco Vidal-Cordasco[1]

1 - EvoAdapta Group, Dpto. Ciencias Históricas, Universidad de Cantabria, Santander, Spain

Human-carnivore interactions have always been a central topic in Palaeolithic research. When *H. sapiens* replaced Neanderthals, the number of carnivore bones bearing anthropic marks or used as ornaments increased meaningfully, and the abundance and richness of the secondary consumer guild started a decreasing trend in Europe. These findings are frequently interpreted as indicators of an increment in the human pressure on carnivores, yet the underlying reasons remain unknown. By integrating species distribution models and probabilistic co-occurrence analyses, this study tests two hypotheses: (1) whether *H. sapiens* occupied a larger portion of the secondary consumers' fundamental niche during the Marine Isotope Stage (MIS) 3 in comparison to Neanderthals, and (2) whether the effects of the MIS 3 climate fluctuations on species distributions and spatial overlaps affected the co-occurrence patterns among secondary consumers at European scale. Results obtained show that the demographic decline of Neanderthals was part of a broader trend of habitat loss for most of the secondary consumers that led to population contractions toward smaller and more isolated patches. As a result, between 45 and 35 kyr BP, the co-occurrence frequency among secondary consumers and intra-guild competition increased significantly. The number of Neanderthal segregations with secondary consumers was twice as large as those observed in modern humans. In this connection, *H. sapiens* had a considerably more significant spatial overlap with all carnivore species, which reflects the ability of our species to occupy a larger portion of the whole secondary consumers' fundamental niche. These results suggest that the MIS 3 climate oscillations and the arrival of our species marked a tipping point in the human-carnivore interactions in Europe. The climatic and environmental fluctuations led to population contractions and increased intraguild competition, while the arrival of our species had a profound impact on the secondary consumers' community structure and assembly.

The European Research Council funded this research under the European Union's Horizon 2020 Research and Innovation Programme (grant agreement number 818299; SUBSILIENCE project - https://www.subsilience.eu). M.V.-C. funded with a Juan de la Cierva Formación Grant (Ref. FJC2021-047601-I).

Poster Presentation Number 67, Session 2, Friday 17:00 – 18:30

A biomolecular approach to investigate the cannibalistic behaviour of the late Upper Palaeolithic human group from Gough's Cave, UK

William A. Marsh[1,2], Selina Brace[1], Oliver E. Craig[2], Ian Barnes[1], Silvia M. Bello[1]

1 - Centre for Human Evolution Research, Natural History Museum, London; 2BioArCh, University of York, York

The late Upper Palaeolithic deposit at Gough's Cave is the most remarkable example of the Magdalenian culture in Britain. Dated to 15 kya [1], the deposit is associated with a period of widespread glacial amelioration in Europe and expansion of human groups northwards as areas in higher latitudes became more habitable. Evidence of human presence at Gough's Cave during this period is plentiful, with characteristic Magdalenian lithic and bone industries, and over 200 fragmentary human remains from both adults and children (MNI=6). Anthropic modification of the human assemblage is found in great abundance, with three cranial vaults modified into skulls-cups, and over 50% of post-cranial elements showing either cut-marks, tooth-marks or percussion damage indicative of cannibalism [2].

To further understand the behaviour of this Magdalenian group, we here present data gathered using a multiproxy biomolecular approach comprising compound specific isotopic techniques and ancient DNA analyses. Both faunal and human material were incorporated into the analysis, with a targeted DNA capture technique employed to overcome the low levels of biomolecular preservation seen across the human remains. Human material incorporated include two modified skull-cups, and 15 long bones that show anthropic modifications directly associated with cannibalism.

Compound specific dietary isotope analysis of human individuals indicate a trophic level associated with omnivory, without any marine protein component. All individuals show a pattern of genetic ancestry seen in other Magdalenian groups across Europe [3]. Close familial relationships between individuals of both sexes are identified. The presence of anthropic modifications found on these individuals indicate that cannibalism was practiced amongst related individuals, strongly suggesting a form of endocannibalism. Few homozygous regions are identified from genetic data, indicating low levels of inbreeding within the group. This result suggests the maintenance of inter-group exchange amongst Magdalenian groups, that allowed for consanguineous mating to be avoided. Such connectivity is in keeping with the "Small-World Network" hypothesis of the social Magdalenian system [4]. Further, the composition of the group, with the presence of related females and males of mixed ages, mirrors what is observed in modern hunter-gatherer groups.

When genetic data are combined with the prior hypothesis that cannibalism was a widespread funerary behaviour intrinsic to Magdalenian groups [5], results suggest that funerary endocannibalism may have been a widespread behaviour across Upper Palaeolithic Europe.

Authors would like to thank The Calleva Foundation for funding this project.

References: [1] Charlton, S., Brace, S., Hajdinjak, M., Kearney, R., Booth, T., Reade, H., Tripp, J.A., Sayle, K.L., Grimm, S.B., Bello, S.M., Walker, E.A., Gilardet, A., East, P., Glocke, I., Larson, G., Higham, T., Stringer, C., Skoglund, P., Barnes, I., Stevens, R.E., 2022. Dual ancestries and ecologies of the Late Glacial Palaeolithic in Britain. Nature Ecology & Evolution. 6, 1658–1668. [2] Bello, S.M., Saladié, P., Cáceres, I., Rodríguez-Hidalgo, A., Parfitt, S.A., 2015. Upper Palaeolithic ritualistic cannibalism at Gough's Cave (Somerset, UK): The human remains from head to toe. Journal of Human Evolution. 82, 170–189. [3] Posth, C., Yu, H., Ghalichi, A., Rougier, H., Crevecoeur, I., Huang, Y., Ringbauer, H., Rohrlach, A.B., Nägele, K., Villalba-Mouco, V., Radzeviciute, R., Ferraz, T., Stoessel, A., Tukhbatova, R., Drucker, D.G., Lari, M., Modi, A., Vai, S., Saupe, T., Scheib, C.L., Catalano, G., Pagani, L., Talamo, S., Fewlass, H., Klaric, L., Morala, A., Rué, M., Madelaine, S., Crépin, L., Caverne, J.-B., Bocaege, E., Ricci, S., Boschin, F., Bayle, P., Maureille, B., Le Brun-Ricalens, F., Bordes, J.-G., Oxilia, G., Bortolini, E., Bignon-Lau, O., Debout, G., Orliac, M., Zazzo, A., Sparacello, V., Starnini, E., Sineo, L., van der Plicht, J., Pecqueur, L., Merceron, G., Garcia, G., Leuvrey, J.-M., Garcia, C.B., Gómez-Olivencia, A., Poltowicz-Bobak, M., Bobak, D., Le Luyer, M., Storm, P., Hoffmann, C., Kabaciński, J., Filimonova, T., Shnaider, S., Berezina, N., González-Rabanal, B., González Morales, M.R., Marín-Arroyo, A.B., López, B., Alonso-Llamazares, C., Ronchitelli, A., Polet, C., Jadin, I., Cauwe, N., Soler, J., Coromina, N., Rufi, I., Cottiaux, R., Clark, G., Straus, L.G., Julien, M.-A., Renhart, S., Talaa, D., Benazzi, S., Romandini, M., Amkreutz, L., Bocherens, H., Wißing, C., Villotte, S., de Pablo, J.F.-L., Gómez-Puche, M., Esquembre-Bebia, M.A., Bodu, P., Smits, L., Souffi, B., Jankauskas, R., Kozakaitė, J., Cupillard, C., Benthien, H., Wehrberger, K., Schmitz, R.W., Feine, S.C., Schüler, T., Thevenet, C., Grigorescu, D., Lüth, F., Kotula, A., Piezonka, H., Schopper, F., Svoboda, J., Sázelová, S., Chizhevsky, A., Khokhlov, A., Conard, N.J., Valentin, F., Harvati, K., Semal, P., Jungklaus, B., Suvorov, A., Schulting, R., Moiseyev, V., Mannermaa, K., Buzhilova, A., Terberger, T., Caramelli, D., Altena, E., Haak, W., Krause, J., 2023. Palaeogenomics of Upper Palaeolithic to Neolithic European hunter-gatherers. Nature. 615, 117–126. [4] Maier, A., 2015. Small-World Networks: Backbone of the Magdalenian Society? In: The Central European Magdalenian, Vertebrate Paleobiology and Paleoanthropology Series, pp. 243–245. [5] Marsh, W.A., Bello, S., 2023. Cannibalism and burial in the late Upper Palaeolithic: Combining archaeological and genetic evidence. Quaternary Science Reviews. 319, 108309.

Poster Presentation Number 68, Session 2, Friday 17:00 – 18:30

The relationship of the hominoid tongue, oral cavity and oropharynx volumes and its reflection of phylogeny and feeding, breathing and speech functions

Sandra Martelli[1], Seungho Choi[2]

1 - UCL Centre for Integrative Anatomy (CIA), Department of Cell and Developmental Biology, Faculty of Life Sciences · 2 - UCL Division of Biosciences, Faculty of Life Sciences

Patterns of integration of tongue volume and hyoid and mandibular size differ between humans, chimpanzees and gibbons, with tighter relationships observed in humans and gibbons [1]. These relationships refer to bone volumes but might be less indicative of how tongue volume integrates with the functional spaces of the oral cavity and the oropharynx (oral cavity plus pharyngeal space), which would have implications for speech sound production and feeding functions. Using one-way ANOVA and non-parametric correlations, we studied the relationship of tongue, oral cavity and oropharynx volumes in a sample of 24 adult humans (*Homo sapiens*), 16 chimpanzees (*Pan troglodytes*) and 7 gibbons (*Hylobates* spec., *Symphalangus syndactylus*) to determine whether these express in a common hominoid phylogenetic pattern or if we can detect functional influences. To compare these hominoid taxa with considerable inter-specific body size differences - but little sexual size dimorphism - we adjusted all volumes using orbit dimensions as a proxy for body mass [2] and we calculated the ratio of tongue volume to oral cavity and oropharynx respectively to explore the relationships.

Raw and size corrected data for tongue, oral cavity and oropharynx volume show that all chimpanzee volumes are absolute and relative larger despite their overall smaller body size compared to humans. Gibbons are smaller in all dimensions than both humans and chimpanzees. When corrected for size, all volumetric differences are statistically significant at ($p<0.01$). The ratio of tongue volume to oral cavity and tongue volume to oropharynx is very similar and non-significantly different in all three species (humans=2.5, chimpanzee=2.52, gibbons=2.92). Interestingly, the human tongue volume has a statistically relevant correlation with the oropharynx volume, which is not observed in the ape species studied here.

Relationships between the volumes of the mandible, tongue and hyoid bone differ significantly between humans, chimpanzees and gibbons, yet the relationships of the tongue with the functional space it occupies in the mouth and the pharynx are much more conserved across apes. Maintaining breathing and feeding functions seem to strongly preserve these relationships in a hominoid-specific pattern. This could be of strong interest as it would allow to calibrate reconstructed fossil hominin (e.g. Neanderthal) vocal tract and pharynx space reconstructions taking these conserved relationships into consideration.

We thank curators of various collections for access and permission to use modern human, chimpanzee and gibbon CT scans: C.E.P. Zollikofer and M. Ponce de Leon, Universität Zürich, J. Hodler and his team at orthopaedic University hospital Zurich, F. Spoor, UCL, P. O'Higgins, University of York, Takeshi Nishimura and the Digital Morphology Museum at the Primate Research Institute, Kyoto University, Frédéric Richard, Aix-Marseille Université, S. Blau and VIFM, Monash University Melbourne, the free access New Mexican Decedent Database funded by the National Institute of Justice grant number 2016-DN-BX-0144 and MorphoSource.org.

References: [1] Gao, X., Martelli, S.A., 2021. Different patterns of integration of the hyoid, mandible and tongue size in Hominoidea-Implications for reconstructing the tongue size in fossil hominins. American Journal of Physical Anthropology. 174: 37. [2] Aiello, L.C., Wood, B.A., 1994. 'Cranial variables as predictors of hominine body mass', American Journal of Physical Anthropology. 95, 409-426.

Poster Presentation Number 69, Session 2, Friday 17:00 – 18:30

Applying 3D shape comparisons to upper central incisors: A comparative landmark-free analysis of the enamel-dentine junction

Nicolas Martin[1], Adrien Thibeault[1], Lenka Varadzinová[2], Stanley H. Ambrose[3], Daniel Antoine[4], Petra Brukner Havelková[2,5], Matthieu Honegger[6], Joel D. Irish[7], Laura Maréchal[8], Piotr Osypiński[9], Frédéric Santos[1], Donatella Usai[10], Nicolas Vanderesse[1], Ladislav Varadzin[11], Rebecca J. Whiting[4], Clément Zanolli[1], Petr Velemínský[5], Isabelle Crevecoeur[1]

1 - Univ. Bordeaux, CNRS, Ministère de la Culture, PACEA, UMR 5199, France · 2 - Czech Institute of Egyptology, Faculty of Arts, Charles University, Prague, Czech Republic · 3 - Department of Anthropology, University of Illinois, IL, USA · 4 - Department of Egypt and Sudan, The British Museum, London, UK · 5 - Department of Anthropology, Natural History Museum, National Museum, Prague, Czech Republic · 6 - Institut d'Archéologie, University of Neuchâtel, Hauterive, Switzerland · 7 - Research Centre in Evolutionary Anthropology and Paleoecology, School of Biological and Environmental Sciences, Liverpool John Moores University, Liverpool, UK · 8 - Laboratory of Archaeology of Africa & Anthropology (ARCAN), Department of Anthropology, University of Geneva, Geneva, Switzerland · 9 - Institute of Archaeology and Ethnology, Polish Academy of Sciences, Poznan, Poland · 10 - Centro Studi Sudanesi e Sub-Sahariani ONLUS, Treviso, Italy · 11 - Institute of Archaeology, Czech Academy of Sciences, Prague, Czech Republic

The development of high-resolution 3D imaging techniques in biological anthropology has unlocked new insights into the inner structure of human hard tissues. In dental anthropology it allows the inner morphology of teeth to be studied in great detail, including quantification and visualisation of the dental tissues (e.g. [1]).; this enables in-depth analyses of dental structure without a need to section teeth. Thanks to this approach, geometric morphometric studies and shape analyses can be applied to analyse the morphology of the enamel-dentine junction (EDJ), allowing comparisons between modern human populations to estimate their biological relatedness [2].

These analyses are mostly based on posterior teeth, especially molars, through the use of sets of landmarks at the EDJ surface [2-3]. So far, little research has focused on the EDJ of anterior teeth, especially incisors, as it can be difficult, if not impossible, to define a consistent set of landmarks. Here, we applied a landmark-free surface deformation-based method [4-5] to a sample of unworn upper central incisors (n=36) from early to mid-Holocene Nile Valley skeletal remains. The results were then compared with previous geometric morphometric and shape analyses on a sample of UM1s (n=57) and UM2s (n=70) from the same sites.

Through the use of principal component analysis (PCA), between-group principal component analysis (bgPCA) and canonical variance analysis (CVA) similar phylogenetic signals were revealed between both upper central incisors and upper first and second molars. This similarity suggests that the EDJ of upper central incisors also carries a strong signal that can be recorded via surface deformation-based landmark-free analyses, to serve as suitable proxies for assessing biological affinities. These results reveal new ways to study biological affinities in micro-evolution context that may provide useful information for interpreting the archaeological record and history of modern human populations. This study also highlights that further research is required to reliably reconstruct slightly worn EDJ on incisors to increase sample size, account for the formation of secondary dentine, and test these methods on other anterior teeth classes.

The authors thank the National Corporation for Antiquities and Museums of the Sudan for their long-term support. We thank the curators, researchers, and institutions who allowed us to examine the comparative original collections in their care at the time of the study: M. Maillot, S. Marchi and J. Reinold (SFDAS), M. Besse and J. Desideri (Université de Genève). We thank R. Lebrun (Institut des Sciences de l'Evolution, Université Montpellier 2) for the microCT acquisitions of the El-Barga dental material; B. Clark (Imaging and Analysis Centre, Natural History Museum, London) for the microCT acquisitions of the Jebel Sahaba; the PLACAMAT platform (UAR 3626, University of Bordeaux) for the microCT acquisitions of the rest of the remains. We thank also A.S. Benoiston and Y. Merigeaud for participating in the data acquisition in the framework of their Master theses. This study received financial support from the International Research Project (IRP) ABASC funded by the CNRS-INEE; the French government in the framework of the University of Bordeaux's IdEx "Investments for the Future" program / GPR "Human Past" (project NeoNile); the French National Research Agency (ANR-14-CE31, project BIG DRY); The Czech Science Foundation (Projects No. GAČR 17-15 03207S and 23-06488S); the Cooperatio Program provided by Charles University, research area Archaeology, implemented at the Faculty of Arts of Charles University; the Ministry of Culture of the Czech Republic (DKRVO 2024-2028/7.I.a, National Museum, 00023272); the National Science Centre – Poland (grant UMO-2020/37/B/HS3/00519).

References: [1] Olejniczak, A.J., Smith, T.M., Feeney, R.N.M., Macchiarelli, R., Mazurier, A., Bondioli, L., Rosas, A., Fortea, J., de la Rasilla, M., Garcia-Tabernero, A., Radovčić, J., Skinner, M.M., Toussaint, M., Hublin, J.-J., 2008. Dental tissue proportions and enamel thickness in Neandertal and modern human molars. Journal of Human Evolution. 55, 12–23. [2] Le Luyer, M., Bayle, P., 2017. Microevolution of outer and inner structures of upper molars in Late Pleistocene and Early Holocene humans. Comptes Rendus Palevol. 16, 632–644. [3] Gamarra, B., Lozano, M., Del Bove, A., Subirà, M.E., Edo, M., Castellana, C., Vergès, J.M., Morales, J.I., Cebrià, A., Oms, F.X., Tornero, C., Gómez-Bach, A., 2022. Identifying biological affinities of Holocene northern Iberian populations through the inner structures of the upper first molars. Archaeological and Anthropological Sciences. 14, 38. [4] Durrleman, S., Prastawa, M., Charon, N., Korenberg, J.R., Joshi, S., Gerig, G., Trouvé, A., 2014. Morphometry of anatomical shape complexes with dense deformations and sparse parameters. NeuroImage. 101, 35–49. [5] Beaudet, A., Dumoncel, J., Thackeray, J.F., Bruxelles, L., Duployer, B., Tenailleau, C., Bam, L., Hoffman, J., de Beer, F., Braga, J., 2016. Upper third molar internal structural organization and semicircular canal morphology in Plio-Pleistocene South African cercopithecoids. Journal of Human Evolution. 95, 104–120.

Poster Presentation Number 70, Session 2, Friday 17:00 – 18:30

Comparison of deciduous molars across genus *Homo* in Europe: how a large modern sample changes the story

Marina Martínez de Pinillos[1,2], Mario Modesto-Mata[1,3], Ian Towle[1], Arthur Thiebaut[1], Raquel Hernando[1,4], Leslea J. Hlusko[1]

1 - Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Burgos, Spain · 2 - Universidad de Burgos, Burgos, Spain · 3 - Universidad Internacional de La Rioja (UNIR), Logroño, Spain ·4 - Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Tarragona, Spain

Deciduous teeth are much less common in the hominin fossil record compared to the permanent dentition. However, because of their importance to the survival of young children, variation in the size and shape of the deciduous teeth may be especially informative for human evolution [1-2]. Here, we test the hypothesis that some deciduous teeth are more taxonomically informative than others.

We first compiled from the published scientific literature a comparative sample of 115 fossil deciduous molars representing four taxa within the genus *Homo* in Europe: *Homo antecessor*, pre-Neanderthals, Neanderthals and *Homo sapiens* fossils. Focusing on the linear dimensions: mesiodistal (MD) and buccolingual (BL) diameters, crown index (BL/MDx100), and crown area (BLxMD), we compared the maxillary and mandibular deciduous molars. Our results pose the hypotheses that the mandibular second molars are the least taxonomically diagnostic and that the first deciduous molars, especially maxillary ones, are the most.

We then tested these two hypotheses by bringing in a large sample of modern human deciduous teeth from the *Ratón Pérez* collection housed at the National Research Centre on Human Evolution (CENIEH) in Burgos, Spain [3]. This deciduous tooth collection currently includes almost 5000 teeth from about 3000 children between the ages of 2 and 15 years. For this study, we used 232 upper and lower deciduous molars of children of both sexes.

Results from the Ratón Pérez collection question both hypotheses deriving from the fossil hominin patterns. For modern humans, the second deciduous molars, maxillary and mandibular, appear to show more taxonomic separation than do the first. This increased variation of the second deciduous molars may reflect the later timing of development. The first deciduous molars develop and calcify earlier during gestation than do the second deciduous molars.

Alternatively, our study may primarily reveal the challenge of working with the small sample sizes available in the fossil record. The patterns observed may be simply a reflection of sample size, as the fossil samples for the first deciduous molars are much smaller than are those for the second molars. However, we find it notable that the dispersion of the second deciduous molars in the modern human sample is less than what we observe for the first deciduous molar. Therefore, we conclude that it is more likely that the increased taxonomic variation of second deciduous molars is a reflection of evolutionary divergence.

This research was supported with funding from the European Research Council within the European Union's Horizon Europe (ERC-2021-ADG, Tied2Teeth, project number 101054659), Spanish Foundation for Science and Technology (FECYT), Spanish Ministerio de Economía y Competitividad (CGL2015-65387-C3-3-P), Fundación La Caixa, Fundación Caja de Burgos.

References: [1] Bailey, S.E., 2017. Deciduous Dentition of Fossil Hominins. Encyclopedia of Life Sciences. 1–7. [2] Bermúdez de Castro, J.M., Martinón-Torres, M., Martín-Francés, L., Martínez de Pinillos, M., Modesto-Mata, M., García-Campos, C., Wu, X., Xing, S., Liu, W., 2017. Early Pleistocene hominin deciduous teeth from the *Homo antecessor* Gran Dolina-TD6 bearing level (Sierra de Atapuerca, Spain). American Journal of Physical Anthropology. 163, 602–615. [3] Martínez de Pinillos, M., Pantoja-Pérez, A., Fernández-Colón, P., Martín-Francés, L., García-Campos, C., Modesto-Mata, M., Moreno-Torres, C., Bermúdez de Castro, J.M., Martinón-Torres, M., 2021. The Ratón Pérez collection: Modern deciduous human teeth at the Centro Nacional de Investigación sobre la Evolución Humana (Burgos, Spain). American Journal of Physical Anthropology. 176, 528–535.

Poster Presentation Number 71, Session 2, Friday 17:00 – 18:30

Molar macrowear analysis to unveil dietary habits in Sima de los Huesos population

Laura Martín-Francés[1,2], Luca Fiorenza[2], María Hernaiz-García[2], José María Bermúdez de Castro[1,3], Juan Luis Arsuaga[4], María Martinón-Torres[1,3]

1 - CENIEH (National Research Center on Human Evolution), Burgos, Spain · 2 - Monash Biomedicine Discovery Institute, Department of Anatomy and Developmental Biology, Monash University, Melbourne, Australia · 3 - University College London Anthropology, London, UK · 4 - Centro Mixto UCM-ISCIII de Evolución y Comportamiento Humanos, Madrid, Spain

The importance of determining hominin diet lies in its relationship with the morphological evolution of the masticatory apparatus. According to isotopic reports, the early Neanderthals from Atapuerca-Sima de los Huesos (SH) site, dated to 448±15 ka [1], probably relied on a rich-protein diet [2], as previously suggested for Neanderthals. In addition, the microwear analysis of the posterior dentition of SH suggested that this population also exploited other resources such as plant foods [3]. By analysing the occlusal macrowear in maxillary molars, this study explores the dietary ecology of this Middle Pleistocene population that likely lived during the MIS 12, one of the coldest periods recorded globally, that in the Iberian Peninsula caused a significant increment in semi-desert vegetation [1]. We employed the Occlusal Fingerprint Analysis (OFA) method [4], a digital approach that allows to reconstruct the individual masticatory behaviour through the analysis of occlusal wear facets. We examined seven maxillary first molars characterised by a moderate degree of tooth wear.

The SH group is characterised by a macrowear pattern with large buccal phase I facets (41%), followed by lingual phase I (29%) and phase II (28%) facets. This pattern is similar to those of Neanderthals who inhabited temperate forests. The comparative analysis (One-way PERMANOVA, N permutation=9999, p=0.0001), further confirms this result, showing significant differences with Eurasian Pleistocene groups from Mediterranean and steppe/coniferous forest areas, but not with Neanderthals from deciduous woodlands.

The results of this preliminary study suggest that the SH population exploited both animal and plant foods. The presence of larger buccal phase I facets in maxillary molars, as those displayed by the SH group, is associated with a diet dominated by animal proteins [5]. Moreover, the high proportion of lingual phase I facets indicates an increase in transverse mandibular movements, generally associated with the consumption of hard and abrasive foods, including roots, seeds, gums, and other plant materials [5]. Consequently, the large lingual phase I facets displayed by the SH group would indicate that this population exploited plant material as well. It is possible that the SH population relied on the consumption of underground storage organs, which are available year-round and are rich in carbohydrates.

Our result is in agreement with the previous reports on isotopic [2] and tooth microwear analyses [3] that suggested that SH mainly relied on a diet rich in animal foods but also exploited hard and poorly processed plant resources, such as tubers, stems and seeds.

This research is funded by the Horizon Program-Marie Sklodowska-Curie Actions of the EU Ninth programme (2021-2027) under the HORIZON-MSCA-2021-PF-01-Project: 101060482 and MCIN/AEI/ 10.13039/501100011033 and "ERDF A way of making Europe" Grant PID2021-122355NB-C33 & -C31. LMF receives funding from the EU Program-Marie Sklodowska-Curie Actions. M-MT has received support from the Leakey Foundation through the personal support of Gordon Getty (2013) and Dub Crook (2014-2022). The authors gratefully thank the curators and institutions which allowed us to study comparative and fossil specimens: Almut Hoffmann (Museum für Vor- und Frühgeschichte, Berlin, Germany), Maria Teschler Nicola (Naturhistorisches Museum Wien, Vienna, Austria), Marta Dočkalová (Moravské Zemské Muzeum, Anthropos Institute, Brno, Czech Republic), Bence Viola (Department of Anthropology, University of Vienna, Austria), Yoel Rak (Department of Anatomy and Anthropology, University of Tel Aviv, Israel), Fabio Parenti (Istituto Italiano di Paleontologia Umana, Rome, Italy), Chris Stringer and Rob Kruszynski (Natural History Museum of London, England), National Museum of Wales (Cardiff, Wales), Angiolo del Lucchese (Museo Preistorico dei Balzi Rossi, Ventimiglia, Italy), and Erik Trinkaus (Department of Physical Anthropology at Washington University in Saint Louis, USA).

References: [1] Demuro, M., Arnold, L.J., Aranburu, A., Sala, N., Arsuaga, J.-L., 2019. New bracketing luminescence ages constrain the Sima de los Huesos hominin fossils (Atapuerca, Spain) to MIS 12. Journal of Human Evolution. 131, 76–95. [2] García, N., Arsuaga, J.L., 2011. The Sima de los Huesos (Burgos, northern Spain): palaeoenvironment and habitats of *Homo heidelbergensis* during the Middle Pleistocene. Quaternary Science Reviews. 30, 1413–1419. [3] Pérez-Pérez, A., Lozano, M., Romero, A., Martínez, L.M., Galbany, J., Pinilla, B., Estebaranz-Sánchez, F., Bermúdez de Castro, J.M., Carbonell, E., Arsuaga, J.L., 2017. The diet of the first Europeans from Atapuerca. Scientific Reports. 7, 43319. [4] Kullmer, O., Benazzi, S., Fiorenza, L., Schulz, D., Bacso, S., Winzen, O., 2009. Technical note: Occlusal fingerprint analysis: Quantification of tooth wear pattern. American Journal of Physical Anthropology. 139, 600–605. [5] Fiorenza, L., 2015. Reconstructing diet and behaviour of Neanderthals from Central Italy through dental macrowear analysis. Journal of Anthropological Sciences (Rivista di antropologia). 3, 119–133.

Poster Presentation Number 72, Session 2, Friday 17:00 – 18:30

To see forest for the trees. A new approach to the Howiesons Poort chronological controversy through Optimal Linear Estimation

Carmen Martín-Ramos[1], Alastair Key[1], Paloma de la Peña [1, 2, 3]

1 - Department of Archaeology, University of Cambridge, Cambridge, UK · 2 - Departamento de Prehistoria y Arqueología, Universidad de Granada, Campus Universitario de Cartuja s/n, Granada, Spain · 3 - Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, South Africa

The Howiesons Poort is a Middle Stone Age cultural industry from southern Africa characterised by the production of large backed pieces and the presence of symbolic behaviour. Traditionally, the Howiesons Poort industry has been dated to approximately 66,000 to 58,000 years ago. However, new excavations at Diepkloof, a significant archaeological site in South Africa, have challenged this traditional dating, suggesting that the industry could be considerably older, possibly originating between 109,000 and 105,000 years ago. This earlier date raises important questions about the evolution of modern human behaviour and the development of complex technology during the Middle Stone Age. The origins and temporal span of the Howiesons Poort industry are therefore still unclear. Some suggest it was a relatively short-lived tradition, while others believe it spanned through a more extended period. This ongoing debate affects how we understand the significance of the Howiesons Poort within the broader context of human evolution, mobility patterns and the so-called modern behaviour.

To help address ambiguities arising from conflicting dating results and chronological interpretations we employed optimal linear estimation modelling to infer the temporal boundaries of the Howiesons Poort. This technique allows us to gain a more accurate resolution on when this lithic industry likely originated and ceased without relying on first and last appearance dates determined by site ages. Using 15 different site-selection scenarios we evaluated the impact of varied dating results from all known Howiesons Poort sites. Through the use of optimal linear estimation, we have been able to provide new data on a long-lived debate concerning the chronological span of the Howiesons Poort, the Middle Stone Age, and their role within the broader narrative of human evolution in southern Africa. This research significantly contributes to the ongoing discussion about the chronology of the Howiesons Poort technology and the emergence of modern human behaviour. It also demonstrates how novel analytical techniques can be applied to existing data and published studies..

We are grateful to the Pouroulis Family Foundation for funding this research as part of its Fellowship in African Quaternary Archaeology and Hominin Palaeoecology at the University of Cambridge.

Poster Presentation Number 74, Session 2, Friday 17:00 – 18:30

Bridging gaps in Lebanon's Paleolithic climate record through speleothem research

Scott D. McLin[1], Fadi Henri Nader[2,3], Carole Nehme[4], Susan M. Mentzer[5,6], Christopher E. Miller[5,6,7], Hai Cheng[8], Kira Rehfeld[9], Valdir F. Novello[9], Sireen El Zaatari[1]

1 - Paleoanthropology, Senckenberg Center for Human Evolution and Paleoenvironment, Eberhard Karls Universität Tübingen, Tübingen, Germany · 2 - Department of Earth Sciences, University of Utrecht, The Netherlands · 3 - IFP Énergies nouvelles, Earth Sciences & Environment Technologies Division, Rueil Malmaison, France · 4 - 1UMR 6266 IDEES CNRS, University of Rouen Normandy, Mont St-Aignan, France · 5 - Institute for Archaeological Sciences, Department of Geosciences, University of Tübingen, Tübingen, Germany · 6 - Senckenberg Centre for Human Evolution and Palaeoenvironment, University of Tübingen, Tübingen, Germany · 7 - SFF Centre for Early Sapiens Behaviour (SapienCE), University of Bergen, Bergen, Norway · 8 - Institute of Global Environmental Change, Xi'an Jiaotong University, Xi'an, China · 9 - Institute of Geoscience, University of Tübingen, Tübingen, Germany

Speleothems are invaluable for reconstructing high-resolution paleoclimatic history and for better understanding the effects of climate dynamics on human evolution and migration. By investigating these critical archives, our research aims to improve the understanding of Lebanon's climatic and environmental conditions, a geographically significant region that serves as a land bridge connecting Africa and Eurasia. Discoveries in the past revealed a rich Paleolithic record, but following the outbreak of the Lebanese Civil War, almost all Paleolithic projects were halted. Half a century later, this research is being continued and advanced by the multidisciplinary project REVIVE.

This study introduces two new speleothem records from Kassarat cave, which is located within the Antelias Valley close to the Lebanese Mediterranean coast about 12 km north of Beirut City. The two speleothems exhibit growth phases corresponding to Marine Isotope Stages 2 and 3 based on U-series data. Employing a multi-proxy approach, we integrate stable isotopic analyses, micromorphology, and micro-XRF spectroscopy to investigate past climatic fluctuations with a high temporal, centennial-scale resolution. We use stable isotopic analyses to examine variations in oxygen and carbon isotopes within the speleothem layers to infer past temperature and precipitation regimes. Micromorphological analyses provide insights into cave sedimentary processes, and micro-XRF spectroscopy allows for the characterization of elemental composition, aiding in the identification of climatic proxies such as Saharan dust input.

Furthermore, the new speleothem records are integrated with other karst geomorphological records and paleoclimate proxies, such as lake sediment records, e.g., from Jeita cave and Yammoûneh basin, to reconstruct Lebanon's past climate and environmental conditions in a more comprehensive way. Additionally, correlating our findings with (geo)archaeological data potentially contributes to a better understanding of human-environment interactions and provides important new insights into the adaptive strategies of early human populations in response to climatic fluctuations.

Overall, REVIVE's geoarchaeological research highlights the significance of speleothem records in studying past climate variability and their relevance in reconstructing regional paleoclimates during critical periods of human migration in Lebanon.

This research has been funded by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (grant agreement number 101001889, REVIVE).

Poster Presentation Number 75, Session 2, Friday 17:00 – 18:30

An application of neural networks to identifying cellular bone growth processes

Shannon P. McPherron[1], Philipp Gunz[1], Alexandra Schuh[1]

1 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

Identifying the two main cellular processes of bone growth, bone formation and bone resorption, on the surface of dry bones is fundamental for our understanding of the ontogenetic processes behind morphological evolution in fossil hominins [1]. Bone modeling studies require the use of quantitative data to assess the intra- and interspecific variability, which have long been lacking. Despite substantial methodological progress, it remains time consuming to manually identify and quantify patterns of bone modeling on dry bone surfaces. Schuh et al [2] developed a workflow that involves manually selecting bone resorption on images of the bone surface captured via confocal or digital microscopy. Bone resorption is distinguishable from its opposite cellular activity, bone formation, as it can be identified through the presence of Howship's lacunae, i.e. small depressions indicating that the bone is being broken down. Depending on its state (aggressive or "skimming" [3]), bone resorption can take different aspects, from respectively deep, rounded depressions to elongated, superficial marks.

Here we present the first steps towards a fully automated workflow for image segmentation of bone formation and resorption using machine learning, which is at its infancy in our field [4-5]. We compare different machine learning architectures based on 4,500 standardized images, which were manually segmented by a single observer (AS). The most basic of these was a U-Net model — a convolutional network that has proven effective for segmenting biomedical images. The source image is first downsampled through a series of convolutional layers which each pass through a rectified linear unit (ReLU) and max pooling. The images are then upsampled to the original image resolution through a series of up-convolution layers and concatenations. In the final step, the pixels are passed through a sigmoid function to pull the values towards 0 or 1 to create masks. These masks are then compared to the original segmentation mask for this image to measure the accuracy of the model. We had our greatest success when training the model on a reduced set of images with clearly delimited areas of bone resorption (i.e., with the "aggressive" state), but more work needs to be done on images with the skimming state. We then used semi-supervised learning to add images and fine tune the model.

In a separate attempt, we adapted Meta's publicly accessible Segment Anything Model (SAM) to our purposes. SAM is trained on 11 million images consisting of 1.1 billion masks. However, this out of the box functionality did not perform well on our bone images. Thus, we added our own training images to the existing model in a type of transfer learning. We then applied this augmented SAM to test images. When given prior information (bounding boxes) on where the bone modeling might be in the test images, this augmented SAM performed extremely well at segmenting our images. This result suggests that a semi-automated system could be built wherein images are more quickly and perhaps more accurately segmented with the aid of such a model.

The use of machine learning thus represents a promising avenue for the identification and quantification of features on dry bone surfaces. Such methods open up new possibilities for analyzing bone surfaces by improving the study of large datasets in a significantly reduced amount of time. Here we show that neural networks can have broad applications to the field of Paleoanthropology.

The authors thank the Max Planck Society for supporting their research. SPM thanks Jonathan Reeves and David Braun for many helpful discussions on machine learning.

References: [1] Bromage, T., 1989. Ontogeny of the early hominid face. Journal of Human Evolution. 18, 751–773. [2] Schuh, A., Kupczik, K., Gunz, P., Hublin, J., Freidline, S.E., 2019. Ontogeny of the human maxilla: a study of intra-population variability combining surface bone histology and geometric morphometrics. Journal of Anatomy. 235, 233–245. [3] McCollum, M.A., 2008. Nasomaxillary remodeling and facial form in robust *Australopithecus*: a reassessment. Journal of Human Evolution. 54, 2–14. [4] Navega, D., Costa, E., Cunha, E., 2022. Adult skeletal age-at-death estimation through deep random neural networks: A new method and its computational analysis. Biology. 11, 532. [5] Courtenay, L.A., Huguet, R., González-Aguilera, D., Yravedra, J., 2019. A hybrid geometric morphometric deep learning approach for cut and trampling mark classification. Applied Sciences. 10, 150.

Podium Presentation, Session 5, Friday 8:30 – 10:10

The emergence of Levallois technology in the Middle Palaeolithic of the Balkans: lithic assemblages from Velika Balanica and Selačka Cave 3

Dušan Mihailović[1], Steven Kuhn[2], Anne Skinner[3], Bonnie Blackwell[3,†], Katarina Bogićević[4], Sofija Dragosavac[1], Danilo Pajović[1], Anđa Petrović[1], Mirjana Roksandic[5]

1 - Faculty of Philosophy, University of Belgrade · 2 - School of Anthropology, University of Arizona · 3 - Department of Chemistry, Williams College, † - Deceased · 4 – Faculty of Mining and Geology, University of Belgrade · 5 - Department of Anthropology, University of Winnipeg

The appearance of the Levallois method marked the beginning of the Middle Paleolithic in Western and Central Europe, where it has been in continuous use since MIS 9, if not earlier [1]. In Eastern Europe and the Southern Caucasus, the appearance of Levallois technology is recorded as early as MIS 9 [2], but widespread use dates back only to MIS 6. However, this technology's appearance in the Balkans has long been unresolved. The Levallois artifacts found at the Mamaia Sat site in Romania are dated to MIS 9-7, with the chronology of the site derived from correlations with the loess-paleosol sequence in the Danube Delta [3], while the artifacts from layer 10b in Kozarnika are dated to MIS 7-MIS 6 but they have not yet been published in detail [4]. At all other sites in the Balkans, Levallois artifacts are dated to a later period - from the transition from MIS6/5 to the end of the Middle Paleolithic. More recent investigations of Velika Balanica and Selačka Cave 3 in eastern Serbia have shed more light on this issue. Both caves were dated using the ESR technique. In Selačka 3 Levallois artifacts were found in layer 3, which was dated to the end of MIS 7 and MIS 6, while in Velika Balanica they were found in layer 2, which, even though earlier dates were obtained for some samples, probably come from the same period. Findings from Selačka Cave 3 and Velika Balanica indicate that the Levallois technology appeared in the Balkans at least as early as the end of MIS 7 and that it continued to be used in MIS 6. These findings have significant implications for understanding the timing and circumstances in which the Levallois method spread to South-East Europe and South-West Asia. Although at this moment it is not possible to see the origin of the Levallois technology in the Eastern Mediterranean, the fact is that it appeared only after the appearance of the Quina/Yabrudian method of blank production, which, when it comes to Southeastern Europe, was also documented in Velika Balanica (in layer 3) [5]. However, it was only with the appearance of the Levallois method in this area that Middle Paleolithic technical behavior was finally shaped.

This research has been supported by the NEEMO project of the Science Fund of the Republic of Serbia (7746827), Natural Science and Engineering Research Council of Canada NSERC (RGPIN-2019-04113) and MIRA project funded by the Social Sciences and Humanities Research Council of Canada SSHRC (895-2024-1005). Funding for ESR analysis came from Williams College, McMaster University, and the Dartmouth Hitchcock Medical Center.

References: [1] Moncel, M-H., Ashton, N., Arzarello, M., Fontana, F., Lamotte, A., Scott, B., Muttillo, B., Berruti, G., Nenzioni, G., Tuffreau, A., Peretto, C., 2020. Early Levallois core technology between Marine Isotope Stage 12 and 9 in Western Europe. Journal of Human Evolution. 139, 102735. [2] Adler, D.S., Wilkinson, K.N., Blockley, S., Mark, D.F., Pinhasi, R., Schmidt-Magee, B.A., Nahapetyan, S., Mallol, C., Berna, F., Glauberman, P.J., Raczynski-Henk, Y., Wales, N., Frahm, E., Jöris, O., MacLeod, A., Smith, V.C., Cullen, V.L., Gasparian, B., 2014. Early Levallois technology and the Lower to Middle Paleolithic transition in the Southern Caucasus. Science 345, 1609-1613. [3] Balescu, S., Tuffreau, A., Dobrescu, R., 2015. Mamaia Sat (Romania): a Late Middle Pleistocene Palaeolithic Site?. L`Anthropologie (Brno). 53, 157–166. [4] Tillier, A., Sirakov, N., Guadelli, A., Fernandez, P., Sirakova, S., Dimitrova, I., Ferrier, C., Guérin, G., Heidari, N., Krumov, I., Leblanc, J., Miteva, V., Popov, V., Taneva, S., Guadelli, J., 2017. Evidence of Neanderthals in the Balkans: The infant radius from Kozarnika Cave (Bulgaria). Journal of Human Evolution. 111, 54–62. [5] Mihailović, D., Kuhn, S., Bogićević, K., Dimitrijević, V., Marín-Arroyo, A., Marković, J., Mercier, N., Mihailović, B., Morley, M., Radović, P., Rink, W., Plavšić, S., Roksandic, M., 2022. Connections between the Levant and the Balkans in the late Middle Pleistocene: Archaeological findings from Velika and Mala Balanica Caves (Serbia). Journal of Human Evolution. 163, 103138.

Poster Presentation Number 76, Session 2, Friday 17:00 – 18:30

Using finite element analysis to understand form variation in lithic artefacts: a flake case study

Anna Mika[1], Alastair Key[1]

1 - Department of Archaeology, University of Cambridge, Cambridge, United Kingdom

Flake stone tools were the foundation of any toolkit and were used in a diverse array of tasks central to the survival of human (and hominin) populations. Yet, the types and forms of flakes produced varied widely within and between Palaeolithic populations, which leads to the question of why hominins produced such variation. The experimental use of flake tools by present-day humans can provide valuable data, but are limited to replica lithics, use contexts removed from Palaeolithic realities, and are often unable to clearly identify the mechanical relationships underlying any performance variation. Here, we investigate whether mechanical and/or functional components were a factor contributing to the variation observed in flake stone tool artefacts using Finite Element Analysis (FEA). FEA is a computer-based analysis tool used to simulate the performance of physical objects in a controlled virtual environment. Used widely to investigate biological structures in human prehistory, its use for understanding variation in artefactual structures has largely been overlooked.

We use FEA to investigate how morphology impacts the distribution of force, stress, and strain through flake tools during their simulated use. Four stone tool types were selected for this study: 1) basic 'expedient' flakes, 2) Levallois flakes, 3) blades, and 4) bladelets. These tools are representative of the fundamental flake technologies observed from the Lower Palaeolithic through to the Mesolithic and beyond. Tools were 3D scanned using the Artec Micro 3D scanner, rendered in Artec Studio Professional, and then imported into ANSYS FEA software. Each 3D model was used to 'cut' into a simulated 'soft solid' meat material. The amount of force, stress, and strain experienced on the edge of each stone tool was recorded. We identified differences in the amount of force each tool type could withstand before breakage, along with patterns to the breakage. These mechanical differences potentially influenced Palaeolithic hominin tool production decisions and the technological transitions observed in flake technologies. The application of FEA in Palaeolithic studies has potential to significantly enhance our understanding of human behavioural evolution.

This work was supported by the University of Cambridge Harding Distinguished Postgraduate Scholars Programme.

Poster Presentation Number 77, Session 2, Friday 17:00 – 18:30

Landscapes of the dead: the African Humid Period human remains record from South West Turkana, Kenya

Marta Mirazón Lahr[1,2,3], Robert Foley[1,2,3]

1 - University of Cambridge · 2 - National Museums of Kenya · 3 - Turkana Basin Institute

The African Humid Period (AHP) (11.8 ka to 5.5 ka) is a time of major environmental and climatic change, occurring during the transition from glacial (MIS 2) to full inter-glacial (MIS 1) conditions. For the Eastern African Rift System, this was characterised by greatly elevated lakes caused by higher rainfall, and corresponding changes in the environment and drainage patterns [1]. Lake Turkana, during this period, reached a maximum height of ~90 m above the historic lake levels (360m asl), and overflowed at various points into the Sobat River system that connects the basin to the Nile drainage system. The higher lake levels were not continuous, but consisted of multiple fluctuations, the final one occurring at 7-6 ka [2]. The very end of the period also sees the transition from hunter-gatherer-fisher foragers to the earliest pastoralists in Eastern Africa.

Since 2007, we have conducted archaeological and palaeoenvironmental excavations and surveys of the lower Kerio Valley in south-west Turkana County. The Kerio is one of the major rivers flowing into Lake Turkana, and the lower reaches consist of a broad valley running north-south, before forming a delta at the lake's edge. This region is characterised by extensive Late Pleistocene and Holocene deposits, representing high lake stands and associated fluvial and deltaic conditions. These deposits contain rich lithic, faunal and human remains. These are widely scattered, and in places form an almost continuous palimpsest from the AHP.

A striking element of this record is the extent and nature of the human skeletal remains that have been recovered. Most of this material was found eroding from sediments as isolated bone fragments or partial to complete elements (N=ca. 1400), while the remains of 67 individuals were found in situ with skeletal parts in articulations. The majority of the latter are poorly preserved, and detailed osteobiogaphical information was obtained from about half the sample. All the remains date from the AHP and represent fisher-foragers communities, with the exception of 3 skeletons of early pastoralists that date to ~4.5 ka.

This human remains record constitutes one of the largest collections of sub-Saharan African Holocene prehistoric people, and throws light on the biology, health, diversity and behaviour of early Holocene populations in Eastern Africa. The evidence of a rare episode of inter-group conflict at Nataruk [3], as well as evidence of violence at other sites, are part of this rich record. However, we highlight here the mortuary aspect of this assemblage. Amongst all the excavated partially articulated individuals, only two clear burials were found (one a double burial) both representing early pastoralist communities that post-date the AHP, while intentional burial could also be inferred from the position of a small group of skeletons of relatively late fisher-foragers. The majority of the human remains share with the faunal remains a pattern of scattered disarticulation on a landscape subject to the ebbing and flowing of water on lake edges or in fluvial contexts, and a significant number shows evidence of animal predation. The distribution of the skeletal remains suggests a widespread and prolonged practice of either accidental deaths and no burial, or 'exposure' or 'sky' burials. The latter practices are found in virtually all parts of the world, under conditions of both organised and mobile societies.

The record of human remains in Southwest Turkana during the African Humid Period indicates that the high lake level stands were associated with landscapes on which human bodies were left exposed, creating a unique a rich record of the past biology and behaviour of the groups that inhabited the area at the time.

Research was carried out with permission from the Government of Kenya (NACOSTI 2009-2024). The work was funded by the European Research Council (#295907 In Africa Project, #101020478 Ngipalajem Project), and the Turkana Basin Institute. We thank the following for assistance in the cataloguing and studying of the remains: Frances Rivera, Alex Wilshaw, Federica Crivellaro, Aurelien Mounier, Jason Gellis, Laura van Holstein, Lucia Nadal & Sarah Paris. We thank Dr Kyalo Manthi, Dr Emmanuel Ndiema and Mr Justus Edung for NMK support and the Government and people of Turkana County and Nakoret and Nakurio subdistricts for their support.

References: [1] Beck, C.C., Feibel, C.S., Wright, J.D., Mortlock, R.A., 2019. Onset of the African Humid Period by 13.9 kyr BP at Kabua Gorge, Turkana Basin, Kenya. The Holocene. 29, 1011–1019. [2] Bloszies, C., Forman, S.L., Wright, D.K., 2015. Water level history for Lake Turkana, Kenya in the past 15,000years and a variable transition from the African Humid Period to Holocene aridity. Global and Planetary Change. 132, 64–76. [3] Lahr, M.M., Rivera, F., Power, R.K., Mounier, A., Copsey, B., Crivellaro, F., Edung, J.E., Fernandez, J.M.M., Kiarie, C., Lawrence, J., Leakey, A., Mbua, E., Miller, H., Muigai, A., Mukhongo, D.M., Van Baelen, A., Wood, R., Schwenninger, J.-L., Grün, R., Achyuthan, H., Wilshaw, A., Foley, R.A., 2016. Inter-group violence among early Holocene hunter-gatherers of West Turkana, Kenya. Nature. 529, 394–398.

Pecha Kucha Presentation, Session 7, Friday 13:30 – 15:00

Data quality and automatic landmarking for ~1,000 cranial CT scans from MorphoSource

Mario Modesto-Mata[1,2], Arthur Thiebaut[1], Marina Martínez de Pinillos[1,3], Ian Towle[1], Raquel Hernando[1], Kristin Krueger[4], Chi Zhang[5], Murat Maga[6], James M. Cheverud[4], Leslea J. Hlusko[1]

1 - Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Burgos, Spain · 2 - Universidad Internacional de La Rioja (UNIR), Logroño, Spain · 3 - Universidad de Burgos, Burgos, Spain · 4 - Loyola University Chicago, Chicago, USA · 5 - Texas A&M University, Dallas, USA · 6 - University of Washington, Washington, USA

In any statistical analysis there's a large investment of time, mostly unseen, dedicated to ensuring and consolidating the datasets that will be used to feed the models. In this study, we measured the distance Prosthion-Basion (PR-BA) between the real skulls and the CT models that were scanned at different slice spacing for the Southwest National Primate Research Center (SNPRC) baboon skull collection downloaded from MorphoSource (n=986). Many scans experienced unexpected problems of slice spacing identity, so we checked the automatic value when they were loaded in 3D Slicer [1], and the expected one in the header that was introduced manually. We compared the values with previously-published landmark data from the same CT models [2] and the real measurements. Our results indicate that scans for which we didn't experience problems loading their DICOM files had a high level of overlap between the real PR-BA distance and the CT-measured distance, no matter the slice spacing. Skulls for which the slice spacing was automatically calculated by the software (and not the value present in the header), the distances exhibited a high level of overlap with the real values. In the latter skulls, when the slice spacing is manually-introduced to fit the header, the CT-measured distance is significantly overestimating the real distance. Because of this mis-match, we also validated the published data to confirm that there was no error in how they calculated the distances between their landmarks.

Once we validated that the CTs are reliable for obtaining linear distances, our next step was to automatically place landmarks over the skulls. To achieve this goal for such a large sample of CT scans, we used 3D Slicer and the functions ALPACA/MALPACA [3-4] of the SlicerMorph extension [5]. We divided the sample in source/target subsamples. For the source sample, we selected 10 male and 10 female skulls based on the "Template selection" option in the software. In these samples we manually selected different landmarks to analyze prognathism and calculated a pairwise distance matrix. The target sample consisted in the remaining skulls where the landmarks were automatically placed based on the average of the source samples. The resulting pairwise distance matrices were calculated. We then randomly selected 20 male and 20 female skulls from the target samples and we manually placed the landmarks.

The comparison of landmark distances in these 40 skulls between automatic and manual landmark positioning are below 5% different. Although the automatic placement of landmarks was highly precise, a quick check of each scan is needed to confirm that the landmarks were placed accurately and the measurements can be reliably calculated. The accuracy and precision of these cranial data meet the requirements for quantitative genetic analyses, which is the next step in our research.

This research was supported with funding from the European Research Council within the European Union's Horizon Europe (ERC-2021-ADG, Tied2Teeth, project number 101054659) to Leslea J. Hlusko.

References: [1] Fedorov, A., Beichel, R., Kalpathy-Cramer, J., Finet, J., Fillion-Robin, J.-C., Pujol, S., Bauer, C., Jennings, D., Fennessy, F., Sonka, M., Buatti, J., Aylward, S., Miller, J.V., Pieper, S., Kikinis, R., 2012. 3D Slicer as an image computing platform for the Quantitative Imaging Network. Magnetic Resonance Imaging. 30, 1323–1341. [2] Joganic, J.L., Willmore, K.E., Richtsmeier, J.T., Weiss, K.M., Mahaney, M.C., Rogers, J., Cheverud, J.M., 2018. Additive genetic variation in the craniofacial skeleton of baboons (genus *Papio*) and its relationship to body and cranial size. American Journal of Physical Anthropology. 165, 269–285. [3] Porto, A., Rolfe, S., Maga, A.M., 2021. ALPACA: A fast and accurate computer vision approach for automated landmarking of three-dimensional biological structures. Methods in Ecology and Evolution. 12, 2129–2144. [4] Zhang, C., Porto, A., Rolfe, S., Kocatulum, A., Maga, A.M., 2022. Automated landmarking via multiple templates. PLOS ONE. 17, e0278035. [5] Rolfe, S., Pieper, S., Porto, A., Diamond, K., Winchester, J., Shan, S., Kirveslahti, H., Boyer, D., Summers, A., Maga, A.M., 2021. SlicerMorph: An open and extensible platform to retrieve, visualize and analyse 3D morphology. Methods in Ecology and Evolution. 12, 1816–1825.

Poster Presentation Number 78, Session 2, Friday 17:00 – 18:30

New virtual reconstruction of the fragmented KNM-OG 45500 *Homo erectus* fossil from Kenya (0.9 Ma BP)

Tommaso Mori[1,2], Costantino Buzi[3,4,6], Katerina Harvati[2,5,6]

1 - Department of Biology, University of Florence, Italy · 2 - Paleoanthropology, Institute for Archaeological Sciences, Eberhard Karls University of Tübingen, Tübingen, Germany · 3 - Catalan Institute of Human Paleoecology and Social Evolution (IPHES-CERCA), Tarragona, Spain · 4 - Department of History and History of Art, Universitat Rovira i Virgili, Tarragona, Spain · 5 - Paleoanthropology, Senckenberg Centre for Human Evolution and Palaeoenvironment, Eberhard Karls University of Tübingen, Tübingen, Germany · 6 - DFG Centre for Advanced Studies 'Words, Bones, Genes, Tools', Eberhard Karls University of Tübingen, Tübingen, Germany

KNM-OG 45500, a significant hominin fossil, comprises portions of a frontal bone, left temporal bone, and cranial vault pieces. Discovered in 2003 within the Olorgesailie Formation in Kenya, it is linked to the *Homo erectus* hypodigm. Originating from a geological context dating back approximately 900 ka BP, this fossil is described as a very small individual, likely female [1-2]. Despite its importance, its fragmented state often limits its use in quantitative comparative analyses.

In a previous study [2], we utilized virtual anthropology techniques to reconstruct the frontal bone. Our current work marks the first endeavor to align the left temporal bone with the frontal bone, seeking to analyze both elements jointly and deepen our understanding of their metric and morphometric characteristics. To achieve this alignment, we employed the digital tool alignment (DTA) from the Arothron package in R statistical software [3]. This tool facilitates semi-automatic alignments of the elements based on a comparison of landmarks taken on both bone portions against a comparative sample. The most similar individual from the comparative sample serves as a reference for aligning the two elements. A total of 13 landmarks were collected on the frontal bone and 8 on the temporal bone, amounting to 21 landmarks in total. These landmarks were also collected on a comparative sample comprising 17 fossils from different taxa and 30 modern humans.

Due to uncertainty regarding Bregma's location on KNM-OG 45500, three different alignments were conducted based on various landmark sets. The first alignment was achieved with Bregma taken on the frontal squama, the second utilized a distant Bregma position from previous reconstructions [2], and the third excluded Bregma from the set. Evaluation of the alignment results involved scaling the reference specimen used for DTA onto KNM-OG 45500. KNM-ER3733 served as the reference specimen for the first and third reconstructions, while D2700 was used for the second. All reconstructions appeared anatomically reasonable, the first and third are almost identical while the second, based on a different reference, positioned the temporal bone in a slightly wider and inferior placement. To achieve a more complete morphology the aligned left temporal bone was mirrored.

These new reconstructions promise to facilitate a more comprehensive analysis of the specimen, paving the way for future studies to delve deeper into its significance and evolutionary context. The detailed examination enabled by these reconstructions will likely yield valuable insights into hominin morphology and evolution.

We thank the following institutions and colleagues for access to fossil comparative material: Richard Potts and colleagues at the Smithsonian Institution, as well as Fredrick Manthi, Timothy Gichunge, and the members of the Department of Earth Science, National Museums of Kenya for access to the KNM-OG 45500 surface scan and CT scans of KNM-ER 3733 and KNM-ER 3883; Gen Suwa, the Authority for Research and Conservation of Cultural Heritage (ARCCH), and the National Museum of Ethiopia for providing the Daka calvarium (BOUVP- 2/66) external mesh reconstruction; Sabine Eggers for access to CT scan from the Department of Anthropology of the Naturhistorisches Museum in Vienna; Giselle Garcia and Eric Delson, American Museum of Natural History; Monica Zavattaro and Jacopo Moggi-Cecchi for access to the CT scans from the Anthropological Collection at the Museo di Storia Naturale dell' Università di Firenze; Antoine Balzeau, Martin Friess, and Dominique Grimaud-Hervé for access to the CT scans from the Muséum national d'Histoire naturelle, Paris. The *H. naledi* (DH1 & DH3 Lesedi1) scans were downloaded from the MorphoSource database, Duke University (media number: M7300-8170). We thank Marlijn Noback for providing access to scans of the modern human comparative sample. This work was funded in part by the German Research Foundation (DFG-FOR-2237) awarded to KH and by the MSCA-IF-2020 (GA n. 101025525) awarded to CB.

References: [1] Potts, R., Behrensmeyer, A.K., Deino, A., Ditchfield, P., Clark, J., 2004. Small Mid-Pleistocene Hominin Associated with East African Acheulean Technology. Science. 305, 75–78. [2] Mori, T., Profico, A., Reyes-Centeno, H., Harvati, K., 2020. Frontal bone virtual reconstruction and geometric morphometric analysis of the mid-Pleistocene hominin KNM-OG 45500 (Olorgesailie, Kenya). Journal of Anthropological Sciences. 98, 49e72. [3] Profico, A., Buzi, C., Davis, C., Melchionna, M., Veneziano, A., Raia, P., Manzi, G., 2019. A New Tool for Digital Alignment in Virtual Anthropology. The Anatomical Record. 302, 1104–1115.

Poster Presentation Number 79, Session 2, Friday 17:00 – 18:30

Femoral neck robusticity through ontogeny in modern humans and Middle Pleistocene humans from Sima de los Huesos (Atapuerca, Spain)

Julia Muñoz-Guarinos[1], Laura Rodríguez[1,2], Juan Luis Arsuaga[3,4], José Miguel Carretero[1,5], and Rebeca García-González[1]

1 - Laboratorio de Evolución Humana. Departamento de Historia, Geografía y Comunicación. Universidad de Burgos, Burgos, Spain · 2 - Área de Antropología. Universidad de León, León, Spain · 3 - Centro UCM-ISCIII de Investigación sobre la Evolución y Comportamiento Humanos, Madrid, Spain · 4 - Departamento de Paleontología, Facultad de Ciencias Geológicas, Universidad Complutense de Madrid, Ciudad Universitaria Madrid, Spain · 5 - Unidad Asociada de I+D+i al CSIC Vidrio y Materiales del Patrimonio Cultural (VIMPAC), Madrid, Spain

Numerous studies have delved into discerning activity pattern disparities across diverse human groups through analysis of the cross-sectional properties of adult femora. Throughout adulthood, bones continue to adapt to the strains they endure through remodelling. Yet, it is during ontogeny that bones exhibit heightened responsiveness to external stimuli and mechanical stress encountered prior to maturity significantly influences skeletal strength in adulthood [1]. In this sense, analysing femoral robusticity through ontogeny is essential to understand adult femoral strength in both modern and extinct humans. Most of the studies focus on the midshaft cross-section, while the femoral neck, which is highly influenced by the hip abductor and the bending from the hip joint, is less studied. Thus, our main goal is to compare the development of femoral midneck cross-sectional properties in a sample of MH and in the non-adult femoral remains from Sima de los Huesos (Atapuerca, Spain).

Sima de los Huesos (SH) Middle Pleistocene site, dated around 430 thousand years ago, has provided 90 specimens belonging to non-adult femora, representing a minimum of 14 individuals in different growth stages [2]. We have analysed six complete and 10 fragmented femora belonging to non-adult individuals from SH and 94 femora belonging to a medieval population from Burgos (aged from 2 to 30 years). As far as we know, this is the largest collection of femoral necks belonging to non-adult individuals in the human fossil record.

Cross-section slices at mid-neck were obtained through CT scans and visualized using the Mimics™ (Materialise, NV., Belgium) software. Cross-sections were then imported into ImageJ to compute the cross-sectional parameters with the MomentMacro plugin [3]. We focus on the total subperiosteal area (TA), cortical subperiosteal area (CA) and medullary cavity area (MA). The growth of CA and MA relative to TA and the growth of MA relative to CA were established using log-log MAR (Major Axis Regression) in the archaeological sample using PAST software. Then, the standardized residuals of these regressions for both, the recent and SH specimens, were calculated. For comparative purposes, MH and SH specimens were sorted into different groups according to proximal femoral metaphysis maturity stages based on morphological traits and on the state of fusion of the femoral head and the greater trochanter. Due to the characteristics of the sample, SH non-adult femora were classified into two groups. The first group encompasses femora with a clear distinction between the metaphyseal surfaces of the femoral head and greater trochanter, while the second group is composed of non-adult femora with fused proximal epiphyses. Differences between MH and SH specimens at the same maturity stage were evaluated through Kruskal-Wallis test.

Our results show that standardized residuals of CA relative to TA in SH femora are well above the mean of our archaeological sample and that those residuals obtained from the relative growth trajectory of MA relative to both TA and CA are well under the mean at the same maturity stage of proximal femoral metaphyseal surface. Moreover, significant differences exist between MH and SH specimens with unfused proximal femoral epiphyses.

At the same maturity stage, SH specimens show more robustness than MH at femoral midneck, with relatively thicker cortices and smaller medullar cavities. Our results align with previous studies carried out in SH adults and non-adults' femoral diaphysis [4-5], showing that differences between MH and SH are present during ontogeny.

We thank the Sima de los Huesos excavation team and the Laboratory of Human Evolution from the University of Burgos. This project is funded by a PhD grant co-funded by the Government of Castilla y León and the European Union -BOCYL-D-07/07/2020 nº 135 p. 23452- and Spanish Ministry of Science, Innovation and Universities project PID2021-122355NB-C31.

References: [1] Pearson, O.M., Lieberman, D.E. 2004. The aging of Wolff's "law": ontogeny and responses to mechanical loading in cortical bone. American journal of physical anthropology, 125S39, 63-99. [2] Arsuaga, J.L., Carretero, J.-M., Lorenzo, C., Gómez-Olivencia, A., Pablos, A., Rodríguez, L., García-González, R., Bonmatí, A., Quam, R.M., Pantoja-Pérez, A., Martínez, I., Aranburu, A., Gracia-Téllez, A., Poza-Rey, E., Sala, N., García, N., Alcázar de Velasco, A., Cuenca-Bescós, G., Bermúdez de Castro, J.M, Eudald, C., 2015. Postcranial morphology of the Middle Pleistocene humans from Sima de los Huesos, Spain. Proceedings of the National Academy of Sciences. 112, 11524-11529. [3] Ruff, C.B., 2006. Moment macro for NIH Image and Image J. Available at http://www.hopkinsmedicine.org/FAE/mmacro.htm. [4] Rodríguez, L., Carretero, J.M., García-González, R., Arsuaga, J.L., 2018. Cross-sectional properties of the lower limb long bones in the Middle Pleistocene Sima de los Huesos sample (Sierra de Atapuerca, Spain). Journal of Human Evolution/Journal of Human Evolution. 117, 1–12.
[5] García-González, R., Rodríguez, L., Carretero, J. M. et al., 2016. The ontogeny of femoral strength in Middle Pleistocene humans from Sima de los Huesos (Atapuerca, Spain). Proceedings of the European Society for the Study of Human Evolution. 5:103.

Poster Presentation Number 80, Session 2, Friday 17:00 – 18:30

New palaeoproteomics evidence at Grotta Guattari (Italy)

Dorothea Mylopotamitaki[1,2], Sara Silvestrini[3], Gaudry Troché[4], Angelica Ferracci[5], Maurizio Gatta[5], Mario F. Rolfo[5], Matteo Romandini[3], Jesper V. Olsen[6], Jean-Jacques Hublin[1,2], Stefano Benazzi[2,3], Frido Welker[4]

1 - Chaire de Paléoanthropologie, CIRB, Collège de France, Université PSL, CNRS, INSERM, Paris, France · 2 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 3 - Department of Cultural Heritage, University of Bologna, , Italy · 4 - Globe Institute, University of Copenhagen, Copenhagen, Denmark · 5 - Department of History, Culture, and Society, University of Rome Tor Vergata, Rome, Italy · 6 - Novo Nordisk Foundation Center for Protein Research, University of Copenhagen, Copenhagen, Denmark

Palaeoproteomic analysis of Pleistocene skeletal assemblages has demonstrated its capacity to assign taxonomic identities to vast numbers of otherwise unidentifiable bone fragments, especially for well-preserved faunal assemblages. After the initial applications of ZooMS [1], the recent introduction of SPIN [2] promises to provide similar capabilities in more highly-degraded contexts. Such challenging locations include Mediterranean environments, such as those encountered at the well-known Neanderthal site of Grotta Guattari (Italy).

Subsequent studies have revealed the skull modifications, previously believed to symbolize Neandertal spirituality and mortuary practices, were actually due to the gnawing activity of hyenas [3]. A new excavation of the innermost and untouched cave deposits, called "Antro del Laghetto" (which is the Italian "Chamber of the Small Lake"), was conducted in October 2019 and resulted in an outstanding amount of mammal bones, about 40 of which were attributable to Neanderthals, including new cranial remains [4]. Preliminary taphonomic results and the collected stratigraphic evidence strongly indicate that the accumulation of the large mammal bones was the work of cave hyenas and that human frequentation was sporadic or absent. This study provided evidence of open and arid environments. The faunal assemblage and the pollen from Grotta Guattari revealed that the local conditions were less severe than previously thought based on regional paleoclimatic records, likely due to the mitigating effect of the Tyrrhenian Sea.

Our study aims to provide an updated faunal composition of the cavity through SPIN [2] taxonomic identifications on unidentifiable skeletal remains (n=489), compare it with the fossil record from previous studies, and discuss its palaeoenvironmental implications and preliminary taphonomic observations. However, due to the poor preservation of the recovered bone material, the automated SPIN extraction protocol [2] failed to retrieve reliable taxonomic identifications. Notably, the analysis of proteome coverage revealed variations in degradation linked to an aquatic environment, alongside significant differences in the number of specimens retrieved from each excavation square.

To overcome this limitation, we followed a recent protocol that suggests the simultaneous ammonium bicarbonate (ABC) and acid extraction as the most suitable approach for highly degraded skeletal remains [5]. We recovered taxonomic identifications for 29% of 490 skeletal remains. Even though we could not identify all the recovered skeletal remains from Grotta Guattari, we identified various mammalian taxa in agreement with previous studies [3-4], including cervids and bovids. Additionally, we identified 4 hominin bone fragments. The identification of hominin remains will allow us to perform additional types of analyses on the selected specimens and excavation layers of interest, and potentially gain further information about hominin occupation and behaviour at Grotta Guattari.

Finally, this study showcased the effect of environmental conditions on the proteome of archaeological skeletal remains providing optimal proteomic extraction conditions that can yield high-resolution mass spectra for taxonomic identification of morphologically unidentified bone fragments.

This project has received funding from the European Union's Horizon 2020 research, the innovation programme under the Marie Sklodowska-Curie (grant agreement No. 861389- PUSHH), the Max Planck Society and the Collège de France. This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 948365).

References: [1] Buckley, M., Collins, M., Thomas-Oates, J., Wilson, J.C., 2009. Species identification by analysis of bone collagen using matrix-assisted laser desorption/ionisation time-of-flight mass spectrometry. Rapid Communications in Mass Spectrometry. 23, 3843–3854. [2] Rüther, P.L., Husic, I.M., Bangsgaard, P., Gregersen, K.M., Pantmann, P., Carvalho, M., Godinho, R.M., Friedl, L., Cascalheira, J., Taurozzi, A.J., Jørkov, M.L.S., Benedetti, M.M., Haws, J., Bicho, N., Welker, F., Cappellini, E., Olsen, J.V., 2022. SPIN enables high throughput species identification of archaeological bone by proteomics. Nature Communications. 13. 2458. [3] Petronio, C., Rolfo, M., Di Mario, F., Ceruleo, P., Ferracci, A., Fiore, I., Gatta, M., Salari, L., 2022. Preliminary report on the new faunal remains from Grotta Guattari (Late Pleistocene, San Felice Circeo, Latium). BORNH Bulletin of Regional Natural History. 1, 1-10. [4] Rolfo, M.F., Bini, M., Di Mario, F., Ferracci, A., Giaccio, B., Hsun-Ming, H., Isola, I., Sadori, L., Shen, C.-C., Vignola, C., Zanchetta, G., 2023. Neanderthal bones collected by hyena at Grotta Guattari, central Italy, 66–65 ka: U/Th chronology and paleoenvironmental setting. Quaternary Science Reviews. 311, 108132. [5] Mylopotamitaki, D., Harking, F.S., Taurozzi, A.J., Fagernäs, Z., Godinho, R.M., Smith, G.M., Weiss, M., Schüler, T., McPherron, S.P., Meller, H., Cascalheira, J., Bicho, N., Olsen, J.V., Hublin, J.-J., Welker, F., 2023. Comparing extraction method efficiency for high-throughput palaeoproteomic bone species identification. Scientific Reports. 13, 18345.

Poster Presentation Number 81, Session 2, Friday 17:00 – 18:30

Tracking Late Pleistocene human occupations in the northern piedmonts of the Tian Shan, Kazakhstan: Insights from the multi-layered Tikenekti-2 and Yntymaq sites

Abay Namen[1], Aristeidis Varis[2], Emily Coco[3], Zhaken Taimagambetov[4], Radu Iovita[5]

1 - Department of Sociology and Anthropology, Nazarbayev University, Kazakhstan · 2 - Palaeoanthropology working group, University of Tübingen, Germany · 3 - Palaeoarchaeology laboratory, Yale University, USA · 4 - National Museum of the Republic of Kazakhstan · 5 - Center for the study of Human origins, New York University, USA

The northern piedmonts of the Tian Shan mountains have recently become a region of interest to investigate the Late Pleistocene human dispersals and adaptations to climatic shifts [1; 2]. This is largely due to its geomorphological settings represented by the thick deposits of wind-blown aeolian sediments that preserve traces of human occupation. Furthermore, these geographic features may have acted as refugia for the Palaeolithic hominins during climatic instability of the Last Glacial Maximum [2-4] . In addition to Maibulaq, whose chronology and paleoenvironmental context are well-known [1], a number of stratified Palaeolithic sites such as Rahat, Uzynagash 1-9, and Saryzhazyq 1-2 have been discovered and will contribute to the discussion of the Upper Palaeolithic human occupations in the intramontane valleys of the region [4]. However, despite the potential to yield new sites, the region remains relatively understudied and most of the current sites are undated. Here, we present two new stratified sites resulting from surveys in the foothills of the Ili Alatau range (northern Tian Shan), Tikenekti-2 and Yntymaq [5]. We provide preliminary data on the lithic assemblage, stratigraphic, and chronological state of the sites. Based on preliminary dating of the upper cultural layer and stratigraphy, Tikenekti-2 was likely occupied during the transitional period from the Late Pleistocene to Early Holocene (10-13 ka BP). The techno-typological diversity of the surface finds and in situ lithics from a lower layer eroding out down the hill could potentially indicate the presence of older cultural layers. At Yntymaq, a total of five layers span the Late Pleistocene to the late Neolithic (5800 BP). Radiocarbon dates for the lower layers are currently pending

The current study was performed within the PALAEOSILKROAD project, and all field research was conducted under license No. 15008746 (12.05.2015) of the National Museum of the Republic of Kazakhstan based on the collaboration protocol between the Eberhard-Karls University of Tübingen and the National Museum. This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement n° 714842; PALAEOSILKROAD project).

References: [1] Fitzsimmons, K.E., Iovita, R., Sprafke, T., Glantz, M., Talamo, S., Horton, K., Beeton, T., Alipova, S., Bekseitov, G., Ospanov, Y., Deom, J.-M., Sala, R., Taimagambetov, Z., 2017. A chronological framework connecting the early Upper Palaeolithic across the Central Asian piedmont. Journal of Human Evolution 113, 107–126. [2] Iovita, R., Varis, A., Namen, A., Cuthbertson, P., Taimagambetov, Z., Miller, C.E., 2020. In search of a Paleolithic Silk Road in Kazakhstan. Quaternary International 559, 119–132. [3] Beeton, T.A., Glantz, M.M., Trainer, A.K., Temirbekov, S.S., Reich, R.M., 2014. The fundamental hominin niche in late Pleistocene Central Asia: a preliminary refugium model. Journal of Biogeography 41, 95–110. [4] Ozherelyev, D.V., Lev, S.Yu., Stolpnikova, E.M., 2023. Problemy verkhnego paleolita predgoriĭ severnogo Tiăn′-Shania̋: noveĭshie otkrytiia̋ i dal′neĭshie perspektivy [Problems of the Upper Paleolithic in the foothills of the Northern Tien Shan: latest discoveries and perspectives]. Vestnik Moskovskogo Universiteta. Serija 23. Antropologija 118–128. [5] Namen, A., Taimagambetov, Z., Varis, A., Coco., E., Coto-Sarmiento, M., Baigunakov, D., Zhumatayev, R., Iovita, R., 2024. New stratified Stone Age sites at Tikenekti-2 and Yntymaq in the Ile Alatau piedmonts (southeastern Kazakhstan). Kazakhstan Archeology 2 (24), 160-175.

Poster Presentation Number 82, Session 2, Friday 17:00 – 18:30

Facial size and brain both shape the endocranial evolution of fossil *Homo sapiens*

Sélim Natahi[1,2], Simon Neubauer[3], Zewdi J. Tsegai[4], Jean-Jacques Hublin[1,5], Philipp Gunz[2]

1 - Chaire de Paléoanthropologie, CIRB, Collège de France, Université PSL, CNRS, INSERM, Paris, France · 2 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 3 - Institute of Anatomy and Cell Biology, Faculty of Medicine, Johannes Kepler University, Linz, Austria · 4 - Department of Organismal Biology and Anatomy, University of Chicago, Chicago, USA · 5 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

It has been proposed that brain reorganization changed within the *Homo sapiens* lineage, based on changes of endocranial shape between 300,000 and 100,000 years ago [1]. These changes include an increase in globularity via bulging of parietals and protrusion of cerebellar areas. Inferring brain organization from endocranial shape is challenging, however, as the braincase is shaped by multiple factors during ontogeny, including the growth and development of the brain [2] and face [3]. Endocranial globularity and small and retracted faces are characteristic of late Pleistocene and Holocene *Homo sapiens*. As the viscerocranium and neurocranium grow and function as an integrated whole, it has been proposed that small and retracted faces are the primary drivers of the globular braincase shape [4]. Our study tests whether evolutionary changes in absolute and relative facial sizes contribute to the emergence of globularity in fossil *Homo sapiens*. To test this hypothesis, we analyzed fossil and recent *Homo sapiens*, as well as Neanderthals based on computed tomographic (CT) scans. We employed geometric morphometrics to quantify endocranial shape, and absolute and relative facial sizes in 88 individuals. We generated endocranial shape variables from a dense set of 935 (semi)landmarks, measured facial size using the centroid size from 52 landmarks, and computed relative facial size as the ratio of the cube root of endocranial volume to absolute facial size. We assessed the effects of facial size on endocranial shape using linear regression models applied to both pooled and recent human samples. Additionally, effects of facial shape on endocranial shape were explored via two-block partial least-squares analyses.

Our results show a decrease in absolute and relative facial sizes of fossil *Homo sapiens* between 300,000 and 100,000 years, with Upper Paleolithic humans displaying values within the range of recent humans. Among recent humans, the impact of facial size on endocranial shape is limited.

However, our models, when built using a pooled modern and fossil sample, suggest that small facial sizes correlate with increased basicranial flexion and protrusion of cerebellar and parietal areas, along with overall endocranial globularity. This suggests that absolute and relative facial sizes have significant effects on the endocranial shapes of fossil humans, contributing to the temporal globularity gradient [1]. However, facial size does not account for the endocranial shape of the Irhoud 1 cranium. This early *Homo sapiens* fossil differs in parietal shape from the model prediction. Discrepancies between model predictions and actual shapes, particularly in parietal and cerebellar areas, were also noted in geologically younger individuals like Qafzeh 6 and 9. Covariation analyses showed no clear relationship between facial and endocranial shapes in both recent humans and pooled samples. Our study provides insights into the endocranial shape variations observed throughout the evolution of *Homo sapiens* and suggests that while differences in facial size contribute to the observed endocranial shape differences between 300,000 and 100,000 years, they do not fully explain the bulging of the parietal and the expansion of the cerebellar area associated with globularity. Our results suggest that both changes in facial size and changes in brain organization played important roles in shaping the endocranium during the evolution of *Homo sapiens*.

References: [1] Neubauer, S., Hublin, J.-J., Gunz, P., 2018. The evolution of modern human brain shape. Science Advances. 4, eaao5961. [2] Neubauer, S., Gunz, P., Hublin, J.-J., 2010. Endocranial shape changes during growth in chimpanzees and humans: a morphometric analysis of unique and shared aspects. Journal of Human Evolution. 59, 555-566. [3] Zollikofer, C.P., Bienvenu, T., Ponce de León, M.S., 2017. Effects of cranial integration on hominid endocranial shape. Journal of Anatomy. 230, 85-105. [4] Zollikofer, C.P., Bienvenu, T., Beyene, Y., Suwa, G., Asfaw, B., White, T.D., Ponce de León, M.S., 2022. Endocranial ontogeny and evolution in early Homo sapiens: The evidence from Herto, Ethiopia. Proceedings of the National Academy of Sciences. 119, e2123553119.

Podium Presentation, Session 5, Friday 8:30 – 10:10

EQuaTe: a European Quaternary Timescale for the expansion and evolution of humans

Ellie F. Nelson[1], Pierre Antoine[2], Nick Ashton[3], Debra Colarossi[4], Robert Davis[3], Thomas Daniel[5], Gaudenz Deplazes[6], Marc Dickinson[1], Geoff A.T. Duller[4], Lukas Gegg[7], Michael Hein[8], Michal Horsák[9], Olaf Jöris[10,11], Lucie Juřičková[12], Thijs van Kolfschoten[13], Simon Lewis[14], Nicole Limondin-Lozouet[2], Lutz Maul[15], Richard W. McIntosh[16], Tom Meijer[17], Stefan Meng[18], Simon Parfitt[19], Zóltan Püspöki[20], Richard C. Preece[21], Samantha Presslee[1], Helen M. Roberts[4], Bálint Szappanos[22], Marcin Szymanek[23], Brigitte Urban[8], Nigel Thew[24], Charles Turner[25], Joachim Wedel[26], Lucy Wheeler[1], Frank Wesselingh[17], Dustin White[1], Kirsty E.H. Penkman[1]

1 - University of York · 2 - CNRS Ile-de-France Meudon · 3 - British Museum · 4 - Aberystwyth University · 5 - Friedrich Schiller University of Jena · 6 - National Cooperative for the Disposal of Radioactive Waste (Nagra) · 7 - Universität Freiburg · 8 - Leuphana University of Lüneburg · 9 - Masaryk University · 10 - MONREPOS Archaeological Research Centre and Museum for Human Behavioural Evolution · 11 - Johannes Gutenberg University Mainz · 12 - Charles University · 13 - Leiden University · 14 - Queen Mary University of London · 15 - Senckenberg Research Station of Quaternary Palaeontology · 16 -University of Debrecen · 17- Naturalis Biodiversity Center · 18 - University of Greifswald · 19 - University College London · 20 - Mining and Geological Survey of Hungary · 21 - University Museum of Zoology Cambridge · 22 - Supervisory Authority for Regulatory Affairs · 23 - University of Warsaw · 24 - Independent, Rue Paul Bouvier 2, 2000 Neuchâtel, Switzerland · 25 - University of Cambridge · 26 - HLNUG

The Quaternary record of Europe has provided rich sedimentological, palaeontological, and archaeological archives suitable to support a detailed history of how climatic and environmental changes influenced and shaped our human story. However, most terrestrial sequences are discontinuous and fragmentary, providing only glimpses or snapshots of any time-related processes. Without a robust chronology applicable to connecting these disjointed events, our understanding of when early humans may have dispersed into Europe and adapted to different environments, and the effects on their cognitive developments and cultural identities, remains limited. Only a secure dating framework will enable us to tie key archaeological sites together, putting researchers in a better position to answer fundamental questions on the evolution of our species.

To build such a framework, the ERC-funded EQuaTe project builds on discoveries that fossil biominerals provide a coherent time signal within their crystals. The opercula of bithyniid snails are commonly occurring fossils in Quaternary sites. They offer a closed-system repository for amino acids (AA) and a stable thermoluminescence (TL) signal. This enables them to be used to build aminostratigraphies using the intra-crystalline protein decomposition method (IcPD) of AA dating, which will be complemented with numerical ages from TL dating to act as tie-points for the chronology. This will open new archives for dating and provide a secure dating framework, which palynological or biostratigraphic models can be tested against.

Our selected study region ranges from the British Isles to the East European Plain, bounded to the south by the Pyrenees, Alps, Caucasus, and the Urals to the east, covering both the potential source regions for populating the northern half of Europe and the periphery of hominin expansions.

Here IcPD has been applied to hundreds of archaeological and palaeontological sites to produce regional aminostratigraphies for Britain, the Seine and Somme river terraces (France), the Netherlands, Czechia, the Pannonian Basin (Hungary), Thuringia, Rhineland and Northern German Plain (Germany), the Swiss Plateau, and Poland. They are compared with other evidence of age to demonstrate how these regional datasets can help to constrain the age of important Palaeolithic sites such as Happisburgh 3, Carpentier, Předmostí, Mauer, and Bilzingsleben. Finally, the temperature differences between the regions are explored to understand how the regional aminostratigraphies can be integrated to build a comprehensive pan-European chronology.

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 865222).

Poster Presentation Number 83, Session 2, Friday 17:00 – 18:30

Exploitation of animals by human foragers during the Last Glacial Maximum: New results of spatial and zooarchaeological analyses at Korman' 9, Ukraine

Philip R. Nigst[1,2], Larissa Kulakovska[3], Vitaly I. Usyk[3,4], Olesia Kononenko[3], Paul Haesaerts[5], Stéphane Pirson[6,7], Pía Spry-Marqués[8], Lilia Popova[9], Yana Popiuk[10], William Chase Murphree[11], Freddy Damblon[5], Marjolein D. Bosch[2,12,13]

1 - Department of Prehistoric and Historical Archaeology, University of Vienna, Vienna, Austria · 2 - Human Evolution and Archaeological Sciences (HEAS), University of Vienna, Vienna, Austria · 3 - Institute of Archaeology, National Academy of Sciences of Ukraine, Kyiv, Ukraine · 4 - Institute of Archaeology of the Czech Academy of Sciences, Brno, Czech Republic · 5 - Royal Belgian Institute of Natural Sciences, Brussels, Belgium · 6 - Agence Wallonne du Patrimoine (AWaP), Service Public de Wallonie, Direction d'appui Scientifique et Technique, Jambes, Belgium · 7 - European Archaeometry Centre and Department of Geology, University of Liège, Belgium · 8 - Independent scholar, Madrid, Spain · 9 - I. I. Schmalhausen Institute of Zoology, Department of Evolutionary Morphology, National Academy of Science of Ukraine, Kyiv, Ukraine · 10 - Yuriy Fed'kovych Chernivtsi National University, Chernivtsi, Ukraine · 11 - Interdisciplinary Center for Archaeology and the Evolution of Human Behaviour (ICArEHB), University of Algarve, Faro, Portugal · 12 - Research group Prehistoric Identities, Department of Prehistory and West Asia/North African Archaeology, Austrian Archaeological Institute, Austrian Academy of Sciences, Vienna, Austria · 13 - Turkana Basin Institute, Turkana, Kenya & Turkana Basin Institute, Stony Brook University, Stony Brook, USA

The Last Glacial Maximum (LGM) between 26,500 and 20,000 years ago is generally thought to have witnessed a European-wide population decline, and is characterized by a scarcity of sites in some regions. One such site in the SW Eastern European Plain is Korman' 9, located in the Dniester valley, Ukraine, and discovered during survey in 2012 and excavated in 2013 [1]. Five Archaeological Layers (AL) are embedded in a ~4m deep loess-palaeolsol sequence covering in part the LGM. AL I and II are radiocarbon-dated on charcoal to ~21.9 ka cal BP and ~22.3 ka cal BP, respectively. The main AL I comprises rich lithic and faunal assemblages attributed to the Epigravettian including organic technology and personal ornaments. Two combustion features have been documented within this AL.

In this poster presentation, we report results of new spatial and zooarchaeological analyses focusing on exploitation of animals and evidence of combustion activity, including spatial distribution of the faunal remains per species, carnivore and human modifications, bone density-mediated attrition, degree of burning among faunal specimens and lithic artefacts as well as an evaluation of spatial patterns among the burned materials. Our results indicate that Epigravettian hunter-gatherers were the main accumulator of the faunal assemblage, whereas carnivores had only secondary access. All recovered taxa show traces of human exploitation. Horse, reindeer and hare were exploited for dietary purposes shown by evidence for skinning, dismembering and filleting. The spatial distributions of burned and unburned remains show no substantial difference and no specific clustering around the two combustion features. Further, there is evidence for on-site working of reindeer antler and a needle fragment attests of bone tool technology. Fox teeth, freshwater and fossil shells were used as beads for personal ornamentation. Thus, in addition to dietary exploitation, animal remains formed a common and diverse part of socio-economic behaviour and were well-incorporated in hunter-gatherer technological and symbolic expression during the LGM at Korman' 9.

The fieldwork and analysis were funded by the following grants awarded to PRN: EC FP7 Marie Curie Career Integration Grant no. 322261 (NEMO-ADAP project), Leakey Foundation general grant (spring 2012 granting cycle), several D.M. McDonald Grants and Awards Fund grants, Isaac Newton Trust Small Grant, Isaac Newton Trust Matching Funding Grant, British Academy/Leverhulme Trust Small Grant, and the Max-Planck-Society. PRN is currently supported by the University of Vienna. MDB is supported by a Seal of Excellence Fellowship of the Austrian Academy of Sciences (TechnoBeads project, grant no. 101061287). VIU is supported by a Researchers at Risk Fellowship of the Czech Academy of Sciences.

References: [1] Kulakovska, L., Kononenko, O., Haesaerts, P., Pirson, S., Spry-Marqués, P., Bosch, M.D., Popova, L., Popiuk, Y., Damblon, F., Usik, V., Nigst, P.R., 2021. The new Upper Palaeolithic site Korman' 9 in the Middle Dniester valley (Ukraine): Human occupation during the Last Glacial Maximum. Quaternary International. 587–588, 230–250.

Poster Presentation Number 84, Session 2, Friday 17:00 – 18:30

Facial morphologies of Middle Pleistocene Europe: Morphological mosaicism and the evolution of Homo neanderthalensis

Siri Olsen[1,2], Suzanna White[3]

1 - School of Biological and Behavioural Sciences, Queen Mary University of London, London, United Kingdom · 2 – Department of Anthropology, University College London, London, United Kingdom · 3 – School of Biological Sciences, University of Reading, Reading, United Kingdom

Hominin evolution during the Middle Pleistocene is a matter of intense scientific debate. Important phylogenetic and taxonomic uncertainties remain, not least due to conflicting results of phylogenetic analyses when methodologies or morphological focus differ. Geography has been proposed to play a key role in Middle Pleistocene hominin diversity, with a potential European group ancestral to Neanderthals (Homo neanderthalensis) and a potential African group ancestral to Homo sapiens, but the evidence is equivocal. In this study, we explore the connection between geography and facial morphology in Middle Pleistocene hominins with particular emphasis on the potential Neanderthal affinities of the European group. Furthermore, to assess the impact of methodology on the results, we employ a multi-method approach. Morphological affinities in facial shape are examined firstly by using geometric morphometrics on a dataset of 38 fossil and 20 recent hominin skulls divided into five groups (European and non-European Middle Pleistocene hominins, Homo sapiens, Homo neanderthalensis, and Homo erectus/ergaster) and then by an analysis of discrete facial traits observed on the same sample. Two main conclusions emerge from these analyses. Firstly, methodological approach has a marked impact on the recorded pattern of morphological affinity, which may explain result discrepancies among previous studies. Secondly, this disparity may be caused by morphological mosaicism and polytypism in the facial region of Middle Pleistocene hominins. Intra-European and intercontinental variation is approximately equal, highlighting the complexity and multiplicity of Middle Pleistocene hominin facial morphology. Results provide slight support for a closer connection between European Middle Pleistocene hominins and Neanderthals, but not every European Middle Pleistocene hominin examined conforms to this pattern, raising questions about the number of hominin lineages in Europe during the Middle Pleistocene. We consequently argue that greater emphasis needs to be placed on clarifying the broader evolutionary processes guiding hominin evolution during this period.

The authors wish to thank Rachel Ives and the Trustees of the Natural History Museum, London, and Douglas Boyer and the Evolutionary Anthropology Department at Duke University, Durham, for kind assistance with loan of data scans, as well as lecturers and research assistants at University College London's Department of Anthropology and Institute of Archaeology for informative teaching, intellectually stimulating discussions, and personal encouragement: Aida Gómez-Robles, Mark Dyble, Ruth Mace, James Steele, Andrew Garrard, Ceri Shipton, Megan Arnot, and Shruti Kamath. The authors would like to acknowledge the ethical issues surrounding the use of anthropological collections such as the Terry Collection.

Poster Presentation Number 85, Session 2, Friday 17:00 – 18:30

A new distal hallucal phalanx from the Neandertal holotype site in the Neander Valley (Germany)

Adrián Pablos[1,2,3], Ana Pantoja-Pérez[2], Ralf W. Schmitz[4], Nohemi Sala[2,5]

1 - Departamento de Geodinámica, Estratigrafía y Paleontología, Facultad de Ciencias Geológicas, Universidad Complutense de Madrid, Spain · 2 - Centro Nacional de Investigación sobre la Evolución Humana-CENIEH, Burgos, Spain · 3 - Departamento de Prehistoria y Arqueología, Universidad de Sevilla, Sevilla, Spain · 4 - LVR-LandesMuseum Bonn, Department of Prehistory, Bonn, Germany · 5 - Centro Mixto UCM-ISCIII de Evolución y Comportamiento Humanos, Madrid, Spain

In the early and mid-19th century, a few discoveries of ancient human remains in Europe led to the birth of paleoanthropology or prehistory. One of these sites (Kleine Feldhofer Grotte, Neander Valley, Germany) yielded several human remains belonging to an incomplete skeleton that was identified as the holotype of *Homo neanderthalensis* [1]. Almost 150 years after the initial discovery of this Neandertal individual in 1856, new excavations and research of the old material from the site have been undertaken and new human remains have been identified. Of these new remains, three directly fit on the Neandertal holotype, and two different individuals have been identified with a direct dating chronology of around of 42 ka cal BP; an adult male (Neandertal 1-holotype) and a gracile female individual (Neandertal 2) [2].

Soon after the 1997 and 2000 excavations, two foot bone fragments were identified: the dorsal portion of a lateral cuneiform – NN22 and a fragment of the calcaneal tuberosity – NN38 [3]. They do not duplicate any of the elements found in 1856 and could represent elements of Neandertal 1. The cuneiform is metrically and morphologically consistent with the range of variation of those of other Neandertals [3], but the dimensions of Neandertal tarsals are similar to those of recent modern humans [4]. The fragmentary nature of the calcaneal fragment precludes any taxonomic assignment. In a recent review of the material recovered during the contemporary excavations, a left human distal hallucal phalanx corresponding to an adult individual was identified among the faunal remains from the Kleine Feldhofer Grotte.

Fossil foot bones associated with the genus *Homo* are extremely rare before the existence of Neanderthals and *Homo sapiens*. In this work, we provide a complete metric and morphological study of this foot phalanx within a global comparative framework in relation to other Pleistocene fossils and recent human samples. We include Neandertals, Middle Paleolithic Modern Humans (MPMH), Upper Paleolithic Modern Humans (UP) and several recent modern human samples as comparative samples for the study of the Felhofer foot phalanx. The age at death for this specimen is that of an adult, based on its fully fused proximal epiphysis. The bone is compressed in its dorsoplantar (DP) dimension, and the proximal articular facet is slightly bi-concave. The distal tuberosity has a slight lateral tilt.

The metrical variables of this hallucal phalanx fit well with the ranges of variation in morphology and dimensions of those of Neandertals throughout the world fossil record. This is particularly relevant for the medio-lateral widths, which in Neandertals and the Feldhofer phalanx are wider than those of recent and fossil *Homo sapiens*. This fact confirms the Neandertal nature of this fossil. Despite the scarcity of Neandertal distal hallucal phalanges, the Feldhofer phalanx groups better with those identified as male. If all of this is confirmed, this phalanx could probably belong to the holotype of *Homo neanderthalensis*.

We would like to thank the excavation and research team at the Kleine Feldhofer Grotte for providing new insights into the context of human evolution. We are indebted to many people who provided access to some important skeletal collections. Part of this research was supported by the Spanish project PID2021-122355NB-C31 funded by MCIN/AEI/10.13039/501100011033/ FEDER, UE. Part of this research has also been funded by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (Grant agreement No. 949330). A. Pablos was funded by a research grant from Junta de Andalucía, Spain (EMERGIA20_00403). N. Sala has received funding from the Ministerio de Ciencia, Innovación y Universidades under the Ramón y Cajal program (RYC2020-029656-I) funded by MCIN/AEI /10.13039/501100011033 and El FSE invierte en tu futuro.

References: [1] King, W., 1864. The reputed fossil man of Neanderthal. Quarterly Review of Science 1, 88-97. [2] Schmitz, R.W., Serre, D., Bonani, G., Feine, S., Hillgruber, F., Krainitzki, H., Pääbo, S., Smith, F.H., 2002. The Neandertal type site revisited: Interdisciplinary investigations of skeletal remains from the Neander Valley, Germany. Proceedings of the National Academy of Sciences of the United States of America. 99, 13342–13347. [3] Smith, F.H., Ostendorf Smith, M., Schmitz, R.W., 2006. Human skeletal remains from the 1997 and 2000 excavations of cave deposits derived from Kleine Feldhofer Grotte in the Neander Valley, Germany. In: Schmitz, R.W. (Ed.), Neanderthal 1856-2006. Verlag Philipp von Zabern, pp. 187–246. [4] Trinkaus, E., 1975. A functional analysis of the Neandertal foot, Faculty of the Graduate school of Arts and Sciences. University of Pennsylvania, Pennsylvania, p. 533. [5] Pablos, A., Arsuaga, J.L., 2024. Metatarsals and foot phalanges from the Sima de los Huesos Middle Pleistocene site (Atapuerca, Burgos, Spain). The Anatomical Record. 307, 2665–2707.

Poster Presentation Number 86, Session 2, Friday 17:00 – 18:30

Controlled experiments to explore decision-making processes in raw material selection and use during the Early Acheulian at Melka Wakena, Ethiopia

Eduardo Paixão[1,2,3], Tegenu Gossa[3], Walter Gneisinger[2], João Marreiros[1,2,4], Sören Tholen[5], Ivan Calandra[2,6], Erella Hovers[3,7]

1 - ICArEHB – Interdisciplinary Center for Archaeology and Evolution of Human Behaviour, University of Algarve, Portugal · 2 - Laboratory for Traceology and Controlled Experiments (TraCEr), MONREPOS – Archaeological Research Centre and Museum for Human Behavioural Evolution, LEIZA, Germany · 3 - Department of Prehistory, Institute of Archaeology, Hebrew University of Jerusalem, Israel · 4 - Institute of Ancient Studies, Department of Prehistoric and Protohistoric Archaeology, Johannes Gutenberg University, Germany · 5 - Tectonics and Structural Geology Working Group, Institute of Geosciences, Johannes Gutenberg University, Germany · 6 - Imaging Platform At LEIZA (IMPALA), LEIZA, Germany · 7 - Institute of Human Origins, Arizona State University, USA

Changes in early human behaviour are underlain by decision-making processes, often reflected in the archaeological record in the form of technological and raw material variability. The selection and use of different raw materials involves decisions that should take into consideration multiple factors such as suitability to produce and design tools, but also their efficiency and durability in performing a given task. Hence, characterizing the physical properties of various lithic raw materials is fundamental for exploring changes in human interactions with the natural environment through time and space and for understanding humans' technological behaviour. Within Acheulean assemblages, it is often possible to observe a variability of lithic raw materials, including in percussive tools. However, the link between that variability and tool function is still understudied.

Located on the Ethiopian highlands, the recently discovered site-complex of Melka Wakena, provides an opportunity for such research, as patterns of raw material selection have been detected in preliminary technological and typological studies of the stone tool assemblage [1-2]. In this talk, we present a characterization of raw materials and an experimental protocol for testing raw materials' performance for the effects of percussive actions. We aim to infer the decision-making criteria involved in the selection and use of various raw materials as percussive tools by the early Acheulian tool makers at the Melka Wakena site-complex.

In this study, we present a laboratory-controlled mechanical set-up for percussive experiments and a combination of multi-scale analyses, including 3D scanning, microscopy, CT-scanning, and Leeb rebound hardness tests. Our results provide qualitative and quantitative data, to access and characterize the effect of percussive actions in different raw materials present in our case study. Based on our data, we advocate that the raw material selection observed in the archaeological case study may reflect a recognition by early hominins. This likely shows that specific raw materials, even when similar to the naked eye, had particular physical properties that could be intentionally 'tailored' to design specific tools and to carry particular activities on different materials.

Our study aims to serve as a quantitative approach for the development of further experiments to test key decision-making processes of early Pleistocene hominins in their interaction with the available resources.

This study was supported by the Fritz Thyssen Foundation under (grant 10.21.1.07AA), the Leibniz-Zentrum für Archäologie, the Hebrew University of Jerusalem, The interdisciplinary Center for Archaeology and Evolution of Human Behaviour (ICArEHB), and by the Portuguese Foundation for Science and Technology (FCT) under the CEEC project "EARLYDECISIONS - Deciphering early hominin decision-making behaviour: High-resolution analysis of percussive stone tools from the African Acheulian"(ref: 2022.07007.CEECIND). We thank the Ethiopian Heritage Authority (EHA) for permission to work on this material and are grateful to Mr. Getahun Tekle and Mr. Sahlesellasie Melaku (EHA curators) for their assistance in the field and the laboratory. We are grateful to the people of Aluba village for their hospitality and help in the field. We specifically thank Mr. Dawud Nure Dawwe and Mr. Abdulkadir Bariso Dube for their help in the field.

References: [1] Gossa, T., Hovers, E., 2022. Continuity and change in lithic techno-economy of the early Acheulian on the Ethiopian highland: A case study from locality MW2; the Melka Wakena site-complex. PLOS ONE. 17, e0277029. [2] Hovers, E., Gossa, T., Asrat, A., Niespolo, E.M., Resom, A., Renne, P.R., Ekshtain, R., Herzlinger, G., Ketema, N., Martínez-Navarro, B., 2021. The expansion of the Acheulian to the Southeastern Ethiopian Highlands: Insights from the new early Pleistocene site-complex of Melka Wakena. Quaternary Science Reviews. 253, 106763.

Poster Presentation Number 87, Session 2, Friday 17:00 – 18:30

The Neanderthal cervical spine anatomy and its respiratory implications

Carlos A. Palancar[1], Benoit Beyer[2], Markus Bastir[1]

1 - Paleoanthropology Group, Department of Paleobiology, National Museum of Natural Sciences, CSIC, Madrid, Spain · 2 - Université Libre de Bruxelles, Laboratory of Anatomy, Biomechanics and Organogenesis. Brussels, Belgium

Since the exhaustive work of Gómez-Olivencia et al. [1] and even before [2], the cervical spine of Neanderthals has been seen as more stable and less lordotic than modern humans'. However, recent work [3] suggested that this difference could not be such. In order to test whether there is evidence for a different curvature between Neanderthals and modern humans at this level of the spine, we analyze via 3D geometric morphometrics a total of 243 recent *Homo sapiens* cervical vertebrae together with 43 of the most classical Neanderthals (La Ferrassie 1, La Chapelle-aux-Saints 1, Kebara 2, Shanidar 2, Regourdou 1 and Krapina). Mean form of each cervical level is obtained for each species. The articulation of those mean vertebrae followed the method of osteological neutral posture (ONP) [4], where maximal overlap of the zygapophyses is the basis.

Results suggest that the cervical spine would have a greater lordosis (as assessed by Cobb angle) in Neanderthals. In addition, it seems that stability of the Neanderthals spine is achieved by means of a more developed cervical musculature, as morphological features such as the reduced uncinate process or the different orientation of the articular facets, likely confer reduced stability. Thus, we suggest that the necessary stronger neck muscles may be reflected by the greater length of the spinous processes.

An important finding is that, together with the different lordosis in these species, transverse processes are differently oriented, being more anteriorly positioned in Neanderthals. Transverse processes are the attachment place of the anterior and middle scalenus muscles, both with a great implication in the inspiration movement of the thorax. They are also attached at the first ribs and thus, allow the elevation of the ribcage. A different orientation and length of these muscles due to the different length and orientation of the cervical spine, and a different rib curature in Neanderthals [5] could result in differences of inspiratory biomechanics and capacity.

The Spanish Ministry of Science and Innovation funds this research via one national project to MB (PID2020-115854GB-I00) and one technician grant to CAP (PTA2020-018205-I). The European Commission's Research Infrastructure Action funded CAP via the SYNTHESYS PLUS Project (FR-TAF-52). Martin Friess (Musee de l'Homme, Paris), Davorka Radovcic (Croatian Natural History Museum, Zagreb) and Bradley Gravina (Musée National de Préhistoire) provided access to the fossil simple. We also acknowledge María Benito Sánchez and María García Velasco (Universidad Complutense de Madrid), Niels Lynnerup (University of Copenhagen), Chiara Villa (University of Copenhagen), María Teresa Ferreira and Ana Luisa Santos (Universidade de Coimbra), and Miguel Almeida (DRYAS) for providing access to the comparative sample and support during data collection. We also thank Marta Gómez Recio and José María López-Rey for their help about statistics and Dr. Asier Gómez-Olivencia and Dr. Bruno Maureille for their help considering the fossil sample location and quality.

References: [1] Gómez-Olivencia, A., Been, E., Arsuaga, J. L., Stock, J.T., 2013. The Neandertal vertebral column 1: The cervical spine. Journal of Human Evolution. 64, 608-630. [2] Boule, M., 1911-13. L'homme fossile de La Chapelle-aux-Saints. Annales de paléontologie. 6-8. [3] Haeusler, M., Trinkaus, E., Fornai, C., Müller, J., Bonneau, N., Boeni, T., Frater, N., 2019. Morphology, pathology, and the vertebral posture of the La Chapelle-aux-Saints Neandertal. Proceedings of the National Academy of Sciences. 116, 4923-4927. [4] Mallison, H., 2010. The digital Plateosaurus II: an assessment of the range of motion of the limbs and vertebral column and of previous reconstructions using a digital skeletal mount. Acta Palaeontologica Polonica. 55, 433-458. [5] Bastir, M., García-Martínez, D., Estalrrich, A., García-Tabernero, A., Huguet, R.., Ríos, L., Barash, A., Recheis, W., de la Rasilla, M., Rosas, A., 2015. The relevance of the first ribs of the El Sidrón site (Asturias, Spain) for the understanding of the Neandertal thorax. Journal of Human Evolution. 80, 64-73.

Poster Presentation Number 88, Session 2, Friday 17:00 – 18:30

Taphonomic analysis of the Neandertal specimens from Neander Valley

Ana Pantoja-Pérez[1,2], Ralf W. Schmitz[3], Nohemi Sala[1,2]

1 - Centro Nacional de Investigación sobre la Evolución Humana, Burgos, Spain · 2 - Centro Mixto UCM-ISCIII de Evolución y Comportamiento Humanos, Madrid, Spain · 3 - LVR-LandesMuseum Bonn, Department of Prehistory, Bonn, Germany

The discovery of the Neanderthal-type specimen in the German cave of Kleine Feldhofer Grotte in 1856 initially consisted only of the cranial calotte and 15 postcranial bones, identified as Neanderthal 1. Almost 150 years later, in 1997, R.W.S. and J. Thissen rediscovered the cave sediments and subsequent excavations revealed a suite of faunal remains, lithic artefacts and new human bone fragments. Among these findings were bones belonging to the original Neanderthal type specimen and another individual, Neanderthal 2 [1]. In 2006, using the ZooMS technique [2] 18 additional human bones were identified. Our recent study contributed further to this account, uncovering 14 new human fragments among the faunal remains.

Since the mid-20th century, cut marks on the bones of the Neandertal 1 have been repeatedly discussed. Both recent cut marks from the moulding in the museum and Paleolithic cut marks were published [3-4]. A significant issue in these examinations is the bone surface contamination with varnish and molding materials. The 19th-century bone material underwent numerous casting procedures (e.g., gypsum wedge form method, condensation, or additive cross-linked silicone). It has been documented that a minimum of 9 casts were crafted for the calotte, with a similar number likely for the postcranial bones [4]. The aim of this study is to conduct an updated taphonomic analysis of the entire collection, comprising 112 human bone fragments attributed to Neandertals 1 and 2. This analysis seeks to clarify the origin of this marks and also, the origin of the accumulation.

The microscopic examination of the bone surfaces unequivocally identified scratches attributed to the casting processes applied to bones recovered during the 19th century. Additionally, materials retrieved from recent excavations exhibit signs of modern trampling, likely associated with quarry activities and subsequent deposition in the secondary location.

In addition to these scratches, clusters of linear marks were identified on 11 human bones. Among these, two distinct patterns can be distinguished. On one hand, the material recovered in the new excavations presents linear marks characterized by partially exfoliated flakes with a color distinct from the surrounding surface, indicating excavation damage. However, in certain marks, manganese dendrite formations are consistently observed on their surface but also on the unaltered surrounding surface. This suggests a potentially older age for these scratches. Yet, upon examining other materials recovered during the 1990s excavation season, we found that many pottery items from the 19th century also exhibit the same dendroid mineral pattern. Hence, it is likely that the manganese deposition occurred between the discovery of the Neanderthal type specimen and the subsequent 1990s excavation, during its secondary placement. On the contrary, in the cranial vault of the Neanderthal 1, recovered during the 19th century, these V-shaped lines are similar in color to the bone surface, complicating interpretation. Microscopic analysis of these marks revealed that they interrupt and alter the dendritic formation. Consequently, these cut marks postdate the deposition of dendrites, suggesting a modern origin. The aged appearance of these marks is likely due to the varnishing that these bones underwent. We infer that some of these marks were originated during casting, while those in the sagittal profile may result from the use of the craniograph, as evidenced in other fossil cranial remains [5].

Finally, over 130 bone fractures were analyzed. The long bones show a fracture pattern dominated by transverse fractures along the axis, complete circumferences, and fracture edges with right angles and jagged surfaces. There are no signs of carnivore or human activity on the skeletons, except for quarrying and casting activities. These results indicate a rapid burial of the bodies, which could be compatible with funerary practices.

This research has received funding from the European Research Council under the European Union's Horizon 2020 research and innovation program (Grant agreement No. 949330) and PID2021-122355NB-C31 and PID2021-122355NB-C33 funded by MCIN/AEI/10.13039/501100011033/FEDER, UE. NS has received funding from the Ministerio de Ciencia e Innovación under the Ramón y Cajal program (RYC2020-029656-I) funded by MCIN/AEI/10.13039/501100011033 and El FSE invierte en tu futuro. The authors wish to thank the DEATHREVOL team, and the staff of the LVR-Landesmuseum. J.-J. Hublin, M. Skinner and H. Temming, MPI-Eva, Leipzig, for microCT scanning.

References: [1] Smith, F.H., Ostendorf Smith, M., Schmitz, R.W., 2006, Human skeletal remains from the 1997 and 2000 excavations of cave deposits derived from Kleine Feldhofer Grotte in the Neander Valley, Germany. In: Schmitz, R.W. (Ed.), Neandertal 1856 – 2006. Rheinische Ausgrabungen 58, Philipp von Zabern, Mainz, pp. 187-246. [2] Lanigan, L.T., Mackie, M., Feine, S., Hublin, J.-J., Schmitz, R.W., Wilcke, A., Collins, M.J., Cappellini, E., Olsen, J.V., Taurozzi, A.J., Welker, F., 2020. Multi-protease analysis of Pleistocene bone proteomes. Journal of Proteomics. 228, 103889. [3] Schmitz, R.W., Pieper, P., Bonte, W., Krainitzki, H., 1995. New investigations of the *Homo sapiens neanderthalensis*, found in 1856. In: Jacob, B., Bonte, W. (Eds.), Advances in Forensic Sciences, Vol. 7, Köster, Berlin, pp. 42-44. [4] Krainitzki, H., 2006. Status of the Neanderthal type specimen remains after the recovery of the finds in 1856 to 1995. In: Schmitz, R.W. (Ed.), Neandertal 1856 – 2006. Rheinische Ausgrabungen 58, Philipp von Zabern,Mainz, pp. 171-186. [5] White, T.D., Toth, N., 1989. Engis: preparation damage, not ancient cutmarks. American Journal of Physical Anthropology. 78, 361-367.

Podium Presentation, Session 1, Thursday 9:20 – 11:00

Wild chimpanzees use engineering skills for tool manufacture

Alejandra Pascual-Garrido[1,2], Susana Carvalho[1,2,3], Deus Mjungu[4], Ellen Schulz-Kornas[5], Adam van Casteren[6]

1 - School of Anthropology and Museum Ethnography, University of Oxford, Oxford, United Kingdom · 2 - Interdisciplinary Center for Archaeology and the Evolution of Human Behaviour, University of Algarve, Faro, Portugal · 3 - Department of Science, Gorongosa National Park, Sofala, Mozambique · 4 - Gombe Stream Research Center, The Jane Goodall Institute, Kigoma, Tanzania · 5 - Department of Cariology, Endodontology and Periodontology, University of Leipzig, Leipzig, Germany · 6 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

The selection of materials based on often inconspicuous mechanical properties is an evolutionary hallmark of human tool-making, evidenced by the production of the earliest stone tools. Yet, our knowledge of the evolution of tool-making skills is incomplete relying almost exclusively on stone tools. This stems from the fact that tools constructed from perishable materials are all but absent from the deep-time archaeological record. However, the prevalence of plant tools in modern hunter-gatherers and non-human primates suggests that a variety of plant-based tools were likely just as important as those made from stones for hominin species. We may never know what early hominin perishable tools looked like, but we can assume the mechanical constraints surrounding tool use and tool manufacture have remained somewhat constant. Using a functional framework to understand the technical capabilities of extant hominoid tool users presents a novel approach to predicting the perishable tool-using capabilities of our earliest relatives. Wild chimpanzees (*Pan troglodytes*) select raw materials when making tools. Yet little is known about the mechanical behaviour of these materials and if this contributes to their preferred use. In this study, we investigate the structural and mechanical properties of plant parts used in the manufacture of termite fishing probes by wild chimpanzees living in Gombe Stream National Park in west Tanzania. Materials sourced from plant species extensively used by chimpanzees in the manufacture of tools produced implements of greater flexibility and made of more compliant materials than implements constructed from plant species available but never used. This pattern was also reflected in chimpanzee material selection preferences, with preferred plant species and even preferred plants producing highly flexible implements. Such implement flexibility aligns with functional predictions by allowing a chimpanzee to easily navigate the tunnels of a termite mound better and likely providing more opportunity for termite attachment. These results indicate that the mechanics of plant materials influence the raw material choice for the making of termite fishing tools by wild chimpanzees. Early hominins were selecting materials based on their mechanical properties for manufacturing cutting tools, such as selecting the raw materials more suitable for flaking. Our study demonstrates that this technical ability extends to the production of perishable tools in a wild nonhuman ape species and it is therefore indicative that this skillset was present in the earliest forms of hominin tool making and more ancient than currently depicted by the archaeological record. The findings of this study provide insights into the technical skills associated with perishable artefact-making and poses questions about how this technical knowledge is learnt and culturally transmitted. Using a functional framework as we do here may also present a novel way of investigating perishable tool use in early hominins, a highly overlooked topic in human technological evolution.

This research was supported by the John Fell Fund, University of Oxford, and the Dennis Stanfield Memorial Fund granted by the Linnean Society of London. We are grateful for permission to conduct research in Gombe Stream National Park by Tanzania National Parks (TANAPA), Tanzania Wildlife Research Institute (TAWIRI), and Tanzanian Commission for Science and Technology (COSTECH); field assistance by Nuhu Japhary Buke; logistical support by The Jane Goodall Institute (JGI); plant identifications by Frank Mbago, Department of Botany, University of Dar es Salaam. Special thanks go to Anthony Collins for valuable support with carrying out this research and for aiding logistics in the field.

Pecha Kucha Presentation, Session 2, Thursday 11:20 – 12:50

Neanderthals as familiar strangers, distinction versus connection in human self-understanding. A philosophical approach

Susan Peeters[1], Marie Soressi[2], Stine Jensen[1], Hub Zwart[1]

1 - Erasmus University, the Netherlands · 2 - Leiden University, the Netherlands

During the past decades, our image of Neanderthals has changed dramatically, and this has philosophical implications as well, challenging us to reconsider our self-understanding: what makes us human? Long considered the losers of the human family tree, Neanderthals are now increasingly regarded as basically human, people like us. And yet, the persistent quest for a minimal difference which separates them from us, and defines us as 'winners', is still noticeable [1].

The key issue here is not the actual distinction between modern humans and Neanderthals (which is continuously being redefined), but rather the dualistic construction of human and nonhuman. At the root of the dominant, western, self-narrative lies a 'hyperseparated' conception of the human, emphasizing autonomy, and separation from and domination of nature [2]. This is not only problematic from a scientific point of view, where the evidence of coexistence and admixture is showing a more complicating picture than that of linear progression and 'inadequate' Neanderthals, but it also leads to a one-sided view of what it means to be human and persistent stereotypes.

We will use Neanderthal discourse as a vantage point from which the logic of 'us' versus 'other' is critically reconsidered. To expose and address implicit assumptions underlying our ideas and ideals of humanness, that form the basis of our understanding of the human past, we reread Neanderthal discourse from an 'oblique' perspective, zooming in on what tends to remain unsaid or unquestioned in standard academic discourse [3]. With the scientific literature serving as a backdrop and frame of reference, we studied a selection of case studies from popular discourse that deal with Neanderthal – *Homo sapiens* encounters. We focus on the ways in which the findings are presented; on the terminology that is used, the images that are projected, and the binary logic of, among others, human versus nature, science versus fiction, masculinity versus femininity. Explicit attention was given to literary archetypes such as the role of the exploring, conquering Hero and the opposite side of the archetypical coin, the Orphan, who, abandoned and alone, desires to connect with others and seeks a sense of belonging.

With this study, we capture a basic ambivalence in establishing identity: the need for self-assertion, distinguishing ourselves, coupled with the longing for connection. An ambivalence that is also relevant for scientific paleoanthropological discourse. Human evolution is still often presented as a hero tale of the superior *Homo sapiens*, a story of struggle and competition. By emphasizing the importance of connectedness, the figure of the Orphan may function as a counterbalance to an inflated heroic view of early human history. We should opt for a more fluid and dynamic view of humanity that no longer relies on the logic of dualist thinking that rigorously distinguishes human from not yet fully human. This will allow us to become open to more inclusive and comprehensive visions of the past, and of what it is to be human.

This study is part of the project 'Neanderthals and "us": how the golden age of Neanderthal research challenges human self-understanding' with project number 406.21.FHR.011 of the research programme Open Competition SSH which is financed by the Dutch Research Council.

References: [1] Peeters, S., Zwart, H., 2020. Neanderthals as familiar strangers and the human spark: How the 'golden years' of Neanderthal research reopen the question of human uniqueness. History and Philosophy of the Life Sciences. 42, 33. [2] Plumwood, V., 1993. Feminism and the Mastery of Nature. Routledge, London. [3] Zwart, H., 2017. The oblique perspective: philosophical diagnostics of contemporary life sciences research. Life Sciences, Society and Policy. 13, 4.

Poster Presentation Number 89, Session 2, Friday 17:00 – 18:30

Taxonomic reassessment of the human remains from the Middle Paleolithic site of Grotta del Poggio (Cilento, southern Italy)

Erica Piccirilli[1], Rita Sorrentino[2], Francesca Seghi[1], Antonino Vazzana[1], Maria Giovanna Belcastro[2], Sahra Talamo[3], Katerina Harvati[4,5,6], Stefano Ricci[7], Adriana Moroni[7], Stefano Benazzi[1]

1 - Department of Cultural Heritage, University of Bologna, Ravenna, Italy · 2 - Department of Biological, Geological and Environmental Sciences, University of Bologna, Bologna, Italy · 3 - Department of Chemistry G. Ciamician, University of Bologna, Bologna, Italy · 4 - Paleoanthropology, Senckenberg Centre for Human Evolution and Palaeoenvironment, Department of Geosciences, Eberhard Karls University of Tübingen, Tübingen, Germany · 5 - Paleoanthropology, Institute for Archaeological Sciences, Department of Geosciences, Eberhard Karls University of Tübingen, Tübingen, Germany · 6 - DFG Centre of Advanced Studies 'Words, Bones, Genes, Tools', Eberhard Karls University of Tübingen, Tübingen, Germany · 7 - Department of Physical Sciences, Earth and Environment, Research Unit of Prehistory and Anthropology, University of Siena, Siena, Italy

Grotta del Poggio, located east of the village of Marina di Camerota (Cilento, southern Italy), is a pivotal site for the Middle Paleolithic in southern Italy, due to the presence of an important anthropogenic deposit (layers 2-13) that has been attributed to the MIS6 according to geological observations [1]. The deposit is part of a thick stratigraphic sequence of more than 20 metres that continues in the adjacent shelter, the latter known as Riparo del Poggio. The cave was excavated between 1964 and 1974 by Prof. Arturo Palma di Cesnola, highlighting that this site was exploited with burial purposes during the Bronze age, after an erosional event, which had dismantled the uppermost part of the Middle Paleolithic deposit. The *terminus ante quem* of the cave's series was set at 111,800 ± 9,500 BP after conducting a thermoluminescence dating from layer 17 of the adjacent shelter [1]. During the excavations in 1967, two human remains were found, namely a left talus found in the collapsed sediment and hypothetically ascribed to layer 4 and a human upper left first molar recovered *in situ* in layer 6 [1]. The talus lacked archaic features, thus generating severe doubts about its attribution to Neanderthal [2]. On the contrary, the molar showed evident Neanderthal-like morphological characteristics (i.e., Carabelli's trait, strongly expressed hypocone, taurodontism). Moreover, its crown diameters fell within the range of the Neanderthal variability.

Here we share the geometric morphometrics (GM) and radiocarbon analyses aimed at disentangling the taxonomic attribution of the two remains. 3D models of the molar and talus were created through routine digital workflows [3-4]. Then, the molar 2D crown outline and the talus 3D shape were subjected to GM analyses. Furthermore, a radiocarbon dating was performed on the talus in order to clarify its absolute age [5].

The attribution to Neanderthal was confirmed on the molar after the GM analysis; conversely, the talus was taxonomically attributed to recent *Homo sapiens*. The latter result was more deeply investigated thanks to the radiocarbon dating directly obtained on the talus, confirming its attribution to a recent *Homo sapiens* from the Bronze age. This could be due to an accidentally slipping down of the bone from the uppermost layers attributed to the Bronze age during the excavation of the underlying layer 4.

Grant ERC AdG 101019659 FIRSTSTEPS. - Grant DFG FOR 2237. 1964-74 research at Grotta del Poggio was funded by the University of Siena.

References: [1] Gambassini, P., Ronchitelli, A., 1998. Linee di sviluppo dei complessi del Paleolitico inferiore-medio nel Cilento. Rivista di Scienze Preistoriche. XLIX, 357-377. [2] Messeri, P., Palma di Cesnola, A., 1976. Contemporaneità di Paleantropi e Fanerantropi sulle coste dell'Italia Meridionale. Zephyrus. XXVI-XXVII, 7-30. [3] Lugli, F., Nava, A., Sorrentino, R., Vazzana, A., Bortolini, E., Oxilia, G., Silvestrini, S., Nannini, N., Bondioli, L., Fewlass, H., Talamo, S., Bard, E., Mancini, L., Müller, W., Romandini, M., Benazzi, S., 2022. Tracing the mobility of a Late Epigravettian (~ 13 ka) male infant from Grotte di Pradis (Northeastern Italian Prealps) at high-temporal resolution. Scientific Reports. 12, 8104. [4] Sorrentino, R., Stephens, N.B., Marchi, D., DeMars, L.J.D., Figus, C., Bortolini, E., Badino, F., Saers, J.P.P., Bettuzzi, M., Boschin, F., Capecchi, G., Feletti, F., Guarnieri, T., May, H., Morigi, M.P., Parr, W., Ricci, S., Ronchitelli, A., Stock, J.T., Carlson, K.J., Ryan, T.M., Belcastro, M.G., Benazzi, S., 2021. Unique foot posture in Neanderthals reflects their body mass and high mechanical stress. Journal of Human Evolution. 161, 103093. [5] Talamo, S., Fewlass, H., Maria, R., Jaouen, K., 2021. "Here we go again": the inspection of collagen extraction protocols for ^{14}C dating and palaeodietary analysis. Science and Technology of Archaeological Research. 7, 62–77.

Poster Presentation Number 90, Session 2, Friday 17:00 – 18:30

The Micoquian Neanderthals from Stajnia Cave, Poland

Andrea Picin[1], Mateja Hajdinjak[2], Wioletta Nowaczewska[3], Gregorio Oxilia[4], Stefano Benazzi[4], Adrian Marciszak[5], Paweł Socha[6], Krzysztof Stefaniak[5], Andrzej Wiśniewski[7], Jean-Jacques Hublin[8,9], Adam Nadachowski[10], Sahra Talamo[1]

1 - Department of Chemistry G. Ciamician, University of Bologna, Bologna, Italy · 2 - Department of Evolutionary Genetics, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 3 - Department of Human Biology, Wroclaw University, Wroclaw, Poland · 4 - Department of Cultural Heritage, University of Bologna, Ravenna, Italy · 5 - Department of Palaeozoology, University of Wroclaw, Wroclaw, Poland · 6 - Computed Microtomography Laboratory, Department of Palaeozoology, University of Wroclaw, Wroclaw, Poland · 7 - Institute of Archaeology, University of Wroclaw, Wroclaw, Poland · 8 - Collège de France, Paris, France · 9 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 10 - Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland

The Last Glacial in Europe marks a significant period of Neanderthal population reorganization following the warm Eemian climate, transitioning into prolonged cooler environments and glacial climatic deteriorations. Recent studies utilizing both the reconstructed complete mitochondrial genomes (mtDNA) and genome-wide data have suggested an apparent age-related division among Neanderthals, coinciding with the conclusion of the glacial stages (MIS 6, MIS 5d, MIS 5b, MIS 4) [1-3]. The dynamics of these population changes and the possible origins of Neanderthal radiation events, i.e. whether they stem from dispersals of different Neanderthal groups out of southern Europe or the Levant, still remain uncertain. Therefore, recovering genomic data from Neanderthals across their geographical and temporal range, and co-analyzing them with the data from archaeology, chronology, and paleoclimate, is crucial for elucidating the potential roles of these refuge areas in Neanderthal population dynamics.

In this study, we present the mtDNA analysis of nine Neanderthal teeth from Stajnia Cave in Poland, an archaeological site characterized by short-term occupations during the Central-Eastern European Micoquian (MIS 5a - MIS 3) [4] and the Early Aurignacian [5]. These teeth were recovered from unit D, stratigraphically correlated with MIS 3. DNA was extracted from between 8 and 29.8 mg of dentine powder and converted into single-stranded DNA libraries. An aliquot of each library was enriched for mitochondrial DNA fragments prior to sequencing on an Illumina platform. We reconstructed full mitochondrial genomes from seven out of eight Stajnia teeth, and co-analyzed them with the previously published mtDNA genome of Stajnia S5000 Neanderthal [4], as well as mitochondrial genomes of 42 Neanderthals, four Denisovans, 54 present-day and 54 securely radiocarbon dated modern humans, a Sima de los Huesos hominin, and a chimpanzee. We reconstructed the partial mitochondrial sequence from the Stajnia 19415 tooth (to the 54.93% completeness) and determined that it falls within the known Neanderthal mtDNA diversity. By utilizing both maximum parsimony and maximum likelihood analysis, we find that all Stajnia mtDNA genomes cluster together, including the mtDNA genome of Stajnia Neanderthal S5000, dated to approximately 116,000 years BP (albeit with large confidence intervals of between 83,101 and 152,515 years ago, [4]). Stajnia teeth S19417, S4619, and S16066 exhibited identical mtDNA genomes, and could thus stem from identical or maternally related individuals. Stajnia S23310 mtDNA genome is the closest to S5000, with only six pairwise differences. In total, based on the reconstructed mtDNA genomes, nine Neanderthal teeth from Stajnia represent a minimum of six different individuals. Notably, all mtDNA genomes from Stajnia teeth have the least number of differences and fall close to the mtDNA genome of the Mezmaiskaya 1 Neanderthal from the Northern Caucasus, and in a clade with the mtDNA sequences recovered from the sediment samples from Galería de las Estatuas in Spain. Further studies integrating sediment DNA results from other European sites will elucidate the processes underlying the distribution of the Stajnia S5000/Mezmaiskaya 1 mtDNA haplotypes across western Eurasia before transitioning to the 'late Neanderthal' type.

This study was funded by the Max Planck Society. S. T. is supported by the European Research Council under the European Union's Horizon 2020 Research and Innovation Programme (Grant Agreement No. 803147-951 RESOLUTION, https://site.unibo.it/resolution-erc/en). S. T. and A. P. collaborate in the Italian grant PRIN20209LLK8S_001 DYNASTY: "Neanderthals dynamic pathway and resilience in central Europe through the chronometric sustainability" funded by the Ministry of University and Research.

References: [1] Hajdinjak, M., Fu, Q., Hübner, A., Petr, M., Mafessoni, F., Grote, S., Skoglund, P., Narasimham, V., Rougier, H., Crevecoeur, I., Semal, P., Soressi, M., Talamo, S., Hublin, J.-J., Gušić, I., Kućan, Ž., Rudan, P., Golovanova, L.V., Doronichev, V.B., Posth, C., Krause, J., Korlević, P., Nagel, S., Nickel, B., Slatkin, M., Patterson, N., Reich, D., Prüfer, K., Meyer, M., Pääbo, S., Kelso, J., 2018. Reconstructing the genetic history of late Neanderthals. Nature 555, 652. [2] Peyrégne, S., Slon, V., Mafessoni, F., de Filippo, C., Hajdinjak, M., Nagel, S., Nickel, B., Essel, E., Le Cabec, A., Wehrberger, K., Conard, N.J., Kind, C.J., Posth, C., Krause, J., Abrams, G., Bonjean, D., Di Modica, K., Toussaint, M., Kelso, J., Meyer, M., Pääbo, S., Prüfer, K., 2019. Nuclear DNA from two early Neandertals reveals 80,000 years of genetic continuity in Europe. Science Advances. 5, eaaw5873. [3] Vernot, B., Zavala, E.I., Gómez-Olivencia, A., Jacobs, Z., Slon, V., Mafessoni, F., Romagné, F., Pearson, A., Petr, M., Sala, N., Pablos, A., Aranburu, A., de Castro, J.M.B., Carbonell, E., Li, B., Krajcarz, M.T., Krivoshapkin, A.I., Kolobova, K.A., Kozlikin, M.B., Shunkov, M.V., Derevianko, A.P., Viola, B., Grote, S., Essel, E., Herráez, D.L., Nagel, S., Nickel, B., Richter, J., Schmidt, A., Peter, B., Kelso, J., Roberts, R.G., Arsuaga, J.-L., Meyer, M., 2021. Unearthing Neanderthal population history using nuclear and mitochondrial DNA from cave sediments. Science. 372, eabf1667. [4] Picin, A., Hajdinjak, M., Nowaczewska, W., Benazzi, S., Urbanowski, M., Marciszak, A., Fewlass, H., Bosch, M.D., Socha, P., Stefaniak, K., Żarski, M., Wiśniewski, A., Hublin, J.-J., Nadachowski, A., Talamo, S., 2020. New perspectives on Neanderthal dispersal and turnover from Stajnia Cave (Poland). Scientific Reports 10, 14778. [5] Talamo, S., Nowaczewska, W., Picin, A., Vazzana, A., Binkowski, M., Bosch, M.D., Cercatillo, S., Diakowski, M., Fewlass, H., Marciszak, A., Paleček, D., Richards, M.P., Ryder, C.M., Sinet-Mathiot, V., Smith, G.M., Socha, P., Sponheimer, M., Stefaniak, K., Welker, F., Winter, H., Wiśniewski, A., Żarski, M., Benazzi, S., Nadachowski, A., Hublin, J.-J., 2021. A 41,500 year-old decorated ivory pendant from Stajnia Cave (Poland). Scientific Reports. 11, 22078.

Pecha Kucha Presentation, Session 2, Thursday 11:20 – 12:50

Ankle loading differences in South African *Australopithecus* and *Paranthropus robustus*

Annalisa Pietrobelli[1], Marine Cazenave[1,2,3], Zewdi J. Tsegai[4], A.J. Heile[5], Alexander Synek[6], Sebastian Bachmann[6], Travis Rayne Pickering[5,7] Ron J. Clarke[7], Dominic Stratford[8,9], Kathleen Kuman[8], Matthew M. Skinner[10], Tracy L. Kivell[1]

1 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 2 - Division of Anthropology, American Museum of Natural History, New York, USA · 3 - Department of Anatomy, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa · 4 - Department of Organismal Biology and Anatomy, University of Chicago, Chicago, USA · 5 - Department of Anthropology, University of Wisconsin-Madison, Madison, Wisconsin, USA · 6 - Institute of Lightweight Design and Structural Biomechanics, TU Wien, Wien, Austria · 7 - Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, South Africa · 8 - School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, Johannesburg, South Africa · 9 - Department of Anthropology, Stony Brook University, Stony Brook, USA · 10 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

Both external and internal morphology of the distal tibia of South African fossils presumed to belong to *Australopithecus* have been suggested to reflect a human-like loading regime, with a neutral position of the ankle joint during bipedal locomotion [1]. However, the internal bone structure of the distal tibia of *Paranthropus robustus*, and its potential locomotor signal, was unknown due to lack of relevant fossils attributed to that species. This gap in the record is now filled with the recent discovery of a complete *P. robustus* tibia (SWT1/HR-2c) from Member 1 (Hanging Remnant) of the Swartkrans Formation [2]. Here, we employ a quantitative holistic comparative approach, to characterize its internal bone structure, comparing it to tibiae StW 358 and StW 389 from Member 4 of the Sterkfontein Formation, presumed from their location to belong to *Australopithecus*. Our modern comparative sample includes the distal tibiae of 45 hominids (*Pongo*, *Pan*, *Gorilla*, as well as humans from 20th century Germany), with different locomotor repertoires and habitual loads. Trabecular bone was imaged using microCT (30-70 μm size). Bone tissues were segmented using MIA clustering [3] and trainable Weka algorithms. Canonical holistic morphometric analysis [4] was used to statistically analyse relative bone volume density (rBV/TV) within and between taxa using principal component (PC) and multivariate analyses.

Results of the PCA show a trend separating *H. sapiens*, having high rBV/TV at the centre of the tibiotalar subarticular surface, from great apes, displaying high rBV/TV in the anterolateral, anteromedial and posterocentral regions of the subarticular surface. This pattern in *H. sapiens* suggests a neutrally loaded ankle, with the tibia perpendicular to the talar trochlea. In comparison, in *Pan* and *Gorilla*, the rBV/TV pattern is consistent with an ankle loaded in dorsal and plantar flexion, which occur during both knuckle- walking and arboreal climbing. *Pongo* plots towards positive PC2 values and shows greater rBV/TV at the fibular incisura and a more homogeneous trabecular distribution across the entire subarticular surface, suggesting more diverse postural and locomotor behaviour.

Both extinct taxa display a unique set of human-like and ape-like characteristics. *P. robustus* falls within the *Gorilla* cluster with PC1 positive values. In contrast, the two presumed *Australopithecus* specimens fall in their own morphospace. This separation is driven by higher rBV/TV anteriorly and posteriorly in *P. robustus* compared to *Australopithecus*, suggesting a potentially higher load at the ankle during dorsiflexion of the foot in *P. robustus*, similar to modern African apes. While the two *Australopithecus* tibiae also show signals of this anterior concentration, they, in addition, reveal greater rBV/TV localized at the centre of the articular surface, suggesting loading in both neutral, human-like postures and in dorsiflexion typical of African apes. All extinct specimens have high rBV/TV across the articular surface in mid-sagittal view, as in *H. sapiens*.

Our results indicate that the loading environments at the ankle differed between *P. robustus* from Swartkrans Member 1 and the australopith specimens from Sterkfontein Member 4, likely resulting from different postural and/or locomotor modes. While previous evidence from the internal structure of the Sterkfontein tibiae suggested a more neutral position of the ankle and human- like joint loading [1], our whole-bone analysis suggests a more diverse locomotor repertoire in *P. robustus*. Differences between the fossil specimens support observations of the internal bone structure of the *P. robustus* and *Australopithecus* hip joint [5], suggesting these two taxa may have exploited different ecological niches.

We acknowledge R. Wittig and C. Crockford of the Tai Chimpanzee Project and P. Gunz of the Department of Human Origins, MPI-EVA for access to Tai Chimpanzee Skeletal collection ; I. Livne to the Gorilla sample of the Powell-Cotton Museum; A. Van Heteren to the Pongo sample of the Zoologische Staatssammlung München; B. Grosskopf to the modern human sample of the Historische Anthropologie und Humanökologie, Johann-Friedrich-Blumenbach-Institut für Zoologie und Anthropologie der Georg-August-Universität Göttingen. We thank D. Plotzki and H. Temming at MPI- EVA, and C. Dunmore at The Imaging Centre for Life Sciences (ICLS) at School of Anthropology and Conservation, University of Kent, for CT scanning. We are also grateful to B. Zipfel of Evolutionary Studies Institute, University of the Witwatersrand for access to the Sterkfontein fossil specimens. This research was supported by The LSB Leakey Foundation; Palaeontological Scientific Trust, University of Wisconsin-Madison, the European Research Council (grant agreement No. 819960) and the Max Planck Society.

References: [1] Barak, M.M., Lieberman, D.E., Raichlen, D., Pontzer, H., Warrener, A. G., Hublin, J.J., 2013. Trabecular evidence for a human-like gait in *Australopithecus africanus*. PLOSONE. 8, e77687. [2] Pickering, T.R., Cazenave, M., Clarke, R.J., Heile, A.J., Caruana, M.V., Kuman, K., Stratford, D., Brain, C.K., Heaton, J.L., submitted. First articulating os coxae, femur, and tibia of a small, young adult hominin from Member 1 (Hanging Remnant) of the Swartkrans Formation, South Africa. Journal of Human Evolution. [3] Dunmore, C.J., Wollny, G., Skinner, M.M., 2018. MIA-

Clustering: a novel method for segmentation of paleontological material. PeerJ. 6, e4374. [4] Bachmann S., Dunmore C.J., Skinner M.M., Pahr D.H., Synek A., 2022. A computational framework for canonical holistic morphometric analysis of trabecular bone. Scientific Reports. 12, 5187. [5] Cazenave M., Kivell, T.L., Dunmore, C., Skinner, M.M., 2023. Signals of early hominin postural and locomotor diversity in the structural arrangement of the femoral neck. American Journal of Biological Anthropology. 189, 29.

Poster Presentation Number 91, Session 2, Friday 17:00 – 18:30

ZooMS analysis of fragmented unidentified bones from Middle to Upper Palaeolithic sites in the Crimea

Emily Pigott[1,2], Katerina Douka[1,2], Annette Oertle[1,2], Lidia Martin[1,2], Thorsten Uthmeier[3], Victor Chabai[4], Marylène Patou-Mathis[5], Tom Higham[1,2]

1 - Department of Evolutionary Anthropology, University of Vienna · 2 - Human Evolution and Archaeological Science (HEAS) Network, Vienna, Austria · 3 - Universität Erlangen Nürnberg (FAU) · 4 - National Ukrainian Academy of Science · 5 - Muséum National d'Histoire Naturelle, France

The Crimean Peninsula contains numerous important Palaeolithic sites, including Kabazi II, Kabazi V, Starosel'e, Chokurcha I and Siuren I. This region has been considered a potential Neanderthal refugium prior to their replacement by *Homo sapiens*. This hypothesis is primarily drawn from lithic technological analysis and radiocarbon dating. All sites have a considerable number of fragmented bones which have not been determined taxonomically due to the bones having no distinct identifiable features.

In this study, we used collagen peptide fingerprinting (Zooarchaeology by Mass Spectrometry, ZooMS) to identify morphologically unidentifiable bones. One key advantage of ZooMS is that it enables screening of a large number of bones. In addition to shedding further light on human subsistence and butchery practices, as well as aspects of the palaeo-environment, this method can also be used to find hominin bone fragments.

Our preliminary ZooMS results show that out of a total of 578 bones which were analysed, 82.5% had a good collagen preservation and have been successful for spectral analysis. At the sites of Kabazi II, Kabazi V, Starosel'e 89% or more of the bones are of *Equidae*. The second highest taxonomic group is *Bovidae* and *Cervidae* indicating a possible cold, but humid steppe environment. At Kabazi II, 17.8% of the analysed samples failed to produce collagen, which may be due to the poor preservation of the open-air site. Siuren I was also characterised by many low collagen bones, with over 25% of the samples failing to produce any measurable collagen. Chokurcha I revealed a significant proportion of mammoth bones (*Elephantidae*) (57.4%), with 27.9% being (*Bovidae* and *Cervidae*). This indicates the possibility that unit IV at Chokurcha I reflects a colder steppic environment. Siuren I has a high percentage of *Bovidae* and *Equidae*, also indicating a steppe environment.

We found one Paleolithic hominin bone from Starosel'e, which is currently under analysis (dating and aDNA).

Our findings correlate well with previous archaeozoological analysis undertaken at some of the sites. We show here that fragmented, previously unidentified faunal remains from significant Palaeolithic sites in Crimea is a great untapped source of archaeological information, which can help to reconstruct ancient lifeways and, in some cases, help us to identify precious hominin remains.

I want to thank all my co-authors for their input and enthusiasm for this undergoing research project and helping me edit my abstract.

References: [1] Strohalm, M., Hassman, M., Košata, B., Kodíček, M., 2008. mMass data miner: an open source alternative for mass spectrometric data analysis. Rapid Communications in Mass Spectrometry. 22, 905–908.

Poster Presentation Number 92, Session 2, Friday 17:00 – 18:30

AMY1 gene copy number variation challenges assumptions about diet in pastoral and farmer populations of the African Sahel

Eliška Podgorná[1], Mame Yoro Diallo[2], Viktor Černý[1]

1 - Archaeogenetics Laboratory, Institute of Archaeology of the Academy of Sciences of the Czech Republic, Prague, Czech Republic · 2 - Department of Anthropology and Human Genetics, Faculty of Science, Charles University in Prague, Prague, Czech Republic

Human populations have adapted to diverse environments and diets over millennia, leading to genetic variations in genes crucial for subsistence. One such gene, the α-amylase enzyme encoded by the *AMY1* gene, plays a pivotal role in starch digestion. Previous studies suggest that in populations with high-starch diets, natural selection may favour repeated duplication of the salivary amylase gene to increase amylase concentrations in saliva. Although numerous investigations have confirmed the positive correlation between the number of *AMY1* gene copies and the level of amylase in saliva, its relation with starch consumption has never been clearly repeated. In order to test this hypothesis, genetic data were collected from 346 individuals belonging to 14 ethnolinguistic groups from the Sahel/Savannah belt of Africa. These African populations, representing both farmers (who were sometimes considered to be high-starch consumers) and pastoralists (who were, on the other hand, considered to be milk and rather relatively low-starch consumers), were analysed for Copy Number Variation (CNV) of the *AMY1* gene using duplex quantitative real-time PCR. Diploid copy numbers were estimated by the CopyCaller v1.0 software (Applied Biosystems), referencing a specific DNA sample with known AMY1 gene copy numbers. Arlequin software computed genetic diversity metrics within populations, including allele frequencies and heterozygosity. Subsequently, AMOVA analysis partitioned genetic variance among and within populations for both allele frequency differences (FST) and the Sum of squared size differences (RST) to calculate pairwise genetic distances. R packages facilitated the comparison of genetic diversity metrics between populations and statistical tests such as Mantel, or Kolmogorov Smirnov tests to assess the significance of genetic differentiation. Among the findings, it is interesting to note the existing heterogeneity in the distribution of copy number variability of the *AMY1* gene within our study cohort. However, our analyses revealed no correlation between copy number and lifestyle, suggesting a more complex scenario of subsistence strategies (agropastoralism) in the Sahel belt. These findings underscore the intricate interplay between genetic adaptations and dietary practices in human populations, highlighting the need for further investigation into the evolutionary forces shaping human dietary adaptations.

The project was supported by the Grant Agency of the Czech Republic (Grant 19-09352S S-P505).

Podium Presentation, Session 4, Thursday 16:20 – 18:00

New insights into the Shanidar 4 ('flower burial') skeleton cluster from the Ralph S. and Rose L. Solecki archives

Emma Pomeroy[1], James Holman[2], Chris Hunt[3], Paul Bennett[2], Tim Reynolds[4], Lucy Farr[1], Lucía López-Polín[1,5,6], Jessica Twyman[2], Graeme Barker[1]

1 - University of Cambridge, UK · 2 - Canterbury Archaeological Trust, Canterbury, UK · 3 - Liverpool John Moores University, UK · 4 - Birkbeck, University of London, UK · 5 - Institut Català de Paleoecologia Humana i Evolució Social, Spain · 6 - Universitat Rovira i Virgili, Spain

The nature and significance of the famous Neanderthal 'flower burial' at Shanidar Cave (Iraqi Kurdistan), found by Ralph Solecki and his team in 1960, has been widely debated. In contrast, the fact that this individual, 'Shanidar 4', was found in a tight, unparalleled cluster with 3 further individuals (Shanidar 6, 8 and 9) has been overshadowed [1]. Unfortunately, the challenges faced by Solecki's team in excavating and removing the delicate, fragile Shanidar 4 and accompanying remains en bloc meant that almost all information about the relative positions of the four skeletons was lost [2]. This has severely limited our ability to understand key aspects of this group of remains, such as how the bodies were positioned and whether they were deposited on one or multiple occasions. This information could be very significant for wider debates about Neanderthal behaviour and cognition.

Our recent excavation of new Neanderthal remains directly adjacent to the original position of the Shanidar 4 cluster, designated 'Shanidar Z' [3], offers an opportunity to gain a more detailed view of this unusual group of skeletons. Directly below the remains of Shanidar Z, though separated by approximately 10 cm of sediment, we have also found the partial and likely disturbed remains of another individual comprising a complete left scapula, two ribs in anatomical position, and a complete right hand [4], which we have designated 'Shanidar A'. Fragments of further individuals have also been identified.

The recent availability of Ralph Solecki's rich archives, in conjunction with those of project osteologist T. Dale Stewart, at the National Anthropological Archives, Smithsonian Institution (Washington DC, USA) offers important unpublished information about the original Shanidar 4 cluster, including photos, excavation records, notebooks, original drawings, and unpublished manuscripts. Extensive research on these archives, along with published information and our own observations from the excavation of Shanidar Z, have permitted some important new insights. First, we are able to confirm that the Shanidar Z remains correspond to those described by Solecki (e.g. [5]) as unidentified remains left in the east section wall adjacent to the location of Shanidar 4, following the removal of the block. Solecki thought these remains may not be hominin (Stewart, who could have given a definitive identification, had returned to Baghdad when they were discovered) and, apart from his initial report on the finds, Solecki considered it was unlikely that they were part of the Shanidar 4 cluster.

In connecting the Shanidar Z remains with Solecki's observations and records, we can be confident that Shanidar Z and associated remains are part of the same cluster. Shanidar Z was cut through at the waist by the removal of the Shanidar 4 block and, having identified Solecki's original datum thanks to the archive, we can show that Shanidar Z lay at the same level as the remains in the east wall and possibly Shanidar 6, just below those of Shanidar 4. However, linking the half skeleton of Shanidar Z to a specific individual from the 1960 excavation (potentially Shanidar 6 or 8) is more challenging. While we cannot simply add the number of individuals from 1960 to the new Shanidar Z and associated remains, the current total minimum number of individuals in the whole cluster is 5.

We also find that some previous interpretations of Shanidar 6 and their position relative to Shanidar 4 may be incorrect, though defining the correct original position of Shanidar 6 may ultimately be impossible based on the information that is preserved. Nonetheless, the combination of archival, published and new excavation data has permitted an important step towards understanding the complex mortuary behaviour this group of skeletons likely represents.

Thank you to the Kurdistan Regional Government for inviting G.B. to conduct new excavations at Shanidar Cave, and the Kurdistan General Directorate of Antiquities. for permission to conduct this work, as well as their invaluable logistical support. We particularly thank the General Directors Mala Awat and Kaifi Mustafa Ali, the Director for the Soran District Abdulwahab Suleiman, and the on-site inspectors from the Soran District Directorate of Antiquities Jeghir Khalil, Sherzad Hasko, and Dlshad Abdulmutalb. Thanks to all members of the Shanidar Cave Project team, past and present, for their contributions to the Project. We gratefully acknowledge a Small Research Grant from The British Academy/ Leverhulme Trust (SRG18R1\180250) and the John Templeton Foundation (ID# 61812) for supporting work with the archives, as well as the John Templeton Foundation, Leverhulme Trust (Research Grant RPG-2013-105), Rust Family Foundation, McDonald Institute for Archaeological Research, the Society of Antiquaries, Wenner Grenn Foundation and the British Academy for supporting ongoing excavations and analyses by the Shanidar Cave Project. Thank you to Molly Kamph, Danielle Davis, Daisy Njoku, Katherine Crowe and Gina Rappaport at the National Anthropological Archives, for all their assistance. Special thanks to John Solecki, Ralph Solecki and Rose Solecki for their help and support.

References: [1] Hunt, C.O., Pomeroy, E., Reynolds, T., Tilby, E., Barker, G., 2023. Shanidar et ses fleurs? Reflections on the palynology of the Neanderthal 'Flower Burial' hypothesis. Journal of Archaeological Science. 159, 105822. [2] Stewart, T.D., 1977. The Neanderthal skeletal remains from Shanidar Cave, Iraq: A summary of findings to date. Proceedings of the American Philosophical Society. 121, 121-165. [3] Pomeroy, E., Bennett, P., Hunt, C.O., Reynolds, T., Farr, L., Frouin, M., Holman, J., Lane, R., French, C., Barker, G., 2020. New Neanderthal remains associated with the 'flower burial' at Shanidar Cave. Antiquity. 94, 11–26. [4] Barker, G., Hill, E., Holman, J., Hunt, C., Lane, R., Lopez-Polin, L., Pomeroy, E., Reynolds, T., Tilby, E., Twyman, J., 2023. Neanderthal life and death in Shanidar Cave, Iraqi Kurdistan. Paleoanthropology. 2023, 283. [5] Solecki, R.S., 1971. Shanidar: the First Flower People. Knopf, Inc., New York

Podium Presentation, Session 10, Saturday 11:00 – 12:40

The Middle Pleistocene Sogen locality along the Solo River (Java, Indonesia): first results of the (chrono)stratigraphical, palaeoenvironmental and palaeoanthropological studies

Eduard Pop[1,2], Mega Hafsari[2,3], Tom Veldkamp[4], Putu Yuda Haribuana[5], Jeroen van der Lubbe[6], Benyamin Perwira Shidqi[7], Jeroen Schoorl[8], Sukiato Khurniawan[9], Fred Spoor[10,11], Dama Qoriy Arjanto[12], Josephine Joordens[1,2,13], Indra Sutisna[14], Harold Berghuis[2], Shinatria Adhityatama[15], Sander Hilgen[1], Olafianto Drespriputra[5], Hans Huisman[16], Pratiwi Yuwono[17], Klaudia Kuiper[6], Wout Krijgsman[18], Nia Marniati E. Fajari[5], Thijs Smink[8], Mara Smit[6], Sofwan Noerwidi[5]

1 - Naturalis Biodiversity Center, Leiden, the Netherlands · 2 - Faculty of Archaeology, Leiden University, the Netherlands · 3 - Pusat Riset Arkeologi, Lingkungan, Maritim, Dan Budaya Berkelanjutan, Badan Riset Inovasi Nasional (BRIN), Jakarta, Indonesia · 4 - Faculty ITC, University of Twente, Enschede, the Netherlands · 5 - Pusat Riset Arkeometri, Organisasi Riset Arkeologi, Bahasa, dan Sastra, Badan Riset dan Inovasi Nasional (BRIN), Jakarta, Indonesia · 6 - Faculty of Science, Vrije Universiteit, Amsterdam, the Netherlands · 7 - Paleontology and Quaternary Research Group, Faculty of Earth Sciences and Technology, Bandung Institute of Technology, Bandung, Indonesia · 8 - Soil Geography and Landscape Group, Department of Environment Sciences, Wageningen University, Wageningen, the Netherlands · 9 - Department of Geoscience, Universitas Indonesia, Jakarta, Indonesia · 10 - Centre for Human Evolution Research, Natural History Museum, London, United Kingdom · 11 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 12 - Departemen Arkeologi Fakultas Ilmu Budaya Universitas Gadjah Mada, Yogyakarta, Indonesia · 13 - Technological Primates Research Group, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 14 - Direktorat Pelindungan Kebudayaan, Direktorat Jenderal Kebudayaan, Kementerian Pendidikan Kebudayaan Riset dan Teknologi, Jakarta, Indonesia · 15 - School of Humanities, Languages and Social Science, Griffith University, Australia · 16 - Cultural Heritage Agency of the Netherlands, Amersfoort, the Netherlands · 17 - Faculty of Science and Engineering, Southern Cross University, Australia · 18 - Fort Hoofddijk Paleomagnetic Laboratory, Utrecht University, the Netherlands

Given Java's abundance of *Homo erectus* fossils, it can potentially serve as a good testing ground for studying hominin adaptations to variable, low-latitude environments. Particularly the high-amplitude glacial-interglacial cycles of the Middle Pleistocene introduce significant environmental variability on the low-lying Sunda Shelf. Unfortunately, the paleoanthropological and paleoenvironmental record for this period on Java is scarce. The new locality Sogen (Java, Indonesia) fills an important gap in the record. Here, the first results are presented of the (chrono)stratigraphical, palaeoenvironmental and palaeoanthropological studies, including the discovery of a fossil hominin parietal as well as stone and bone artifacts.

The Sogen stratigraphy was studied over a distance of 1.3 km along the Solo River, covering a series of 57 m of inclined deposits. The lower 20 m are massive lahars with interbedded clays with paleosols and fluvial deposits. At Trinil, the same lahars are attributed to the Batu Gajah Fm, with the uppermost lahar (BGL-5) dated to ~780 ka. This lahar underlies the fossil-rich deposits excavated by Dubois [1-3]. At Sogen, this age estimate is supported by preliminary palaeomagnetic results. The overlying Middle Pleistocene deposits, attributed to the Trinil Fm [1], consist of a lower part (20 m) that documents a low-energy delta setting in a basin environment with several fining upward sequences from sands to silt/clays with paleosols that contain carbonate concretions, suggesting relatively dry conditions. The preliminary results of the isotope studies on these concretions do show changes from C3 to C4 conditions, that are, together with grain size fluctuations, tentatively interpreted as glacial/interglacial cycles. The upper part (17 m) shows a transition to wetter conditions with higher-energy transport (i.e. conglomerates), absence of carbonate concretions in paleosols, and lake deposits. The latter are hypothesized to correlate with high-amplitude interglacials OIS 11 or OIS 9. If supported by absolute dating currently being carried out ($pIRIR_{290}$, Ar/Ar, US-ESR), this transition could tentatively reflect a recent model in which the Sunda Shelf was emerged prior to 400 ka and only being submerged during subsequent interglacials [4] that were consequently more humid. The inclined deposits are discordantly overlain by terrace deposits and are, based on up- and downstream correlations, most likely of Late Pleistocene age [1].

Fossils are relatively numerous in the lower part of the Trinil Fm. Particularly the tops of the palaeosols and the overlying layers of reworked carbonate nodules yielded abundant fossils including Bovidae, Suidae, Cervidae, Proboscidea, and possibly hyena and Panthera, and reptiles including crocodile, gharial, and hard and softshell turtle. Some of these indicate the proximity of aqueous environments as also reflected by the presence of fossils of catfish, freshwater gastropods and bivalves, while fossils of shark and stingray are less expected in this context.

Several of the fossiliferous units also yielded in situ stone tools. These include manuports of sizes and lithologies not naturally occurring in these deposits, but also flakes and flaked pieces of both volcanic (andesite, dacite, obsidian) and cryptocrystalline rock (chalcedony, jasper). Bone flakes have been found in proximity to manuports, and may suggest that the latter were used to break bones. Apart from in situ finds, a slab of indurated Trinil Fm deposits protruding far into the riverbed created a whirlpool-like feature that erodes but also winnows out fine material, and hence created deposits enriched in larger elements including fossil fauna and stone artifacts. Within this feature, a parietal fragment of a Pleistocene hominin was found. Although reworked, it is likely that

it was locally eroded from Trinil Formation deposits. Further analyses are employed to assess its taxonomic affinity, provenance, and age.

This research was carried out with permission of the National Research and Innovation Agency of Indonesia (BRIN research permits 5/SIP.EXT/IV/FR/7/2023 to Pop) under the project 'Bones And Stones IN Situ (BASINS)'. The research was funded by the Dutch Research Council NWO (OCENW.M20.152). We would like to thank Herry Jogaswara (BRIN), Marlon Ririmasse (BRIN), BPCB Jawa Timur, the Government Regency of Ngawi, the Trinil Museum staff (notably Catur Hari Gumono, Agus Hadi Widianto and Suwono), our field assistants (notably Ari Mukti), and the students from Gajah Mada University, Udayana University, and Universitas Indonesia for making this research possible.

References: [1] Berghuis, H.W.K., Veldkamp, A., Adhityatama, S., Hilgen, S.L., Sutisna, I., Barianto, D.H., Pop, E.A.L., Reimann, T., Yurnaldi, D., Ekowati, D.R., Vonhof, H.B., van Kolfschoten, T., Simanjuntak, T., Schoorl, J.M., Joordens, J.C.A., 2021. Hominin homelands of East Java: Revised stratigraphy and landscape reconstructions for Plio-Pleistocene Trinil. Quaternary Science Reviews. 260, 106912. [2] L. Hilgen, S., Pop, E., Adhityatama, S., A. Veldkamp, T., W.K. Berghuis, H., Sutisna, I., Yurnaldi, D., Dupont-Nivet, G., Reimann, T., Nowaczyk, N., F. Kuiper, K., Krijgsman, W., B. Vonhof, H., Ekowati, D.R., Alink, G., Ni Luh Gde Dyah Mega Hafsari, Drespriputra, O., Verpoorte, A., Bos, R., Simanjuntak, T., Prasetyo, B., Joordens, J.C.A., 2023. Revised age and stratigraphy of the classic *Homo erectus*-bearing succession at Trinil (Java, Indonesia). Quaternary Science Reviews. 301, 107908. [3] Pop, E., Hilgen, S., Adhityatama, S., Berghuis, H., Veldkamp, T., Vonhof, H., Sutisna, I., Alink, G., Noerwidi, S., Roebroeks, W., Joordens, J., 2023. Reconstructing the provenance of the hominin fossils from Trinil (Java, Indonesia) through an integrated analysis of the historical and recent excavations. Journal of Human Evolution. 176, 103312. [4] Sarr, A.-C., Husson, L., Sepulchre, P., Pastier, A.-M., Pedoja, K., Elliot, M., Arias-Ruiz, C., Solihuddin, T., Aribowo, S., Susilohadi, 2019. Subsiding Sundaland. Geology. 47, 119–122.

Poster Presentation Number 93, Session 2, Friday 17:00 – 18:30

Inferring hominin phylogeny using Procrustes-aligned landmark data: a preliminary comparison with traditional methods

Nicholas W. Post[1,2,3], Kelsey D. Pugh[2,3,4], Santiago A. Catalano[2,5,6] Sergio Almécija[2,3,7], Ashley S. Hammond[2,3]

1 - Richard Gilder Graduate School, American Museum of Natural History, New York, USA · 2 - Division of Anthropology, American Museum of Natural History, New York, USA · 3 - New York Consortium in Evolutionary Primatology (NYCEP), New York, USA · 4 - Department of Anthropology, Brooklyn College, City University of New York, NY, USA · 5 - Unidad Ejecutora Lillo, Consejo Nacional de Investigaciones Científicas y Técnicas – Fundación Miguel Lillo, Argentina · 6 - Facultad de Ciencias Naturales e Instituto Miguel Lillo, Universidad Nacional de Tucumán, Argentina · 7 - Institut Català de Paleontologia Miquel Crusafont (ICP-CERCA), Universitat Autònoma de Barcelona, Barcelona, Spain

In morphological phylogenetic analyses, the accuracy of reconstructed trees generally depends on employing appropriate types of informative data. Fossil studies may be particularly prone to weak results due to the paucity of available material. Therefore, using multiple data types in phylogenetic total-evidence analyses may provide additional information that can be utilized to strengthen analyses. The high dimensionality offered by 3D geometric morphometric data (3DGM) could represent an excellent source of information for studying complex morphologies, especially that of extinct species represented by fragmentary fossils. However, 3DGM data in phylogenetic analyses has been the subject of considerable debate [1-2]. Because of this, many previous GM-based phylogenetic studies have used the principal component scores derived from landmarks as continuous character data (e.g., [3]). However, recent advances have facilitated using Procrustes-aligned landmark coordinates directly to infer evolutionary relationships.

In this preliminary study, we test the ability of Procrustes-aligned data to recover the phylogenetic relationships of seven extant anthropoids (*Colobus*, *Papio*, *Hylobates*, *Pongo*, *Gorilla*, *Pan*, modern humans) and five fossil hominins (*Paranthropus boisei* [KNM-ER 406], *Homo habilis* [OH24], *H. erectus* [Sangiran 17], *H. heidelbergensis* [Petralona 1], *H. neanderthalensis* [La Ferrassie 1]), and compare the results to trees reconstructed using traditional (discrete) characters. Forty-three cranial landmarks were collected on high-resolution 3D models of fossil hominins using Stratovan Checkpoint 2021. Landmarks for the extant sample were collected using Landmark Editor. In addition, a previously published morphological character matrix with 107 characters was adapted for traditional phylogenetic inference [4]. Datasets were analyzed with parsimony using TNT v. 1.6 [5].

Results indicate that GM data produce trees consistent with previous phylogenetic analyses for fossil hominins relying on discrete characters. However, parsimony analysis of the landmark-based cranial data reconstructs extant primate relationships different from previous morphological and molecular analyses, likely driven by homoplasy (e.g., *Papio* recovered as sister to *Pongo* rather than to *Colobus*, *Pan* is recovered as the most basal great ape). These results suggest that GM data can be utilized to accurately reconstruct the relationships of closely related hominin taxa while highlighting directions for future work. Future work will investigate appropriate weighting schemes to combine GM data with traditional characters for total-evidence analyses, examine larger—morphological and taxonomic—matrices of fossil hominins, and consider additional factors (e.g., allometry, missing data). This study represents a promising first look at the ability to incorporate GM data into the phylogenetic inference of fossil hominins.

We thank Christopher Gilbert and Will Harcourt-Smith for their project feedback and assistance in procuring fossil casts. We thank Eva-Mercé Fuentes for her assistance in data preparation.

References: [1] Rohlf, F.J., 1998. On applications of geometric morphometrics to studies of ontogeny and phylogeny. Systematic Biology. 47, 147-158. [2] Zelditch, M.L., Fink, W.L., Swiderski, D.L., Lundrigan, B.L., 1998. On applications of geometric morphometrics to studies of ontogeny and phylogeny: a reply to Rohlf. Systematic Biology. 47, 159-167. [3] Gilbert, C.C., 2010. Phylogenetic analysis of the African papionin basicranium using 3-D geometric morphometrics: The need for improved methods to account for allometric effects. American Journal of Physical Anthropology. 144, 60–71. [4] Mongle, C.S., Strait, D.S., Grine, F.E., 2019. Expanded character sampling underscores phylogenetic stability of *Ardipithecus ramidus* as a basal hominin. Journal of Human Evolution. 131, 28–39. [5] Goloboff, P.A., Catalano, S.A., 2016. TNT version 1.5, including a full implementation of phylogenetic morphometrics. Cladistics. 32, 221–238.

Poster Presentation Number 94, Session 2, Friday 17:00 – 18:30

Lactase persistence in Western Sahel: exemplary evidence of subsistence-driven adaptation

Edita Priehodová[1], Viktor Černý[1]

1 - Archaeogenetics Laboratory, Institute of Archaeology of the Academy of Sciences of the Czech Republic, Prague, Czech Republic

The food production practices of ancestors can have a lasting impact on their descendants. One example is lactase persistence (LP) – the ability to digest lactose throughout adulthood. LP, a prime illustration of parallel evolution, has independently emerged in various populations in Africa and Eurasia. The single nucleotide polymorphism (SNP) responsible for LP occurs in five known variants. These pro-LP variants were positively selected only in populations with a history of dairy farming; therefore, LP is one of the most evident examples of genetic and cultural co-evolution. Moreover, LP is an example of ongoing selection in the human genome, which allows us to determine the selection forces attempting to spread this trait. However, the primary factor leading to the spread of pro-LP variants is still unclear. The findings of our project, which focused on LP in the Western Sahel, show a strong correlation between the appearance of LP and lifestyle. In this presentation, we aim to demonstrate findings of LP gained through various approaches: genotyping of pro-LP variants in pastoral and farmer populations in Western Africa, whole genome SNP array genotyping and NGS sequencing of the target region related to LP in Fulani, Tuaregs, and Moors—the main representatives of pastoralists in this region.

The first problem was whether subsistence as a part of cultural practices has a more substantial effect than environmental conditions. This question comes from the patchy distribution of LP in Africa. Some theories suggest that the climatic conditions influenced the selection forces that caused the spread of LP; for example, African regions with hot, dry climates favour the people who can gain liquids from milk. Nevertheless, our answer to his problem is not straightforward; our results support the theory that in the Sahel, nomadic pastoralism was the primary and most successful adaptation to climatic conditions because it seemed to be the most effective way to cope with a seasonally dry environment. Consequently, this behavioural adaptation leads to the spread of the pro-LP alleles, which raises the fitness of local populations even more. Our research reveals that high frequencies of lactase persistence are found exclusively in pastoral populations: Fulani, the Tuaregs, and Moors have a high occurrence of the pro-LP variant -13910*T (up to 60%). In contrast, neighbouring farmer populations from Burkina Faso, such as Gurunsi, Gourmatche, and Mossi, do not show any evidence of lactase persistence despite being in contact with Fulani, and there is proven gene flow between them [1-2]. Therefore, our findings demonstrate that subsistence plays a more significant role in the western Sahel than climatic conditions in this region.

Another aspect we explored is when and why the LP appeared and started to rise. Regarding the Fulani pastoralists, who have the same pro-LP variant (-13910*T) as Europeans, we investigated whether this similarity was due to convergent evolution or gene flow. In one of our previous studies [3], we analysed the surrounding haplotype of the -13910*T variant in the Fulani population and found that they share the same haplotype background with Europeans. This suggests that the -13910*T variant was introduced to the Fulani population through contact with northern African pastoral populations like the Tuaregs or the Moors. Its origin is possibly in the Near Eastern region, in the former ancestor population of European farmers and Saharan pastoralists. This intricate process of adaptive introgression, which occurs only in pastorals, adds another layer of complexity to our research. Our results not only shed light on the dynamics of this example of gene-cultural adaption but also significantly contribute to our understanding of human evolution.

The project was supported by the Grant Agency of the Czech Republic (Grant 19-09352S S-P505), the Czech Academy of Sciences award Praemium Academiae, and the Czech Academy of Sciences Programme to support prospective human resources – postdocs.

References: [1] Cerny, V., Priehodova, E., Fortes-Lima, C., 2023. A population genetic perspective on subsistence systems in the Sahel/Savannah Belt of Africa and the historical role of pastoralism. Genes 14, 14. [2] Priehodová, E., Austerlitz, F., Čížková, M., Nováčková, J., Ricaut, F.X., Hofmanová, Z., Schlebusch, C.M., Černý, V., 2020. Sahelian pastoralism from the perspective of variants associated with lactase persistence. American Journal of Physical Anthropology. 173, 423-436. [3] Vicente, M., Priehodová, E., Diallo, I., Podgorná, E., Poloni, E.S., Černý, V., Schlebusch, C.M., 2019. Population history and genetic adaptation of the Fulani nomads: inferences from genome-wide data and the lactase persistence trait. BMC Genomics 20, 915.

Podium Presentation, Session 8, Friday 15:20 – 17:00

The evolution of hominin body mass and canine size sexual dimorphism

Thomas A. Püschel[1], Jorge Avaria-Llautureo[2], Chris Venditti[2]

1 - Institute of Human Sciences, School of Anthropology and Museum Ethnography, University of Oxford, Oxford, UK · 2 - School of Biological Sciences, University of Reading, Reading, UK

Among extant and extinct anthropoid primates, sexual dimorphism is a widespread occurrence. The most noticeable secondary sex differences among anthropoids are body mass and canine size dimorphism. These two traits are particularly relevant in fossils as they can inform on socio-behavioural hypotheses about human evolution, as they are related to different reproductive and resource utilisation strategies, which are in turn crucial for understanding both present and past adaptations. Yet, to date, no study has systematically characterised the evolution of sexual body and canine size dimorphism across most hominin species or directly examined the relationship between these two dimorphic traits using a phylogenetic comparative framework. Here, we computed a sexual size dimorphism metric for several hominin species using a Bayesian mixture approach to characterise sexual size dimorphism in body mass and canine size. The obtained sexual dimorphism values were then analysed using a Bayesian phylogenetic comparative framework by comparing the statistical fit of Brownian motion versus a Directional model to elucidate the evolutionary pattern of sexual size dimorphism. Our findings indicate that a Directional model with a negative trend better fits the body mass and lower canine ratios, indicating directional changes towards diminished sexual dimorphism in these traits. Moreover, our approach enabled us to discern changes in male and female size independently, facilitating an evaluation of the respective contributions of each sex to sexual size dimorphism levels throughout human evolution. We found a positive trend in female body mass, thus suggesting that female body mass drove the general decrease in size sexual dimorphism observed in human evolution. We also found a negative trend in male lower canine size, thus suggesting that male canine size reduction drove the general decrease in canine sexual dimorphism. These findings underscore the relevance of understanding sexual size dimorphism among hominins, and highlight the intricate interplay between reproductive strategies, resource utilisation, and phenotypic adaptations over time.

This project was funded by the Leverhulme Trust (RL-2019-012).

Poster Presentation Number 95, Session 2, Friday 17:00 – 18:30

A quantitative assessment of technical and stylistic evolution of backed armatures during the Late Glacial in NE Iberia

José Ramón Rabuñal[1,2,3], Felix Riede[3]

1 - GEPN-AAT, Grupo de Estudos para a Prehistoria do Noroeste Ibérico–Arqueoloxía, Antigüidade e Territorio, Department of History, Faculty of Geography and History, University of Santiago de Compostela, Santiago de Compostela, Spain · 2 - Centro de Investigación Interuniversitario das Paisaxes Atlánticas (CISPAC), Edificio Fontán, Cidade da Cultura de Galicia, Santiago de Compostela, Spain · 3 - Department of Archaeology and Heritage Studies, Aarhus University, Højbjerg, Denmark

Eastern Iberian Late Glacial lithic assemblages –commonly labelled as Final Upper Magdalenian– are described as microblade industries chiefly characterized by endscrapers and backed artefacts. Based on the overall stability of their general design in terms of production and typological composition, their continuity with respect to the Mediterranean Late Magdalenian industries is beyond question [1-3]. Yet, some diachronic patterns of subtle modifications have been suggested, including varying stylistic configurations of backed artefacts and a microlithisation of the armatures. The latter is also expressed in the incorporation of geometric microliths from around 12.7 ka cal BP, which led to the definition of a 'Sauveterrian' facies. The definition of this novel cultural taxonomic unit is not without problems, however, as assemblages with and without geometrics coexist all through the Younger Dryas and during the early Holocene.

In this paper, we interrogate the variability and cultural evolution in Late Glacial lithic industries from Eastern Iberia by testing competing hypotheses about the evolutionary dynamics of backed armatures suggested in the literature. We tested whether there is i) a microlithisation process, ii) a shift in the frequency of straight backs to curved backs, and iii) an increase in the frequency of bipolar backs. Furthermore, we also tested whether iv) the introduction of geometric armatures is accompanied by increased morphological standardization of the backed points. We conducted attribute-based morpho-technical analysis and 2D outline-based Geometrics Morphometrics of a sample of 90 backed points from six archaeological levels from two key Late Glacial sequences from NE Iberia: Cova de Les Borres (Layers 2, 1.2 and 1.1) and Abric del Filador (Layers VI, V and IV-III). Both sites are located in the Catalan Pre-coastal mountain range, only about 20 km apart. Notably, they are two of the very few sites across all of Eastern Iberia documenting successive Late Glacial occupation associated with the Final Upper Magdalenian and the Sauveterrian, in a stratigraphic sequence lacking erosive hiatuses [4-5]. Their geographical proximity and the synchronicity of their sequences render their analysis complementary and comparable, offering particularly valuable insights into processes of technological evolution.

We have tested the variability in the dimensions, configuration attributes and shape of a sample of backed armatures with particular attention to intra-site diachronic variability across each sequence according to three phases (Final Upper Magdalenian, Sauveterrian 1 and Sauveterrian 2), diachronic variability across those same three phases but integrating both sites, and comparison of the aggregated sites and techno-complexes (Final Upper Magdalenian vs. Sauveterrian). Our analysis quantitatively corroborates the notion of armature microlithisation but does not find support for a parallel morphological standardization. Interestingly, for other cases such as back delineation or retouch direction, both sites show different characteristics and trajectories, and the alleged evolutionary patterns only emerge after their aggregation by phases and techno-complexes. This highlights, we argue, the critical interplay between idiosyncratic processes and supposedly culture-wide norms.

Our work serves as a robust foundation for subsequently expanding the sample of backed armatures. A larger sample from a bigger region and more sites will allow us to investigate stylistic variability among the backed artefacts at regional and macro-regional scales. In addition, future research will integrate other domains of lithic technological variability, such as production strategies. In doing so, we will be able to arrive at a more nuanced understanding of Final Upper Magdalenian technological variability and explore cultural evolutionary processes such as regionalization or assemblage diversification related to site function.

This research is funded by the Generalitat de Catalunya (CLT009/18/00053, CLT009/22/000024, CLT009/18/00024, ARQ001SOL-172-2022) AGAUR (2017 SGR 836, 2021 SGR 001237, 2021 SGR 00337)) and La Febró council. This research was supported by the Spanish Ministry of Science and Innovation through the project PID2020-113960GB-I00 and the "María de Maeztu"excellence accreditation (CEX2019-000945-M). J.R.R. is supported by a Juan de la Cierva postdoctoral fellowship (JDC2022-050014-I) - MICIU/AEI/10.13039/501100011033 and European Union NextGenerationEU/PRTR. F.R. contribution is part of CLIOARCH, an ERC Consolidator Grant project that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 817564).

References: [1] Román, D., García-Argüelles, P., Nadal, J. y Fullola, J.M., 2021. The late microblade complexes and the emergence of geometric microliths in Northeastern Iberia. In: Borić, D., Antonović, D. y Mihailović, B. (Eds.). Foraging Assemblages, vol. 2., Serbian Archaeological Society, Belgrade, pp. 457-463. [2] Román, D., García-Argüelles, P., Fullola, J.M., 2020. Las facies microlaminares del final del Paleolitico en el Mediterráneo ibérico y el valle del Ebro. Monografies del SERP, no17. SERP-Universitat de Barcelona i Societat Catalana d'Arqueologia, Barcelona. [3] Soto, A., Alday, A., Mangado, X., Montes, L., 2016. Epipaleolítico y Mesolítico en la vertiente sur de los Pirineos desde la perspectiva de la industria lítica. Munibe Antropologia-Arkeologia. 67, 295–312. [4] García-Argüelles Andreu, P., Nadal I Lorenzo, J., Fullola I Pericot, J.M., 2005. The Filador Rock Shelter (Margalef de Montsant, Tarragona) and its cultural and chronological context in Northeastern Iberia. Trabajos de Prehistoria. 62, 65-83. [5] Rabuñal, J.R., Soto, M., Morales, J.I., Lombao, D., Soares-Remiseiro, M., Fernández-Marchena, J.L., Vallverdú, J., Under review. La secuencia tardiglaciar de la Cova de Les Borres (La Febró, Tarragona). Trabajos de Prehistoria.

Podium Presentation, Session 4, Thursday 16:20 – 18:00

New insights into Neanderthal cannibalism integrating biomolecular methods, zooarchaeology and histotaphonomy: the case of Abri Moula (France)

Pauline Raymond[1], Karen Ruebens[1,2], Geoff M. Smith[2,3], Klervia Jaouen[4], Manon Armengaud[4], Frido Welker[5], Jean-Jacques Hublin[1,6]

1 - Paleoanthropology Chair, CIRB, Collège de France, PSL University, CNRS, INSERM, Paris, France · 2 - University of Reading, Reading, UK · 3 - School of Anthropology and Conservation, University of Kent, Canterbury, UK · 4 - Géosciences Environnement Toulouse, Observatoire Midi Pyrénées, UMR 5563, CNRS, Toulouse, France · 5 - Globe Institute, University of Copenhagen, Copenhagen, Denmark · 6 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

The early 20th-century discovery of the Krapina site by Gorjanović-Kramberger (1906) [1] marked the beginning of a long-standing discussion on Neanderthal cannibalism. Cut-marked human remains have been noted at different Palaeolithic sites; however, the interpretation of such evidence as definitive signs of cannibalism remains contentious and requires further investigation. At the key site of Abri Moula (Ardèche, France) over 100 Neanderthal bones from at least six individuals have been found, most with anthropogenic modifications suggestive of cannibalistic practices [2]. The remains were found in layer XV (MIS-5, 97 ± 10 ka - 119 ± 13 ka) relating to a climatic transition from cold to more temperate conditions. Cannibalism was interpreted as a survivalist behavior at Abri Moula, resulting from this climatic and environmental instability [3]. This study reevaluates Neanderthal cannibalism at Abri Moula through the integration of morphological identified material alongside a multifaceted analysis of the morphologically unidentifiable bone fragments from layer XV.

Zooarchaeological and taphonomic analyses (e.g. bone elements, anthropogenic and carnivore modifications) were combined with a range of biomolecular methods, including paleoprotomics (ZooMS and SPIN [4]), stable isotopes (carbon and nitrogen) and microtomographic virtual histology [5]. In total, 946 morphologically unidentifiable bone fragments were sampled for collagen fingerprinting (ZooMS) with excellent collagen preservation (87.5% identification rate). Bird bones were identified for the first time, alongside a significant amount of new human remains (n=43). The ZooMS sample illustrates differences in the species representation, with more Cervinae, and fewer human remains, compared to the morphological identifications. Glutamine deamidation values, indicators of collagen preservation, revealed varying preservation patterns, with differences between humans and bears. Shotgun proteomics [Species by Proteome INvestigation (SPIN)] was applied to a subsample of human (n=10) and Bos/Bison (n=10) remains to verify and enhance the ZooMS identifications to provide additional palaeoecological information.

Human modifications on the ZooMS fragments, resulting from butchery practices (e.g. marrow fractures and cut marks), were compared to the morphological assemblage, unexpectedly showing lower amounts of human modifications on the ZooMS human remains (7.0%) than on other ungulates (e.g. Cervinae 20.9%, Equidae 26.7%). This suggests a differential treatment of the carcasses. Human modifications were also observed on Reindeer, Suidae, Rhinocerotidae and Ursidae, which had not been reported previously. The analysis of carbon and nitrogen stable isotopes on faunal bones (n=15) were successful in retrieving significant amounts of collagen despite the age of the site and provide fresh insights on their environment and diet, especially for the carnivores. Hence, additional isotope analyses on the Neanderthal remains are planned. Finally, 75 ZooMS-identified fragments were micro-CT scanned for a virtual histotaphomomic assessment, which when applied to animal and human bones can enable to assess whether a carcass was deposited fully fleshed or disarticulated according to the bacterial bioerosion traces observed.

Overall, this study demonstrates the power of applying a multidisciplinary approach to enhance our understanding of hallmark sites such as Abri Moula. By studying existing museum collections through an integrative approach, combining paleoproteomics, zooarchaeology, taphonomy and stable isotopes, we can achieve novel perspectives on complex behaviours like Neanderthal cannibalism, challenging existing assumptions and unraveling the intricacies of past human behavior.

This PhD project is founded by the Labex MemoLife grant. We thank the regional archeology service (SRA) of the Auvergne-Rhône-Alpes region and the Museum of Soyons (Ardèche) for giving us access to the Abri Moula collection. We also thank Nicolas Vanderesse (PACEA, UMR 5199, University of Bordeaux) for the micro-CT scans of the bones. GMS was funded by the European Union's Horizon 2020 research and innovation programme (grant agreement 101027850). The stable isotopes analysis is funded by the ERC ARCHEIS project (grant number 803676).

References: [1] Gorjanović-Kramberger, D., 1906. Der diluviale mensch von krapina in kroatien: ein beitrag zur paläoanthropologie. CW Kreidel, Wiesbaden. [2] Defleur, A., White, T., Valensi, P., Slimak, L., Crégut-Bonnoure, E., 1999. Neanderthal Cannibalism at Moula-Guercy, Ardèche, France. Science. 286, 128–131. [3] Defleur, A.R., Desclaux, E., 2019. Impact of the last interglacial climate change on ecosystems and Neanderthals behavior at Baume Moula-Guercy, Ardèche, France. Journal of Archaeological Science. 104, 114–124. [4] Rüther, P.L., Husic, I.M., Bangsgaard, P., Gregersen, K.M., Pantmann, P., Carvalho, M., Godinho, R.M., Friedl, L., Cascalheira, J., Taurozzi, A.J., Jørkov, M.L.S., Benedetti, M.M., Haws, J., Bicho, N., Welker, F., Cappellini, E., Olsen, J.V., 2022. SPIN enables high throughput species identification of archaeological bone by proteomics. Nature Communications. 13, 2458. [5] Dal Sasso, G., Maritan, L., Usai, D., Angelini, I., Artioli, G., 2014. Bone diagenesis at the micro-scale: Bone alteration patterns during multiple burial phases at Al Khiday (Khartoum, Sudan) between the Early Holocene and the II century AD. Palaeogeography, Palaeoclimatology, Palaeoecology. 416, 30–42.

Poster Presentation Number 96, Session 2, Friday 17:00 – 18:30

Improved radiocarbon dating of archaeological bone collagen using XAD-2 resin: a case study from the early Upper Palaeolithic sites of Geißenklösterle and Lommersum

Alisa Redtenbacher[1], Laura van der Sluis[1,2], Maddalena Giannì[1,2], Tom Higham[1,2]

1 - Department of Evolutionary Anthropology, Faculty of Life Sciences, University of Vienna, Vienna, Austria · 2 - Human Evolution and Archaeological Science (HEAS) Network, Vienna, Austria

The transition from the Middle Palaeolithic to the Upper Palaeolithic witnesses the transition from Neanderthals to *Homo sapiens*. In tandem we observe a wide variation in the different lithic technocomplexes present. For many years, the Aurignacian has been widely accepted as one of the first industries solely associated with modern humans. There are, however, many questions concerning its origin, development, definition and variations. The Swabian Jura, southwestern Germany, is a key area in this debate. Geißenklösterle is among the many important sites, as it has been suggested that it may be where the Aurignacian first appeared in central Europe. Similarly, Lommersum is an important Aurignacian open-air site documenting the presence of this lithic technocomplex. Questions have arisen when it comes to the dating and interpretation of Geißenklösterle, particularly the Aurignacian levels. While radiocarbon dating is an immensely important method for dating of organic materials, recent redating of materials at numerous sites has shown that due to insufficient pretreatment methods many dates are not reliable. When it comes to Aurignacian sites like Geißenklösterle and Lommersum, this is especially acute since the samples are close to the limit of radiocarbon dating (~50 000 years ago).

To test the reliability of the dates from these two sites we have applied an XAD-2 resin purification approach. We wanted to test whether this method can successfully remove contaminants in comparison with other bulk collagen methods. It is possible for humic acids to crosslink to collagen, making them difficult to remove with a classical chemistry treatment. If humics are crosslinked to collagen, the collagen structure must be broken apart to release this contamination, which happens during the hydrolysis step of the XAD purification method. Compared to dating of single amino acids like hydroxyproline, the XAD-2 method enables all the collagen amino acids in a sample to be dated. For this reason, XAD-2 preparation is attractive because the sample yields are higher and the precision of the resulting AMS date is increased [1-4].

We will place the new results from Geißenklösterle and Lommersum within a wider perspective. A Bayesian model will be built to model the early occupation of *Homo sapiens* at Geißenklösterle and Lommersum, and the results will be compared to similar sites across Europe. The aims are to answer the question of whether Geißenklösterle represents an early appearance of the Aurignacian or whether the industry found there should be classified as something else.

References: [1] van der Sluis, L.G., Zazzo, A., Tombret, O., Thil, F., Pétillon, J.-M., 2023. Testing the use of XAD resin to remove synthetic contamination from archaeological bone prior to radiocarbon dating. Radiocarbon. 65, 1160–1175. [2] Waters, M.R., Stafford, T.W., Kooyman, B., Hills, L.V., 2015. Late Pleistocene horse and camel hunting at the southern margin of the ice-free corridor: Reassessing the age of Wally's Beach, Canada. Proceedings of the National Academy of Sciences. 112, 4263–4267. [3] Stafford, T.W., Brendel, K., Duhamel, R.C., 1988. Radiocarbon, ^{13}C and ^{15}N analysis of fossil bone: Removal of humates with XAD-2 resin. Geochimica et Cosmochimica Acta. 52, 2257–2267. [4] Stafford, T.W., Hare, P.E., Currie, L., Jull, A.J.T., Donahue, D.J., 1991. Accelerator radiocarbon dating at the molecular level. Journal of Archaeological Science. 18, 35–72.

Pecha Kucha Presentation (virtual), Session 7, Friday 13:30 – 15:00

Vindija: a new look at the frontal bone morphology

Carolin Röding[1,2], Ivor Janković[3], Katerina Harvati[1,2,4]

1 - Paleoanthropology, Senckenberg Centre for Human Evolution and Palaeoenvironment, Eberhard Karls University of Tübingen, Tübingen, Germany · 2 - Paleoanthropology, Institute for Archaeological Sciences, Eberhard Karls University of Tübingen, Tübingen, Germany · 3 - Centre for Applied Bioanthropology, Institute for Anthropological Research, Zagreb, Croatia · 4 - DFG Centre of Advanced Studies 'Words, Bones, Genes, Tools', Eberhard Karls University of Tübingen, Tübingen, Germany

The fossil assemblage from Vindija Cave, Croatia, provides a unique opportunity to study frontal bone morphology in Neanderthals. Fragmentary remains originating from layers F, G, and I at Vindija cave have been assigned to Neanderthals based on overall morphology as well as ancient DNA analyses. Despite this attribution, Wolpoff et al. [1] described some anatomical traits, like thinner and less projecting supraorbital tori as well as possibly higher foreheads, as more similar to *Homo sapiens* than Neanderthals. A total of ten fragments from Vindija preserve parts of the brow region including the supraorbital torus. Previous comparative studies of the adult sample also found some intermediate morphology in the Vindija frontals on the basis of single linear measurements (e.g., [2]).

Here, we present the first results of an ongoing study employing the toolkit of virtual anthropology to place the brow ridge morphology from Vindija in a comparative 3D shape framework. The preliminary results focus on the individual Vi-11.1+11.1a. Vi-11.1+11.1a comprises two fragments of the same adult individual that preserve aspects of the midsagittal plane and the left supraorbital torus. The two original fragments are glued together along their matching breaking edge. Therefore, a single surface scan was acquired for Vi-11.1+11.1a using an Artec Space Spider by one of us (CR). The surface was extracted as triangular mesh and reconstructed via mirroring along the midsagittal plane (see [3]). This procedure was repeated six times and all resulting reconstructions were used in a preliminary shape analysis.

Although Vi-11.1+11.1a is the largest frontal bone fragment within the Vindija sample and its reconstructions exhibit an almost complete supraorbital torus, the number of preserved homologous osteometric points is limited. We therefore employed the surface registration method [4], which relies on a reduced number of landmarks compared to typical landmark-based geometric morphometric approach. This approach creates a dataset of meshes with an identical number of corresponding vertices for the brow region. Our comparative dataset included seven Neanderthals spanning central Europe as well as Western Asia; the three European Middle Pleistocene individuals Petralona, Arago 21, and Sima de los Huesos 5; and a diverse *Homo sapiens* sample ranging from Skhul 5 to European Upper Paleolithic and Holocene individuals.

Multivariate analyses (PCA) of the reconstruction of Vi-11.1+11.1a reflect the expected separation between *H. sapiens* with a flattened supraorbital trigon (more positive PC1 scores) and Neanderthals/Middle Pleistocene individuals with a prominent supraorbital region (more negative PC1 scores). All the Vi11.1+11.1a reconstructions plot with our Neandertal sample and show no intermediate shape between Neanderthals and modern humans. Our preliminary results, therefore, showed no effect of the proposed reduction of the supraorbital torus in the Vindija assemblage on its clear affinities to Neanderthals with regard to specimen Vi-11.1.+11.1a.

This study demonstrates the great potential of virtual anthropology and methods like surface registration for advancing the understanding of the important, but highly fragmentary, remains from Vindija Cave. Such work will help shed light both on the taxonomic affinities and the morphological variation within this important fossil assemblage.

This research was supported by the ERC AdG FIRSTSTEPS (101019659) and COST Action CA19141 - Integrating Neandertal Legacy: From Past to Present (iNEAL). We thank all collaborators, curators, and their institutions for access to original specimens or CT scans used in this study.

References: [1] Wolpoff, M.H., Smith, F.H., Malez, M., Radovčić, J., Rukavina, D., 1981. Upper pleistocene human remains from Vindija cave, Croatia, Yugoslavia. American Journal of Physical Anthropology. 54, 499–545. [2] Ahern, J.C.M., Lee, S.-H., Hawks, J.D., 2002. The late Neandertal supraorbital fossils from Vindija Cave, Croatia: a biased sample? Journal of Human Evolution. 43, 419–432. [3] Brdarić, M., Röding, C., Janković. I., Harvati, K., submitted abstract. From Fragments to a Face: Virtual Reconstruction of Neanderthal cranial fragments from Vindija Cave. [4] Röding, C., Stringer, C., Lacruz, R.S., Harvati, K., 2022. Mugharet el'Aliya: Affinities of an enigmatic north African Aterian maxillary fragment. American Journal of Biological Anthropology. 180, 352–369.

Pecha Kucha Presentation (virtual), Session 2, Thursday 11:20 – 12:50

Megaherbivore isotopic biogeochemistry supports glacial microrefugium status of the Megalopolis Basin (Greece) across the Middle Pleistocene

Effrosyni Roditi[1], Hervé Bocherens[2,3], George E. Konidaris[1,3], Athanassios Athanassiou[4], Vangelis Tourloukis[1,5], Panagiotis Karkanas[6], Eleni Panagopoulou[4], Katerina Harvati[1,3]

1 - Paleoanthropology, Institute for Archaeological Sciences, Department of Geosciences, Eberhard Karls University of Tübingen, Tübingen, Germany · 2 - Biogeology, Department of Geosciences, Eberhard Karls University of Tübingen, Tübingen, Germany · 3 - Senckenberg Centre for Human Evolution and Paleoenvironment, University of Tübingen, Tübingen, Germany · 4 - Hellenic Ministry of Culture, Ephorate of Paleoanthropology–Speleology, Athens, Greece · 5 - Department of History and Archaeology, School of Philosophy, University of Ioannina, Greece · 6 - M.H. Wiener Laboratory for Archaeological Science, American School of Classical Studies at Athens, Greece

After the Mid-Pleistocene Climate Transition, Eurasian ecosystems were governed by longer (~100 ky) but higher amplitude climatic periodicity (glacial-interglacial cycles). The increased intensity of the glacial cycles impacted floral, faunal, and hominin biogeography. Glacial refugial areas in Peninsular southern Europe had a prominent role in the survival and persistence of several taxa. Here, we present evidence for the existence of a microrefugium in the Megalopolis Basin (Peloponnese, Greece) at the southernmost part of the Balkan Peninsula.

We reconstructed individual megaherbivore ecologies through isotopic biogeochemistry to infer millennial and decadal scale climatic and environmental conditions in the area between 700 and 450 ka. The studied specimens originate from five Middle Pleistocene fossiliferous sites in the Megalopolis Basin [1-4], namely Marathousa 1 (ca. 450 ka), Marathousa 2 (ca. 450 ka), Kyparissia 3 (ca. 650 ka), Kyparissia 4 (ca 700 ka), and Kyparissia-T (early Middle Pleistocene). The contextual association of the specimens with hominin activity, either directly in the form of butchering marks or indirectly through their stratigraphic association with stone tools, extended our interpretations to the hominin paleoenvironmental niche in the basin. We employed carbon, oxygen, and strontium isotope analyses on enamel carbonates of *Palaeoloxodon antiquus* (n=1) and *Hippopotamus antiquus* (n=5) specimens to reconstruct their foraging patterns, habitat and mobility, as well as the climatic conditions in the basin during different chrono-stratigraphic intervals. A sequential sampling strategy on herbivore teeth that grow over multiple years, such as continuously growing hippopotamus tusks and elephant molars, provides sub-annual and decadal-scale stable isotope data for the selected individuals.

Carbon isotopes of both *P. antiquus* and *H. antiquus* enamel revealed the persistence of C_3-dominated ecosystems and a mosaic of habitats in the basin, including forested patches and mesic open woodland/grassland. Oxygen isotopes indicate mild hydrological and climatic conditions, even during cold glacial stages. The intra-tooth isotopic profiles revealed moderate seasonality in the basin. *Hippopotamus antiquus* carbon isotope profiles likely demonstrate dietary adaptions to seasonally available resources, whereas multi-annual fluctuations in the carbon isotopic composition of *Palaeoloxodon antiquus* suggest limited mobility within the basin for the exploitation of diverse micro-habitats [5]. Overall, the Megalopolis Basin provided both climatic and ecological or environmental stability, thus facilitating the survival of these megaherbivores throughout multiple glacial stages. These results offer further substantiation to the basin's role as a microrefugium, an area in which organisms survived through adverse conditions and from which they were able to re-establish viable populations in northern settings during climatic amelioration, but also highlight the resilience and adaptability of both megafauna and hominin populations to changing environments.

Excavation at Marathousa 1 was conducted under a permit granted to the Ephorate of Palaeoanthropology-Speleology, Hellenic Ministry of Culture. This research was funded by the European Research Council (ERC-StG-283503 and ERC-CoG-724703, awarded to K. Harvati). Megalopolis Palaeoenvironmental Project (MEGAPAL) is a collaboration between the Ephorate of Palaeoanthropology-Speleology and the American School of Classical Studies at Athens, under the direction of Dr. Panagopoulou, Dr. Karkanas and Prof. Dr. Harvati and funded by the European Research Council (CoG 724703). K.H., G.E.K., and V.T. were also supported by the DFG Project no. 463225251 ("MEGALOPOLIS"). E.R. and K.H. are also supported by ERC-AdG-101019659.

References: [1] Panagopoulou, E., Tourloukis, V., Thompson, N., Konidaris, G., Athanassiou, A., Giusti, D., Tsartsidou, G., Karkanas, P., Harvati, K., 2018. The Lower Palaeolithic site of Marathousa 1, Megalopolis, Greece: Overview of the evidence. Quaternary International. 497, 33–46. [2] Konidaris, G., Athanassiou, A., Tourloukis, V., Thompson, N., Giusti, D., Panagopoulou, E., Harvati, K., 2018. The skeleton of a straight-tusked elephant (*Palaeoloxodon antiquus*) and other large mammals from the Middle Pleistocene butchering locality Marathousa 1 (Megalopolis Basin, Greece): preliminary results. Quaternary International. 497, 65–84. [3] Karkanas, P., Tourloukis, V., Thompson, N., Giusti, D. Tsartsidou, G., Athanassiou, A., Konidaris, G., Roditi, E., Panagopoulou, E., Harvati, K., in press. The Megalopolis Paleoenvironmental Project (MEGAPAL), CROSSROADS. In Human evolution at the CROSSROADS: Research in Greece and beyond, Eds. M. Ioannidou & K. Harvati. [4] Athanassiou, A., Michailidis, D., Vlachos, E., Tourloukis, V., Thompson, N., Harvati, K., 2018. Pleistocene vertebrates from the Kyparíssia lignite mine, Megalopolis Basin, S. Greece: Testudines, Aves, Suiformes. Quaternary International. 497, 178–197. [5] Roditi, E., Bocherens, H., Konidaris, G., Athanassiou, A., Tourloukis, V., Karkanas, P., Panagopoulou, E., Harvati, K., 2024. Life-history of *Palaeoloxodon antiquus* reveals Middle Pleistocene glacial refugium in the Megalopolis basin, Greece. Scientific Reports. 14., 1390.

Pecha Kucha Presentation, Session 2, Thursday 11:20 – 12:50

Developmentally plastic trabecular bone sheds new light on the role of arboreal locomotion in hominin evolution

Jaap Saers[1]

1 - Naturalis Biodiversity Center

Humans are the only apes that do not rely for their survival on the arboreal locomotion that characterises the niches of all other living apes. Climbing affords access food and safety from danger, especially for infants. Therefore, abandoning the ability to climb from a young age must have presented early hominins with significant challenges in terms of food access, predator avoidance, and infant transportation [1]. Despite its evolutionary importance, the nature and pacing of the shift from a partially arboreal to fully terrestrial lifestyle remains contested. Alongside clear adaptations to bipedal locomotion, early hominins retained 'ape-like' anatomical features associated with arboreal locomotion in modern apes. These ape-like traits are interpreted in two ways [2]: 1) like other African apes, early hominins relied on combinations of arboreal and terrestrial locomotion, or 2) the ape-like traits were unused retentions of an ancestral state. Falsifying these hypotheses requires developmentally plastic skeletal traits reflective of locomotion during life. A large body of work has demonstrated that trabecular bone structure dynamically adapts to variation in loading conditions and therefore represents a functional record of habitual behaviour [3-4].

The aims of this project are 1) to compare variation in the distribution of trabecular bone in whole joints throughout the upper limb of modern humans and other extant apes with varying locomotor repertoires, 2) link variation in species typical locomotor behaviour to trabecular bone structure throughout the upper limb in extant taxa, and 3) compare trabecular structure in fossil hominins to extant taxa and determine if the upper limb was used in locomotion. Trabecular bone structure was imaged using high resolution microCT scanning in the distal humerus of South African hominins (*Australopithecus africanus*, *A. sediba*, *Paranthropus robustus*, *Homo naledi*) and extant apes (gibbons, gorillas, chimpanzees, orangutans, humans). CT scans were digitally segmented using a deep learning algorithm. Variation in trabecular bone structure was then quantified throughout whole bones using a custom written R package (Trabmap).

In non-human apes, trabecular bone is strongly reinforced in regions that are loaded during climbing but not during other locomotor activities, such as the attachment of the finger flexors on the medial epicondyle, and the posterior aspect of the trochlea. *Australopithecus* and *Paranthropus* show the ape-like condition where regions associated with heavy loading during climbing are reinforced. These results provide support for the continued importance of climbing in South African hominins for millions of years after the evolution of bipedalism. The comparison of developmentally plastic traits such as trabecular bone in a broader sample of hominin fossils may provide exciting new insights into hominin paleobiology, such as the functional relevance of ancestral traits, inter- and intraspecific variation in locomotor behaviour, and how a mixed terrestrial and arboreal locomotor strategy fits into the adaptive landscape.

This project has received funding from the European Union's Horizon 2021 research and innovation programme under the Marie Sklodowska Curie grant agreement number 101066276.

References: [1] Saers, J.P.P., 2023. Skeletal indicators of developmental changes in arboreality and locomotor maturation in extant apes and their relevance to hominin paleobiology. Frontiers in Ecology and Evolution. 11, 1274762. [2] Alemseged, Z., 2023. Reappraising the palaeobiology of *Australopithecus*. Nature. 617, 45–54. [3] Kivell, T.L., 2016. A review of trabecular bone functional adaptation: what have we learned from trabecular analyses in extant hominoids and what can we apply to fossils? Journal of Anatomy. 228, 569–594. [4] Saers, J.P.P., DeMars, L.J., Stephens, N.B., Jashashvili, T., Carlson, K.J., Gordon, A.D., Shaw, C.N., Ryan, T.M., Stock, J.T., 2020. Combinations of trabecular and cortical bone properties distinguish various loading modalities between athletes and controls. American Journal of Physical Anthropology. 174, 434–450.

Poster Presentation Number 97, Session 2, Friday 17:00 – 18:30

Exploring clavicular ontogeny: insights from 3D geometric morphometric analysis of subadult clavicles from Sima de los Huesos

Azahara Salázar[1], Laura Rodríguez[1,2], Yulieth Quintino[1,3], Juan Luis Arsuaga[4,5], José Miguel Carretero[1,6], Rebeca García-González[1]

1 - Laboratorio de Evolución Humana, Departamento de Historia, Geografía y Comunicación, Universidad de Burgos, Burgos, Spain · 2 - Área de Antropología. Universidad de León, León, Spain · 3 - Centre for Ecology, Evolution and Environmental Changes, Faculdade de Ciencias, Universidade de Lisboa, Lisboa. Portugal · 4 - Centro UCM-ISCIII de Investigación sobre la Evolución y Comportamiento Humanos, Madrid, Spain · 5 - Departamento de Paleontología, Facultad de Ciencias Geológicas, Universidad Complutense de Madrid, Ciudad Universitaria Madrid, Spain · 6 - Unidad Asociada de I+D+i al CSIC Vidrio y Materiales del Patrimonio Cultural (VIMPAC), Madrid, Spain

The clavicle serves as a fundamental component in upper body function, providing essential support and facilitating a wide range of movements. Functioning as a supportive strut, it maintains the arms at a lateral distance from the trunk, thereby expanding the shoulder girdle's mobility [1]. This bone is also known for its extended skeletal maturation process; it begins ossification around 9 weeks in utero and typically fully fuses between the ages of 20 and 25 years. Thus, it is the first bone to initiate ossification and the last one to complete it fully. Despite its importance, paleoanthropologists historically overlooked the evolutionary trajectory of the hominid clavicle in comparison to other long bones due to its intricate morphology and the scarcity of well-preserved specimens in the fossil record [2]. Nonetheless, despite these challenges, relative recent comparative analyses have yielded valuable insights into clavicular length and curvature, thereby revealing morphological distinctions among species [3]. A similar predicament is evident in studies of ontogeny in paleoanthropology, which have also been constrained not only by the lack of archaeological remains, but also by the absence of studies conducted on our own species that could serve as comparisons for this archaeological material.

One of the most renowned paleoanthropological sites, the Middle Pleistocene site of Sima de los Huesos (SH) has provided a wealth of skeletal remains, with subadult postcranial bones representing approximately 60% of the findings [4]. This makes it a promising source for studying the developmental aspects of the postcranial skeleton in a fossil human species. Therefore, in this research we focus on three different immature clavicles from the SH site [5]. For comparative purposes our research introduces a novel approach by applying 3D geometric morphometrics (3DGM) to analyze the ontogeny of the clavicle using a mixed modern human sample of 131 individuals with ages from birth to 21 years old. This mixed sample consists of the know age collection of the Natural History Museum in Lisbon and San Pablo archaeological collection housed at Laboratory of Human Evolution at University of Burgos.

The San Pablo collection was 3D scanned using the structured-light scanner EinScan Pro (Shining 3D Tech. Co., Ltd. Hangzhou, China). Whereas the Bocage Museum collection was 3D scanned using the NextEngine Desktop 3D laser scanner (NextEngine, Inc., Malibu, CA). Regarding the SH sample was digitalized from CT scans. All 3D models were exported as .ply files to Autodesk Meshmixer (RRID:SCR_015736) for treating minor defects (i.e closing holes). For the 3DGM analyses, a template configuration of 14 fixed landmarks and 102 curve semilandmarks was created to capture the morphology of the clavicle using Stratovan Checkpoint (Stratovan Corporation 2020). Further statistical process analysis was executed though the softwares MorphoJ and Past 4.13.

Our findings show that most shape changes assessed through 3DGM follow a development sequence which allow us to tentatively estimate a skeletal age in SH non-adult clavicles. However, SH clavicles differ from those of modern humans in certain aspects of clavicular shape, which may be related to factors other than age, such as body shape differences.

We thank the Sima de los Huesos excavation team and the Laboratory of Human Evolution from the University of Burgos. This project is funded by a PhD grant co-funded by the Government of Castilla y León and the European Union -BOCYL-D-07/07/2020 nº 135 p. 23452- and Spanish Ministry of Science, Innovation and Universities project PID2021-122355NB-C31.

References: [1] Rosas, A., Rodriguez-Perez, F.J., Bastir, M., Estalrrich, A., Huguet, R., García-Tabernero, A., Pastor, J.F., De La Rasilla, M., 2016. Adult Neandertal clavicles from the El Sidrón site (Asturias, Spain) in the context of Homo pectoral girdle evolution. Journal of Human Evolution/Journal of Human Evolution. 95, 55–67. [2] Taylor, C.E., Masao, F., Njau, J.K., Songita, A.V., Hlusko, L.J., 2023. OH 89: A newly described ~1.8-million-year-old hominid clavicle from Olduvai Gorge. bioRxiv (Cold Spring Harbor Laboratory). [3] Trinkaus, E., Holliday, T.W., Auerbach, B.M., 2014. Neandertal clavicle length. Proceedings of the National Academy of Sciences of the United States of America. 111, 4438–4442. [4] Arsuaga, J.L., Carretero, J.-M., Lorenzo, C., Gómez-Olivencia, A., Pablos, A., Rodríguez, L., García-González, R., Bonmatí, A., Quam, R.M., Pantoja-Pérez, A., Martínez, I., Aranburu, A., Gracia-Téllez, A., Poza-Rey, E., Sala, N., García, N., De Velasco, A.A., Cuenca-Bescós, G., De Castro, J.M.B., Carbonell, E., 2015. Postcranial morphology of the middle Pleistocene humans from Sima de los Huesos, Spain. Proceedings of the National Academy of Sciences of the United States of America. 112, 11524–11529. [5] García-González, R., Rodríguez, L., Salazar-Fernández, A., Arsuaga, J.L., Carretero, J., 2023. Updated study of adult and subadult pectoral girdle bones from Sima de los Huesos site (Sierra de Atapuerca, Burgos, Spain). Anatomical and age estimation keys. The Anatomical Record. 1–28.

Poster Presentation Number 98, Session 2, Friday 17:00 – 18:30

Lullaby of little bones: a multidisciplinary approach for the study of perinatal and infant burials in Late Bronze and Iron Ages north-central Iberia

Javier Salcines-Montaña[1], Teresa Fernández-Crespo[1]

1 - Departamento de Prehistoria, Arqueología, Antropología Social y Ciencias y Técnicas Historiográficas, Universidad de Valladolid, Spain

Perinatal and infant individuals have been and continue to be virtually non-existent in the construction of narratives related to prehistoric communities. Although research on infancy is experiencing a growing development in archaeology, these subjects continue to occupy a small place on the margins, and their actual experiences within society are not easy to read [1]. During the last stages of prehistory, in a large part of Europe, including the Iberian Peninsula, the dominant funerary ritual consisted of the cremation of the deceased and the deposition of the remains in ceramic urns destined for burial outside the settlements. However, in some regions there also was a differential ritual for some perinatal and infant individuals, consisting of the burial of their bodies in domestic contexts [2], making the bone remains of these individuals the main representation of the osteological record. This is the case of north-central Iberia, which hosts a privileged sequence of over 400 intramural burials of perinatal and infant individuals in domestic contexts spanning a millennium between the Late Bronze and Iron Ages.

The study of this population segment requires a particular and refined methodology. A multidisciplinary approach that targets not only the determination of the developmental conditions of the perinatal and infant individuals or the patterns of infant mortality, but also the community's strategies with regard to aspects like fertility, demographics and social attitudes, especially those surrounding infanthood, is necessary. Here we present a methodology based on three approaches. First, osteology and dental histology will be used to estimate the palaeobiological characteristics of individuals, including information on their health, as well as on the physical connection with mothers and on maternal conditions in the later stages of pregnancy [3]. Second, stable isotope analyses carried out in previous research [4] will be extended in order to obtain more complete information on practices such as exclusive breastfeeding and weaning. Third, aDNA analyses will be conducted in a number of samples to track some genetic conditions, possible kinship relationships between individuals and general diachronic population dynamics. This will provide relevant data about the reproductive patterns, sex and biological age of the individuals, their congenital pathologies, as well as the genetic affinity of the communities to which they belong [5].

The proposed research will have the largest sample studied to date, which will offer new understandings about the criteria for access to this type of ritual and the demographic profiles, patterns of health and illness, rearing practices and socio-cultural dynamics of later prehistoric communities from northern Iberia. All of this will take place by placing perinatal and infant individuals, a vulnerable and historically invisible group that is unable to become aware of itself or its true historical relevance, at the very centre of the discourse.

Javier Salcines-Montaña ha sido financiado con cargo a la convocatoria de contratos predoctorales UVa 2023, cofinanciada por el Banco Santander. El trabajo es parte de la actuación CNS2022-136080, financiada por MCIN/AEI/10.3039/501100011033 y por la Unión Europea "Next Generation EU"/PRTR.

References: [1] Hodson, C.M., 2021. New prospects for investigating early life-course experiences and health in archaeological fetal, perinatal and infant individuals. Childhood in the past. 14, 3-12. [2] Fernández-Crespo, T., 2008. Los enterramientos infantiles en contextos domésticos en la Cuenca Alta/Media del Ebro: a propósito de la inhumación del despoblado altomedieval de Aistra (Álava). MUNIBE (Antropologia-Arkeologia) 59, 199-217. [3] Rissech, C., Witzel, C., Guardia, M., López-Costas, O., Götherström, A., Krzewińska, M., Kırdök, E., Mendiela, S., Merino, M. and Franès, J., 2023. Skeletal remains of human perinatal individuals from the fortified Iberian Period settlement of Ca n'Oliver (6th century to 50 years BCE). Archaeological and Anthropological Sciences. 15), 5-44. [4] Fernández-Crespo, T., Ordoño, J., Bogaard, A., Llanos, A. and Schulting, Rick, 2019. A snapshot of subsistence in Iron Age Iberia: The case of La Hoya village. Journal of Archaeological Science. Report 28, 102037. [5] Papac, L., De Miguel Ibáñez, P., Rohrlach, A.B., Armendáriz, J., Peres, M., Lamnidis, T.C., Mötsch, A., Schiffels, S. and Risch, R., 2023. Intramural child burials in Iron Age Navarra: How ancient DNA can contribute to household archaeology. In Meller, H., Krause, J., Haak, W., Risch, R. (Eds.), Kinship, Sex, and Biological Relatedness. The contribution of archaeogenetics to the understanding of social and biological relations: Tagungen des Landesmuseums für Vorgeschichte Halle 28, pp. 263-295.

Poster Presentation Number 99, Session 2, Friday 17:00 – 18:30

Sex assessment in a hominin upper second molar (RV-350) from the "Ruidera-Los Villares" Middle Pleistocene paleoanthropological site: a proteome-based analysis of the amelogenin

Paula Sanz Henche[1], Inés Zapico[2], Luis Felipe Clemente[2], Maria Luisa Hernández[2], Luis Ríos[1], Mar Casquero Muñoz[1], Candelas Buenestado Ruíz[1], Francisco Gascó-Lluna[3], Sara Díaz Pérez[4], Carlos A. Palancar[5], Daniel García-Martínez[1,6,7]

1 - Physical Anthropology Unit, Biodiversity, Ecology and Evolution Department, Universidad Complutense de Madrid, Madrid, Spain · 2 - Proteomics Unit, Complutense University of Madrid, Madrid, Spain · 3 - Faculty of Humanities and Social Sciences, Universidad Isabel I, Burgos, Spain · 4 - Institute of Archaeology, University of Wrocław, Wrocław, Poland · 5 - Grupo de Paleoantropología, Departamento de Paleobiología, Museo Nacional de Ciencias Naturales (MNCN - CSIC) · 6 - Laboratory of Forensic Anthropology, Centre for Functional Ecology, Department of Life Sciences, Universidade de Coimbra, Coimbra, Portugal · 7 - CENIEH (National Research Center on Human Evolution), Paseo de la Sierra de Atapuerca 3, Burgos, Spain ·

Estimating sex in fossil human remains is crucial for understanding ancient populations' evolutionary anatomy, demographic structure, social behaviors, and evolutionary dynamics. Traditionally, this estimation combined morphological and metric analyses, leveraging features like pelvic and skull characteristics for sexual dimorphism assessment [1]. Modern advancements in technology, such as CT scanning and 3D imaging, have greatly improved accuracy by enabling precise virtual reconstructions and measurements of skeletal features. These methods enhance our ability to reconstruct evolutionary narratives and gain insights into biological diversity in human fossils, contributing significantly to our understanding of human evolution. Molecular analyses, particularly proteomic analysis focusing on the amelogenin protein in dental enamel, have become essential in sex estimation for fossil specimens [2]. Amelogenin, a sexually dimorphic protein encoded by genes on the X and Y chromosomes, can be analyzed using mass spectrometry and proteomic techniques from preserved enamel peptides. This method offers advantages in cases where traditional methods are inconclusive due to fragmentary remains, providing direct molecular evidence of biological sex without damaging samples. Proteomic analysis of amelogenin has been successfully used in paleoanthropological studies, enhancing our understanding of ancient populations' sex composition alongside traditional methods [3].

In this work, we aimed to use proteomics methods to estimate the sex of a second upper molar RV'23-350 found in the 2023 campaign from the Middle Pleistocene paleoanthropological site of Ruidera-Los Villares (Castilla-La Mancha, Spain, Iberian Peninsula) [4]. Before studying the RV tooth, we tested the amelogenin extraction protocol using a double-blinded approach: a sex-balanced sample of two contemporary teeth from documented sex, and two archaeological teeth from a Nubian Early Meroitic site in Northern Sudan (3rd-1st cent. BCE) of estimated sex through DSP were subjected to amelogenin extraction with a 100% of success. Once this protocol was accepted, we proceeded with the RV teeth. The specimen sex was determined by mass spectrometry using MALDI as described elsewhere. Tooth enamel was etched with 5% HCl acid for two minutes after washing the tooth sequentially with 3% H2O2, two times ddH20, and 5% HCl. Cleaning peptides in reverse chromatography were applied to a MALDI plate, and spectra were acquired in positive and reflector modes. The detection of peak 1079.55 Da was characteristic of the peptide from chromosome X amelogenin copy, and the detection of peak 879.44 Da from chromosome Y amelogenin copy. Our sample showed both peaks, so it was assigned as a male individual.

To the best of our knowledge, this study represents the first estimation of sex in Middle Pleistocene teeth using amelogenin analysis, which holds significant implications for understanding anatomical variability within hominins of this period, potentially named *Homo heidelbergensis* (sensu [5]). The utilization of amelogenin as a molecular marker provides a novel and direct approach to sex determination in fossil remains, overcoming potential challenges associated with morphological assessments alone. The data derived from the Ruidera-Los Villares site contribute significantly to this field, shedding light on the demographic structure and population dynamics of hominins inhabiting the Iberian Peninsula during the Middle Pleistocene. By integrating proteomic analysis into our toolkit for paleoanthropological investigations, we enhance our ability to reconstruct the evolutionary history of ancient populations and gain deeper insights into the biological and behavioral aspects of human evolution during this critical period.

We thank Antonio Ruiz Reinosa, guard of the house state, for collaboration in the preservation of the archaeo-paleontological heritage in Los Villares. We also want to acknowledge Ignacio Mosqueda (Parque Natural de las Lagunas de Ruidera), Josefa Moreno (Ruidera mayoress), and JCCM for specific permits to carry out the excavation campaigns. Finally, we want to thank the excavation team for their great work in the first excavation campaign. DGM is funded by the PR3/23-30817 project (UCM), and the excavation campaign was funded by www.goteo.org and institutions such as the Laboratorio de Poblaciones del Pasado (UAM).

References: [1] Rmoutilová, R., Brůžek, J., Gómez-Olivencia, A., Madelaine, S., Couture-Veschambre, C., Holliday, T., Maureille, B., 2024. Sex estimation of the adult Neandertal Regourdou 1 (Montignac, France): Implications for sexing human fossil remains. Journal of Human Evolution. 189, 103470. [2] Buonasera, T., Eerkens, J., de Flamingh, A., Engbring, L., Yip, J., Li, H., Haas, R., DiGiuseppe, D., Grant, D., Salemi, M., Nijmeh, C., Arellano, M., Leventhal, A., Phinney, B., Byrd, B.F., Malhi, R.S., Parker, G., 2020. A comparison of proteomic, genomic, and osteological methods of archaeological sex estimation. Scientific Reports. 10, 11897. [3] Welker, F., Ramos-Madrigal, J., Gutenbrunner, P., Mackie, M., Tiwary, S., Rakownikow Jersie-Christensen, R., Chiva, C., Dickinson, M.R., Kuhlwilm, M., de Manuel, M., Gelabert, P., Martinón-Torres, M., Margvelashvili, A., Arsuaga, J.L., Carbonell, E., Marques-Bonet, T., Penkman, K., Sabidó, E., Cox, J., Olsen, J.V., Lordkipanidze, D., Racimo, F., Lalueza-Fox, C., Bermúdez de Castro, J.M., Willerslev, E., Cappellini, E., 2020. The dental proteome of *Homo antecessor*. Nature. 580, 235–238. [4] García Martínez, D., Duval, M., Zhao, J., Feng, Y., Wood, R., Huguet, R., Cifuentes-Alcobendas, G., Palancar, C.A., Moya-Maleno, P.R., 2022. Los Villares locality (Ruidera, Castilla-La Mancha, Spain): a new Middle Pleistocene fossil assemblage from the Southern Iberian Plateau with possible evidence of human activity. Cuaternario y Geomorfología. 36, 7–35. [5] Di Vincenzo, F., Manzi, G., 2023. *Homo heidelbergensis* as the Middle Pleistocene common ancestor of Denisovans, Neanderthals and modern humans. Journal of Mediterranean Earth Sciences, 15, 303-315.

Poster Presentation Number 100, Session 2, Friday 17:00 – 18:30

Using shape models from pooling extant humans and great apes to predict missing parts in fossil hominin ossa coxae

Stefan Schlager[1], Caroline VanSickle[2], Mirella Woodert[3], Martin Haeusler[3], Nicole Torres-Tamayo[3]

1 - Department of Oral and Maxillofacial Surgery, University Medical Center Freiburg, Germany · 2 - Department of Anatomy, Des Moines University, USA · 3 - Institute of Evolutionary Medicine, University of Zürich, Switzerland

Reconstruction of partially preserved hominin fossil remains is a crucial task to model patterns in human evolution, which holds especially true for pelvis morphology. This can be the correct assemblage of fragments or entails the estimation of entirely missing parts. Most hominin pelvic fossils preserve the more robust ilio-ischial regions surrounding the acetabulum but frequently lack the pubic region, making it difficult to measure, let alone interpret, functional aspects that rely on that part of the pelvis. Here we present a method for approximating this underpreserved anatomy based on Statistical Shape Modeling (SSM), a well-established approach for estimating missing/fragmented parts in medical surgery planning [1-2]. While this approach is straightforward when estimating missing parts using a model from the same species or even the same population, this technique is challenging to apply to fossils where no such reference samples exist for correctly learning the shape variation of that specific extinct species.

In order to capture the shape morphology of extinct hominins, we built three shape models based on (pooled) data from extant great apes (101 *Pan*, 57 *Gorilla*), as well as 113 *Homo sapiens*, thereby creating a kind of "metaspecies" spanning a large shape variability. SSMs work by exploiting the covariance between predictor and response. We therefore worked with the assumption that, while taxa exhibit diverging morphologies due to adaptations, the covariance structure between those parts is stable among closely related taxa. We validated this method by applying it to four nearly complete hominin ossa coxae to see if our prediction method yields the anatomy preserved in the original fossils. Our fossil sample includes A.L. 288-1 (*Australopithecus afarensis*), Sts 14 (*A. africanus*), MH2 (*A. sediba*), Kebara 2 (*H. neanderthalensis*), and Ohalo 2 (an Upper Palaeolithic *H. sapiens*). When possible, we used different reconstructions of these models to assess convergences and differences. Homologous sets of (semi-)landmarks were placed on the preserved parts of the ilium and ischium both on the SSM mean shape and the fossils. After aligning the fossil to the model using those landmarks, the most likely shape fitting these landmark constraints [3] was generated and realigned to the original fossil. Prediction accuracy was estimated by computing the average distance (in millimeters) between the estimate and the original surface.

For all reference fossils hominins, with exception of Ohalo 2 (*H. sapiens*), the prediction error decreases with each species added to the model. Notably, the prediction of the particularly long pubis of Kebara 2 became more accurate when the gorilla sample was added to the predictive model. As SSMs used in this context are based on Principal Components, we found that limiting the PCs to those accounting for 99% of the variance yielded the most accurate approximations which indicates that it is mainly the interspecies variability as well as the modes explaining common traits that are important for reasonable predictions, underlining the artificial "metaspecies" concept.

Depending on the species and the preserved anatomy, this method has the potential to increase the sample of fossil hominin hipboes, provide a scaffold on which to arrange smaller fossil fragments and to compare deviations in the actual fossil morphology from the prediction leading to insights into unique morphological features of that fossil.

Financial support comes from the Swiss National Science Foundation grants No. 310030_212984 and 31003A_176319 (to MH).

References: [1] Semper-Hogg, W., Fuessinger, M.A., Schwarz, S., Ellis, E., Cornelius, C.-P., Probst, F., Metzger, M.C., Schlager, S., 2017. Virtual reconstruction of midface defects using statistical shape models. Journal of Cranio-Maxillofacial Surgery. 45, 461–466. [2] Fuessinger, M.A., Schwarz, S., Neubauer, J., Cornelius, C.-P., Gass, M., Poxleitner, P., Zimmerer, R., Metzger, M.C., Schlager, S., 2019. Virtual reconstruction of bilateral midfacial defects by using statistical shape modeling. Journal of Cranio-Maxillofacial Surgery. 47, 1054–1059. [3] Albrecht, T., Lüthi, M., Gerig, T., Vetter, T., 2013. Posterior shape models. Medical Image Analysis. 17, 959–973.

Podium Presentation, Session 11, Saturday 13:50 – 15:30

New cranial and postcranial remains from the Neandertal specimens from Neander Valley

Ralf W. Schmitz[1], Ana Pantoja-Pérez[2,3], Nohemi Sala[2,3]

1 - LVR-LandesMuseum Bonn, Department of Prehistory, Bonn, Germany · 2 - Centro Nacional de Investigación sobre la Evolución Humana, Burgos, Spain · 3 - Centro Mixto UCM-ISCIII de Evolución y Comportamiento Humanos, Madrid, Spain

In August 1856, quarry workers discovered the Neandertal type specimen in the 'Kleine Feldhofer Grotte' cave in Germany. They collected only the skull calotte and 15 of the larger bones of a male individual (Neandertal 1). In 1997, the sediments of the destroyed cave were rediscovered by R.W.S. and Jürgen Thissen. The field campaigns brought to light 73 bones and bone fragments of the type specimen and a previously unknown Neandertal female (Neandertal 2) [1-2], alongside faunal remains and lithic artifacts. A screening of questionable fragments using "ZooMS" revealed 18 additional hominin fragments in 2016 [3]. During the taphonomic analysis of human remains conducted since 2022, a comprehensive review was undertaken of all the faunal remains and finds from wet sieving from the excavations dating back to the late 1990s. The primary aim of this review was to provide contextual insights into the bone surface modifications observed on the human remains in comparison with the rest of the bone assemblage. This fauna review has yielded significant findings, disclosing the presence of fourteen previously unidentified human remains, intermingled among the animal skeletal collection.

The discovered remains include: a complete distal hallucal phalanx of the left foot; a complete hamate bone of the right side; three fragments of the ischiopubic ramus from both sides, likely belonging to the pelvis of Neandertal 1, although these fragments do not directly refit with the original coxae; two fragments of the radial head that fit together; a small cranial (parietal) fragment; two rib and three vertebra fragments; and a small portion of the proximal articular surface (head) of the left humerus. Furthermore, 50 smaller bone fragments, presumably human, have been selected for scrutiny through ZooMS. Among the findings, the complete bone remains of the hand and foot and the fragments of the pelvis stand out. Those specimens exhibit Neandertal traits, evident in their robustness and morphology and are compatible with the type specimen.

Despite the total destruction of the site due to quarrying activities, these newly found remains provide highly pertinent insights into skeletal part representation of the two Neandertal individuals. Elements such as distal phalanges of the feet or carpal bones are exceedingly rare in contexts lacking complete skeletons (e.g., accumulations by carnivores, cannibalism, or other agents). Conversely, in sites where Neandertals have been recovered, these small elements are mainly found in funerary contexts [4]. While the accumulation origin of these two skeletons remains unknown, these new findings suggest that the original Kleine Feldhofer Grotte cave likely contained complete skeletons. These new remains help expand the sample of one of the most iconic human fossils in the field of the paleoanthropology, broadening the scant representation of some anatomical elements within the Middle Paleolithic fossil record.

This research has received funding from the European Research Council under the European Union's Horizon 2020 research and innovation program (Grant agreement No. 949330) and PID2021-122355NB-C31 and PID2021-122355NB-C33 funded by MCIN/AEI/10.13039/501100011033/FEDER, UE. NS has received funding from the Ministerio de Ciencia e Innovación under the Ramón y Cajal program (RYC2020-029656-I) funded by MCIN/AEI/10.13039/501100011033 and El FSE invierte en tu futuro. The authors wish to thank the DEATHREVOL team, particularly A. Pablos and A. Gómez-Olivencia, for their advice on the fossil material, and the staff of the LVR-Landesmuseum. J.-J. Hublin, M. Skinner and H. Temming, MPI-Eva, Leipzig, for microCT scanning.

References: [1] Schmitz, R.W., Serre, D., Bonani, G., Feine, S., Hillgruber, F., Krainitzki, H., Pääbo, S., Smith, F.H., 2002. The Neandertal type site revisited: Interdisciplinary investigations of skeletal remains from the Neander Valley, Germany. Proceedings of the National Academy of Sciences of the United States of America. 99, 13342–13347. [2] Smith, F.H., Ostendorf Smith, M., Schmitz, R.W., 2006. Human skeletal remains from the 1997 and 2000 excavations of cave deposits derived from Kleine Feldhofer Grotte in the Neander Valley, Germany. In: Schmitz, R.W. (Ed.), Neandertal 1856 – 2006. Rheinische Ausgrabungen 58, Philipp von Zabern, Mainz, pp. 187-246. [3] Lanigan, L.T., Mackie, M., Feine, S., Hublin, J.-J., Schmitz, R.W., Wilcke, A., Collins, M.J., Cappellini, E., Olsen, J.V., Taurozzi, A.J., Welker, F., 2020. Multi-protease analysis of Pleistocene bone proteomes. Journal of Proteomics 228, 103889. [4] Pablos, A., Gómez-Olivencia, A., Arsuaga, J.L.. 2019. A Neandertal foot phalanx from the Galería de las Estatuas site (Sierra de Atapuerca, Spain). American Journal of Physical Anthropology. 168, 222-228.

Poster Presentation Number 101, Session 2, Friday 17:00 – 18:30

Middle Palaeolithic asymmetric stone tool design and use: functional analysis to assess Neanderthal technology

Lisa Schunk[1,2,3], Ivan Calandra[2,4], João Marreiros[2,5,6]

1 - McDonald Institute for Archaeological Research, University of Cambridge, Cambridge, UK · 2 - TraCEr. Laboratory for Traceology and Controlled Experiments. MONREPOS Archaeological Research Centre and Museum for Human Behavioural Evolution, LEIZA, Neuwied, Germany · 3 - Institute of Archaeology, Faculty of Historical and Pedagogical Sciences, University of Wroclaw, Poland · 4 - IMPALA. Imaging Platform at LEIZA. Mainz, Germany · 5 - ICArEHB, Interdisciplinary Center for Archaeology and the Evolution of Human Behaviour, University of Algarve, Faro, Portugal · 6 - Institute for Prehistoric and Protohistoric Archaeology, Johannes Gutenberg University, Mainz, Germany

Variability within the Palaeolithic archaeological record, including temporal and spatial diversification, is exemplified by its lithic technologies. Consequently, research questions on how to link this variability with human behaviour centre upon the design, the production, the function, and the use of lithic artefacts. Especially tool design seems to play a key role in the case of Central and Eastern European Late Middle Palaeolithic bifacial backed knives (late OIS 5 until mid OIS 3; hereafter Keilmesser) [1]. The asymmetric Keilmesser is produced in a highly standardised mode, displaying a single active edge located opposite to a blunt back, resulting in the tool's wedge-shaped section. The active edge itself is often composed of sections of significantly varying edge angles. Keilmesser function and use, however, remain speculative but have been inferred from tool morphology and their well-documented production sequences, assuming repeated phases of re-sharpening and re-use, leading commonly to extended tool-life-histories.

The study presented here attempts to comprehend how the special edge design of Keilmesser is related to their function and use. In support of this, we present the results of functional analysis conducted on asymmetric lithics from three archaeological sites – Balver Höhle [2], Buhlen [3], both in Germany, and La Grotte de Ramioul [4], in Belgium. The use-wear analysis was performed qualitatively as well as quantitatively. The combined results show a technology applied in a standardised manner aiming at the production and use of a handheld backed tool with a single active edge. Designed with an edge angle increasing from the distal tip to the proximal base of the tool, the tool's active edge may have served different functions.

The study highlights the complementary character of both types of analysis, qualitative and quantitative. As demonstrated, Laser Scanning Confocal Microscopy can be applied to archaeological samples to successfully discriminate varying use-wear traces and thus increases the extent of knowledge possible to gain with this type of analysis.

References: [1] Jöris, O., 2006. Bifacially Backed Knifes (Keilmesser) in the Central European Middle Palaeolithic. In: Goren-Inbar, N., Sharon, G. (Eds.), Axe Age - Acheulian Toolmaking, from Quarry to Discard. Approaches to Anthropological Archaeology. Equinox, London, pp. 287–310. [2] Günther, K., 1964. Die altsteinzeitlichen Funde der Balver Höhle. Bodenaltertümer Westfalens VIII, Münster. [3] Jöris, O., 2001. Der spätmittelpaläolithische Fundplatz Buhlen (Grabungen 1966-69) : Stratigraphie, Steinartefakte und Fauna des oberen Fundplatzes. Universitätsforschungen zur prähistorischen Archäologie 73, Bonn. [4] Ulrix-Closset, M., 1975. Le paleolithique moyen dans le bassin mosan en Belgique. Éditions Universa, Liege.

Poster Presentation Number 102, Session 2, Friday 17:00 – 18:30

The Laschamps event (~41 ka BP) straddles the Mousterian-Châtelperronian transition in Western Europe

Mark J. Sier[1,2], Ola T. Lygre[3], Igor Djakovic[3], Marie Soressi[3]

1 - Department of Earth Sciences, Faculty of Geosciences, Utrecht University, Utrecht, the Netherlands · 2 - CENIEH, Burgos, Spain · 3 - Faculty of Archaeology, Leiden University, Leiden, the Netherlands

The Laschamps event (named after the type site in the Massif Central in France) was one of the first geomagnetic excursions to be identified, and has since been found in both sedimentary and volcanic contexts across the planet [1]. The event is currently dated to around 41 thousand years ago (ka BP) and had a duration of less than one thousand years ([1] and ref therein). Given its proximity to the estimated disappearance date of Neandertals from the fossil record, the Laschamps event may serve as an important geochronological marker to refine our spatiotemporal understanding of the transition from Neandertals to *Homo sapiens* across Eurasia. The event caused a large increase in atmospheric ^{14}C and is considered by some as a driver of global environmental and evolutionary changes [2-3]. Furthermore, the Laschamps event could help refine the chronologies of sites without organic preservation, allowing these to be linked to sites with well-defined radiocarbon chronologies, potentially on a global level. Historically, the use of the Laschamps event as a geochronological marker in archaeology has been confined to Russia and central Asia, including at Kostenki 14 [4]. In this poster, we present a paleomagnetic study of the archaeological sequence of Quinçay, France, where the Laschamps event is found to straddle the Mousterian and Châtelperronian layers. The cave site of Quinçay, near Poitiers, West-Central France, was discovered in the 1950s and contains a succession of Mousterian and Châtelperronian industries [5]. The site was reopened in 2019. These new campaigns included a detailed paleomagnetic study of the whole stratigraphic sequence. This study found evidence of reversed paleomagnetic signals, indicating a temporary geomagnetic excursion that straddles the Mousterian and Châtelperronian levels that we interpret as the Laschamps event. This identification enhances the geochronological constraints of the chrono-cultural sequence and represents the first identification of the Laschamps excursion in a western European archaeological context. Our results suggest that the final Mousterian and Châtelperronian occupations at Quinçay may have occurred very close to, or possibly during, a one thousand year period around 41 thousand years ago (ka BP). Finally, we discuss the potential implications of these results for the dating of the Châtelperronian and sub-contemporaneous archaeological industries.

M.J. Sier is funded by HORIZON-MSCA-2022-PF-01 Project: 101109142, ABCCycle. I. Djakovic and M. Soressi are funded by the Dutch Research council (NWO). 'Neandertal Legacy' grant (VI.C.191.070) awarded to M. Soressi.

References: [1] Channell, J.E.T., Singer, B.S., Jicha, B.R., 2020. Timing of Quaternary geomagnetic reversals and excursions in volcanic and sedimentary archives. Quaternary Science Reviews. 228, 106114. [2] Cooper, A., Turney, C.S.M., Palmer, J., Hogg, A., McGlone, M., Wilmshurst, J., Lorrey, A.M., Heaton, T.J., Russell, J.M., McCracken, K., Anet, J.G., Rozanov, E., Friedel, M., Suter, I., Peter, T., Muscheler, R., Adolphi, F., Dosseto, A., Faith, J.T., Fenwick, P., Fogwill, C.J., Hughen, K., Lipson, M., Liu, J., Nowaczyk, N., Rainsley, E., Bronk Ramsey, C., Sebastianelli, P., Souilmi, Y., Stevenson, J., Thomas, Z., Tobler, R., Zech, R., 2021. A global environmental crisis 42,000 years ago. Science. 371, 811–818. [3] Picin, A., Benazzi, S., Blasco, R., Hajdinjak, M., Helgen, K.M., Hublin, J.-J., Rosell, J., Skoglund, P., Stringer, C., Talamo, S., 2021. Comment on "A global environmental crisis 42,000 years ago." Science. 374. [4] Gernik, V.V., Guskova, E.G., 2002. Палеомагнитные характеристики отложений разреза ст. Костенки 14 (Маркина гора) [Palaeomagnetic evidence for sediment sequences of Kostenki 14 (Markina gora)]. In Sintsyn, A.A., Sergin, V.Ya., Hoffecker, J.F. (Eds.), Особенности развития верхнего палеолита Восточной Европы [Trends in the evolution of the East European Palaeolithic]. Kostenki in the context of the Palaeolithic of Eurasia. – Proceedings of Kostenki expedition IHMC RAS, ser. Research. 1, 247–249. [5] Roussel, M., Soressi, M., Hublin, J.-J., 2016. The Châtelperronian conundrum: Blade and bladelet lithic technologies from Quinçay, France. Journal of Human Evolution. 95, 13–32.

Poster Presentation Number 103, Session 2, Friday 17:00 – 18:30

Between teeth: morphological covariation in the human postcanine dentition

Petra G. Šimková[1,2], Cinzia Fornai[1,2,3,4,5], Viktoria A. Krenn[1,5,6], Lisa Wurm[7], Vanda Halász[8], Dominika Lidinsky[9], Gerhard W. Weber[1,2,10]

1 - Department of Evolutionary Anthropology, University of Vienna, Austria · 2 - Human Evolution and Archaeological Sciences HEAS, University of Vienna, Austria · 3 - Department of Research in Occlusion Medicine, Vienna School of Interdisciplinary Dentistry – VieSID, Klosterneuburg, Austria · 4 - Center for Clinical Research, University Clinic of Dentistry Vienna, Medical University of Vienna, Austria · 5 - Institute of Evolutionary Medicine, University of Zurich, Switzerland · 6 - Fraunhofer Austria Research GmbH, Klagenfurt, Austria · 7 - Medical Technology Cluster, Business Upper Austria – OÖ Wirtschaftsagentur GmbH, Linz, Austria · 8 - LearnChamp Consulting GmbH & Co KG, Vienna, Austria · 9 - Sandoz GmbH, Kundl, Austria · 10 - Core Facility for Micro-Computed Tomography, University of Vienna, Austria

Morphological covariation within the modern human postcanine dentition is still an open field of study. Understanding covariation patterns of the three-dimensional (3D) shapes between different tooth types is relevant for the advancement of human biology and evolution, as well as dental anthropology, phylogeny and medicine. Previous 3D morphological studies of various tooth types suggest that the geographical origin of the sampled individuals does not play a decisive role in determining the shape of the individual dental crowns, whose genesis is dominated by genetic factors [1-2]. Here, we analysed 3D shape covariation of the postcanine dentition (third molars excluded), both within and between dental arches using geometric morphometrics.

Eight geographically variable samples of upper and lower third and fourth premolars (P3 and P4, respectively) and first and second molars (M1 and M2, respectively) from Sub-Saharan, Egyptian, European, South American, Southeast Asian, Oceanian, and Near Eastern modern human skeletal remains were considered in this study (N=526 teeth). The analysed samples consisted of 70 lower P3s, 74 lower P4s, 76 upper P3s, 74 upper P4s, 49 lower M1s, 48 lower M2s, 59 upper M1s and 76 upper M2s. High-resolution scans of the maxillae and mandibles were acquired at the Vienna Micro-CT lab and were further reconstructed and processed to generate 3D models of the dentinal crowns [3], which were represented by landmark configurations combining the occlusal edge of the enamel-dentine junction with the cervical outline. The landmark configurations were designed for each of the dental types specifically. Two-Block Partial Least Squares analysis was used to investigate the covariation between various dental type pairs.

We found very high pairwise correlation in tooth pairs within the dental arches (lower P3 and P4, r=0.89; upper P3 and P4, r=0.81; upper M1 and M2, r=0.83). The correlation values between antagonists of the same tooth varied notably from the highest value detected in M1s (r=0.9), to the lowest between the upper P4s and lower M1s (r=0.58). This could be explained by the need for morphological compatibility of the dental arches in order to guarantee stable occlusion and efficient function during mastication. Given that the tooth articulation does not exclusively occur between antagonists, the covariation between some of them might not be as high as expected. The morphological compatibility of the entire dental arches in occlusion is superior to the compatibility of antagonists only. Noticeably high correlation values were detected in some of the tooth type pairs that do not articulate in a normal dentition. A relatively high pairwise correlation was found in the pairs of lower (r=0.79) and upper (r=0.77) P4s and M1s, which are the only tooth type pairs of the postcanine dentition, belonging to different tooth classes and still serve the same function [4].

With this study, we provided an overview of pairwise correlations and percentages of covariation between different tooth types within the human postcanine dentition, possibly laying the groundwork for future genetic research.

We are grateful to Gerlinde Gruber (Medical University of Vienna), Sabine Eggers (Natural History Museum Vienna) and Israel Hershkovitz (Department of Anatomy and Anthropology, Sackler Faculty of Medicine, Tel Aviv University) for granting access to the samples. Special thanks to Martin Dockner (Vienna µCT Lab) for his technical assistance.

References: [1] Krenn, V.A., Fornai, C., Wurm, L., Bookstein, F.L., Haeusler, M., Weber, G.W., 2019. Variation of 3D outer and inner crown morphology in modern human mandibular premolars. American Journal of Physical Anthropology. 169, 646–663. [2] Šimková, P.G., Wurm, L., Fornai, C., Krenn, V.A., Weber, G.W., 2024. Shape variation in modern human upper premolars. PLOS ONE. 19, e0301482. [3] Weber, G.W., and Bookstein, F.L., 2011. Virtual anthropology: A guide to a new interdisciplinary field. Springer, New York. [4] Kraus, B.S., Jordan, R.E., Abrams, L., 1969. Dental anatomy and occlusion; A study of the masticatory system. Williams and Wilkins, Baltimore.

Pecha Kucha Presentation, Session 2, Thursday 11:20 – 12:50

Cracking the code of the marked mammoth rib from the Gravettian of Hohle Fels Cave, Germany

Natasha T. Singh[1], Nicholas J. Conard[1,2]

1 - Department of Early Prehistory and Quaternary Ecology, University of Tübingen, Tübingen, Germany · 2 - Senckenberg Centre for Human Evolution and Palaeoenvironment at the University of Tübingen, Tübingen, Germany

Marked objects from the Upper Palaeolithic are among the most intriguing and puzzling artifacts of human antiquity. Geometric engravings in particular can pose challenges in how we interpret meaning and extract information they store about past hunter-gatherer groups. One such example comes from Hohle Fels Cave in the Swabian Jura of southwestern Germany. During the 2017 season, excavators recovered a 44 cm-long mammoth rib, which we subsequently dated with radiocarbon to 31.3 kcal BP, establishing a Gravettian age for this remarkable artifact [1]. Finding such a large, well-preserved mammoth bone is a rare occurrence in the Swabian Gravettian, but even more noteworthy are the anthropogenic modifications that the rib bears. The makers of the artifact removed the head of the rib and rounded the remaining surface. They also truncated the distal end but did not round or polish it to the same extent. The rib preserves a series of pronounced markings, including two rows of 83 and 90 engraved parallel marks on the cranial edge of the rib and 13 longer, shallower incisions on one of the broad surfaces of the rib. The structure and regularity of the markings suggest potential use of the bone for artistic, symbolic or functional purposes. The markings are clearly the result of intentional cuts using stone tools, and we argue that the Gravettian inhabitants of Hohle Fels used this mammoth rib to store information about some aspect of their lives. This study aims to develop and test a series of hypotheses about the function of these markings and to explore what they might signify. We hypothesize that the rib could represent a calendrical device, a numerical counter or a decorative object. We use the dimensions and morphological characteristics of the individual marks to compare the mode and manner of their production. We consider if sequences of marks were made using the same tool in close temporal proximity and consider arguments for reconstructing the order in which the marks were made. Additionally, we examine whether or not the different groups of marks exist in relation to one another as part of a cohesive design. Detailed microscopic observations combined with spatial and contextual information help us evaluate the plausibility of competing hypotheses to explain the markings and decode their meaning.

References: [1] Conard, N.J., Janas, A., 2018. Fortsetzung der Ausgrabung am Hohle Fels und die Entdeckung einer markierten Mammutrippe aus dem Gravettien. Archäologische Ausgrabungen in Baden-Württemberg 2017.

Podium Presentation, Session 11, Saturday 13:50 – 15:30

Hominin palaeoproteomics: potential and limitations for understanding human evolution

Pontus Skoglund[1], Helen Fewlass[1,2], Helen Flynn[3], Oded Rimon[1], Dorothea Mylopotamitaki[4,5], Kyriaki Anastasiadou[1], Thomas Booth[1], Mark Skehel[3], Bram Snijder[3], Frido Welker[1,6]

1 - Ancient Genomics Lab, The Francis Crick Institute, London, UK · 2 - Department of Anthropology and Archaeology, University of Bristol, Bristol, UK · 3 - Proteomics STP, The Francis Crick Institute, London, UK · 4 - Chaire de Paléoanthropologie, CIRB (UMR 724 – U1050), Collège de France, Paris, France · 5 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 6 - Globe Institute, University of Copenhagen, Copenhagen, Denmark

Many outstanding questions in human evolution could be more clearly understood with genetic information from hominin remains whose age or contexts are substantially beyond the DNA preservation envelope. Some structural proteins degrade slower than DNA and thus appear to be preserved on million-year time-scales, but retrieved proteins have so far only covered a handful of evolutionarily informative polymorphisms [1-3]. It thus remains largely unexplored to which extent proteomic data from different tissues and degrees of preservation could distinguish between the ancestries of early hominins. More specifically, different levels of preservation might be able to distinguish hominin ancestries of different degrees of divergence and genetic differentiation. We present computational experiments of the expected evolutionary genetic resolution from ancient proteomes. We use translated genomic data from archaic humans [4], in concert with newly generated and published ancient proteomic data from humans to extract subsets of the proteome that have been successfully observed in skeletal tissue. We then apply f-statistics approaches [5] and phylogenetic methods to test statistical power to distinguish *Homo sapiens*, Neanderthals, and Denisovans at those amino acid positions, assessing statistical uncertainty with weighted block jackknife and bootstrap resampling, respectively. We compare the genetic differentiation needed as suggested by our experiments (Wright's FST) to morphological differentiation observed in the human fossil record. Using these results, we review some of the outstanding questions in human evolution that could be addressed with current resolution, and which questions seem to remain out of reach without substantial technological progress for proteome retrieval. Our results provide insights into the statistical power expected for different tissues and preservation metrics. Understanding which evolutionary questions might be possible to address with proteomic data is key to assess prior to sampling, to ensure responsible study of the fossil record.

References: [1] Welker, F., Ramos-Madrigal, J., Gutenbrunner, P., Mackie, M., Tiwary, S., Jersie-Christensen, R.R., Chiva, C., Dickinson, M.R., Kuhlwilm, M., De Manuel, M., Gelabert, P., Martinón-Torres, M., Margvelashvili, A., Arsuaga, J.L., Carbonell, E., Marques-Bonet, T., Penkman, K., Sabidó, E., Cox, J., Olsen, J.V., Lordkipanidze, D., Racimo, F., Lalueza-Fox, C., De Castro, J.M.B., Willerslev, E., Cappellini, E., 2020b. The dental proteome of *Homo antecessor*. Nature. 580, 235–238. [2] Chen, F., Welker, F., Shen, C.-C., Bailey, S.E., Bergmann, I., Davis, S., Xia, H., Wang, H., Fischer, R., Freidline, S.E., Yu, T.-L., Skinner, M.M., Stelzer, S., Dong, Guangrong, Fu, Q., Dong, Guanghui, Wang, J., Zhang, D., Hublin, J.-J., 2019. A late Middle Pleistocene Denisovan mandible from the Tibetan Plateau. Nature. 569, 409–412. [3] Welker, F., Hajdinjak, M., Talamo, S., Jaouen, K., Dannemann, M., David, F., Julien, M., Meyer, M., Kelso, J., Barnes, I., Brace, S., Kamminga, P., Fischer, R., Kessler, B.M., Stewart, J.R., Pääbo, S., Collins, M.J., Hublin, J.-J., 2016. Palaeoproteomic evidence identifies archaic hominins associated with the Châtelperronian at the Grotte du Renne. Proceedings of the National Academy of Sciences of the United States of America. 113, 11162–11167. [4] Patramanis, I., Ramos-Madrigal, J., Cappellini, E., Racimo, F., 2023. PaleoProPhyler: a reproducible pipeline for phylogenetic inference using ancient proteins. Peer Community Journal. 3, e112. [5] Reich, D., Thangaraj, K., Patterson, N., Price, A.L., Singh, L., 2009. Reconstructing Indian population history. Nature 461, 489–494.

Podium Presentation, Session 11, Saturday 13:50 – 15:30

Exploring the potential of histotaphonomy to assess the depositional context of animal and human Palaeolithic bone fragments

Geoff M. Smith[1,2], Patrick Mahoney[2], Alina Hiß[3], Pauline Raymond[4], Vera Aldeias[5], Jean-Jacques Hublin[3,4], Johannes Krause[3], Matthew M. Skinner[3]

1 - Department of Archaeology, University of Reading, Reading, UK · 2 - School of Anthropology and Conservation, University of Kent, Canterbury, UK · 3 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 4 - Chaire de Paléoanthropologie, CIRB, Collège de France, Université PSL, CNRS, INSERM, 75005 Paris, France · 5 - Interdisciplinary Center for Archaeology and Evolution of Human Behavior, Faro, Portugal

Fragmented animal bones form the backbone of zooarchaeological and taphonomic studies, providing a wealth of macro-scale data on palaeoenvironment, site formation and subsistence. Additional data on depositional histories, including macroscopically invisible alterations such as bacterial bioerosion, can be obtained through the microscopic study of taphonomic alterations to the inner structure of bone, known as histotaphonomy [1]. Histotaphonomic characterisations have direct behavioural implications and can be used to assess whether bones entered the archaeological record butchered or fully fleshed (complete carcass burial or natural death) [1-3]. The integrated study of macro- and microscopic taphonomic features has the potential to provide new insights into site formation, subsistence practices, human burial and even cannibalism at Palaeolithic sites.

In a first step, we will present data from micro-CT scanning, hard tissue histology and aDNA analysis of bone fragments from the Medieval site at Northgate cemetery, Canterbury [4]. This site provided a unique dataset allowing us to develop a workflow for the identification of bacterial bioerosion in human (burial, n=20) and animal (butchered, n=20) remains. We identified more intense bioerosion in the human bones, compared to animal remains. We confirmed these results through identification and categorisation of hard tissue histological thin sections. Next, we extracted aDNA from the human bones that displayed a bioerosion signal, both from bioeroded and normal bone regions. Some potential differences between these regions were observed, including the identification of DNA from Clostridium and Fictibacillus.

The second part of the talk presents a series of ongoing case studies in which we apply histotaphonomy to Palaeolithic bone assemblages. In general, the identification of bioerosion in micro-CT scans of animal and human remains from Palaeolithic contexts was site-dependent. At Ranis (Germany, n=50), evidence for bacterial bioerosion was limited. However, micro-CT scanning of both bone and micromorphological blocks from Bacho Kiro Cave (Bulgaria, n=20) and human and animal bones from Abri Moula (France, n=50) identified signatures consistent with bioerosion. At Moula these were identified on both human and animal material and provided novel data to further investigate Neanderthal cannibalism at the site [5].

Overall, our combined approach, using micro-CT, hard tissue histology and aDNA to study different taxa (human, carnivore, or herbivore) has the potential to add novel information about site formation and human behaviour during the Palaeolithic. Further work is required to more fully understand the specific factors affecting bacterial bioerosion within and across sites, and especially in Palaeolithic contexts. Further development and application of this method are therefore ongoing.

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement Nos. Marie Sklodowska-Curie grant 101027850 and consolidator grant 819960). V. Aldeias is funded by the European Union (ERC, MATRIX project n°101041245). Thank you to Tsenka Tsanova and Nikiolay Sirakov for access to Bacho Kiro Cave specimens and Tim Schüler for access to Ranis bone material. We thank Nicolas Vanderesse (PACEA, UMR 5199, University of Bordeaux) for scanning of bone remains from Abri Moula.

References: [1] Brönnimann, D., Portmann, C., Pichler, S.L., Booth, T.J., Röder, B., Vach, W., Schibler, J., Rentzel, P., 2018. Contextualising the dead – Combining geoarchaeology and osteo-anthropology in a new multi-focus approach in bone histotaphonomy. Journal of Archaeological Science. 98, 45–58. [2] Fernández-Jalvo, Y., Andrews, P., Pesquero, D., Smith, C., Marín-Monfort, D., Sánchez, B., Geigl, E.-M., Alonso, A., 2010. Early bone diagenesis in temperate environments. Palaeogeography, Palaeoclimatology, Palaeoecology. 288, 62–81. [3] White, L., Booth, T.J., 2014. The origin of bacteria responsible for bioerosion to the internal bone microstructure: Results from experimentally-deposited pig carcasses. Forensic Science International. 239, 92–102. [4] Hicks, M. and Hicks, A., 2001. St Gregory's Priory, Northgate, Canterbury: Excavations 1988-1991 (Vol. 2). Canterbury Archaeological Trust Limited. [5] Defleur, A., White, T., Valensi, P., Slimak, L. and Cregut-Bonnoure, E., 1999. Neanderthal cannibalism at moula-guercy, ardèche, France. Science, 286, 128-131.

Podium Presentation, Session 8, Friday 15:20 – 17:00

The use and misuse of trace element patterns in hominin and nonhuman primate teeth

Tanya M. Smith[1], Christine Austin[2]

1 - Griffith Centre for Social and Cultural Research & Australian Research Centre for Human Evolution, Griffith University, Australia · 2 Department of Environmental Medicine and Public Health, Icahn School of Medicine at Mount Sinai, USA

Assessments of elemental chemistry in teeth often employ laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) sampling of discontinuous spots or linear tracks, which may fail to distinguish between precise changes in body chemistry during tooth mineralization and diagenesis after burial. By contrast, mapping the entirety of sectioned tooth crowns and roots with LA-ICP-MS provides comprehensive longitudinal developmental records of dietary behavior, health, and neurotoxicant exposure [1]. These maps permit the comparison of spatial element patterns with developmental geometry in multiple tissues and across successive teeth, and reveal differential element-specific preservation and diagenesis [1-2]. This is possible because biogenic elemental geometry is consistent with secretory patterns evident under light microscopy [1], and can be distinguished from diagenetic alteration as the later often shows more localized diffuse patterns, particularly when multiple elements are considered in tandem [2-3].

Comprehensive dental analyses of captive and wild nonhuman primates, as well as human children with prospective nursing and health records, reveal nutritional and physiological experiences of individuals in unprecedented detail. The nonessential metals barium (Ba) and strontium (Sr) are now commonly assessed with LA-ICP-MS for insights into nursing and weaning behaviours, including in fossil hominins and living humans. While much remains to be understood about their natural bioavailability and gastrointestinal absorption, Ba is generally a more reliable indicator of the initiation of milk intake than Sr, rising and falling in parallel with nursing intensity and milk concentrations in captive macaque first molars as well as in first molars of baboons and humans. Calcium-normalized barium (Ba/Ca) shows more distinct zonation in tooth enamel than Sr/Ca, enabling the timing of behavioural changes from microscopic growth lines. This pattern of Ba/Ca distribution is not substantially altered by mineral incorporation after secretion, yielding the first precise ages for the cessation of nursing (weaning) in Neanderthals [2-3].

We have also detailed how developmentally-informed trace element mapping reveals concurrent physiological disruptions in captive macaques [1,4], which differ from broader circa-annual dietary banding patterns seen in wild orangutans [5]. Recent studies have inferred substantial nutritional stress in australopithecines based on the presence of prominent elemental bands formed repetitively over months, yet also inferred greatly reduced dietary diversity due to the absence of these bands in *Gigantopithecus blacki*, supposedly contributing to their extinction. Such studies fail to consider the more likely scenario of the variable consumption of foods containing bioavailable metals, as evident in wild baboon and chimpanzee dentitions. While trace element distributions offer a potent mechanism for understanding ancient behavior and health in the past, we encourage additional research on the concentrations of these metals in dietary items, as well as the pairing of complementary isotopic systems for confidence in inferences of seasonal behaviors and illnesses [2].

Funding was provided by the Australian Research Council (DP210101913, FT200100390) and the Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health (R00HD087523).

References: [1] Smith, T.M., Cook, L., Dirks, W., Green, D.R., Austin, C., 2021. Teeth reveal juvenile diet, health and neurotoxicant exposure retrospectively: What biological rhythms and chemical records tell us. BioEssays: news and reviews in molecular, cellular and developmental biology. 43. e2000298 [2] Smith, T.M., Austin, C., Green, D.R., Joannes-Boyau, R., Bailey, S., Dumitriu, D., Fallon, S., Grün, R., James, H.F., Moncel, M.H., Williams, I.S., Wood, R., Arora, M., 2018. Wintertime stress, nursing, and lead exposure in Neanderthal children. Science Advances. 4, eaau9483. [3] Austin, C., Smith, T.M., Bradman, A., Hinde, K., Joannes-Boyau, R., Bishop, D., Hare, D.J., Doble, P., Eskenazi, B., Arora, M., 2013. Barium distributions in teeth reveal early-life dietary transitions in primates. Nature. 498, 216–219. [4] Austin, C., Smith, T.M., Farahani, R.M.Z., Hinde, K., Carter, E.A., Lee, J., Lay, P.A., Kennedy, B.J., Sarrafpour, B., Wright, R.J., Wright, R.O., Arora, M., 2016. Uncovering system-specific stress signatures in primate teeth with multimodal imaging. Scientific Reports. 6, 18802. [5] Smith, T.M., Austin, C., Hinde, K., Vogel, E.R., Arora, M., 2017. Cyclical nursing patterns in wild orangutans. Science Advances. 3, e1601517.

Poster Presentation Number 104, Session 2, Friday 17:00 – 18:30

A revisit of site formation and chronology at the Middle Pleistocene hominin site Bilzingsleben

Mareike C Stahlschmidt[1,2], Tobias Lauer[3], Thomas Daniel[4], Susann Heinrich[5], Kirsty Penkman[6], Clemens Pasda[7]

1 - Department of Evolutionary Anthropology, University of Vienna, Vienna, Austria · 2 - Human Evolution and Archaeological Sciences, University of Vienna, Vienna, Austria · 3 - Geo- und Umweltforschungszentrum (GUZ), University of Tübingen, Tübingen, Germany · 4 - Institute of Earth Sciences, Friedrich Schiller University of Jena, Jena, Germany · 5 - Former Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 6 - Department of Chemistry, University of York, York, United Kingdom · 6 - Institut für Orientalistik, Indogermanistik, Ur- und Frühgeschichtliche Archäologie, Universität Jena, Jena, Germany

Bilzingsleben is a well-known Middle Pleistocene site situated in the Thuringian Basin in Central Germany that was shown to preserve several hominin remains in association with cultural and a large number of faunal remains. The hominin fossils were discovered in the 1970s and followed by extensive excavations by D. Mania from 1971-2002. Exacavations were then continued by the University of Jena from 2004 to 2007. Based mainly on field observations, Mania and Mania [1] interpretated the site as an in situ preserved hunting camp with huts and fireplaces formed during marine isotope stage (MIS) 11. This early interpretation of the site formation was critiqued based on a lack of empirical data. The new excavations by the University of Jena revealed that the finds were distributed through two distinct layers, a silty and a sandy find layer. Furthermore, reinvestigation of the faunal and lithic material from the site revealed limited human modification on the recovered faunal and non-flint material [2-3]. Fabric analysis of bone and rocks from the find layer (as they were defined by Mania but based on material from the 2004 to 2007 excavation) indicate natural site formation processes of the assemblage [4,5]. Such detailed fabric data is not available for the 1971-2002 excavations. Another critical aspect is the dating of the site, with a variety of ages presented thus far. Here, we present microcontextual analysis of the find-bearing sediments as well as numerical (luminescence and IR-RF) and relative (amino acid) dating of the sediments and embedded gastropods opercula respectively. Our chronological analyses suggest a deposition of the find-bearing sediments prior to MIS 9 and thus we provide further support for an association of the fossil and the few archaeological materials with MIS 11. Microcontextual analysis in concert with a detailed re-assessments of site formation using separate fabric analysis for the two find-bearing layers situate the site within a lacustrine setting with laterally variable relocated, clastic input in a setting influenced by nearby tufa formation. These observations agree with a model of only ephemeral hominin activities and the locally restricted relocation of their physical remains by natural processes.

This research project was supported by several institutions: the Max-Planck-Society for micromorphological analysis, luminescence and IR-RF measurements; a scholarship by the Federal State of Thuringia to TD for micropalaeontological investigations; renewed excavations from 2003 to 2007, their analysis and of rock material from the previous excavations were supported by the University of Jena and two DFG grants awarded to CP (project number 35388362 and 264889190); and the European Research Council ERC under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 865222 - EQuaTe) awarded to KP for amino acid analyses.

References: [1] Mania, D., Mania, U., 2005. The natural and socio-cultural environment of *Homo erectus* at Bilzingsleben, Germany. In: Gamble, C., Porr, M. (Eds.), The Hominid Individual in Context. Archaeological Investigations of Lower and Middle Palaeolithic Landscapes, Locales and Artefacts. Routledge, London, pp. 98–114. [2] Bock, C., Neubeck, V., Pasda, C., 2017. Non-flint from the Middle Pleistocene site of Bilzingsleben (excavation from 1971 to 2002): Die Gesteine aus der mittelpleistozänen Fundstelle Bilzingsleben (Ausgrabungen 1971-2002). Quartär – Internationales Jahrbuch zur Erforschung des Eiszeitalters und der Steinzeit. 64, 7–25. [3] Brasser, M., 2017. Die Megafauna von Bilzingsleben, Veröffentlichungen des Landesamtes für Denkmalpflege und Archäologie Sachsen-Anhalt 73. Landesamtes für Denkmalpflege und Archäologie Sachsen-Anhalt, Halle (Saale). [4] Müller, W., Pasda, C., 2011. Site formation and faunal remains of the Middle Pleistocene site Bilzingsleben: Fundplatzgenese und Faunareste der mittelpleistozänen Fundstelle Bilzingsleben. Quartär – Internationales Jahrbuch zur Erforschung des Eiszeitalters und der Steinzeit. 58, 25–49. [5] Pasda, C., 2012. A study of rocks and flints from Bilzingsleben. Quartär - Internationales Jahrbuch zur Erforschung des Eiszeitalters und der Steinzeit 59, 7-40.

Podium Presentation, Session 9, Saturday 9:00–10:40

Cortical bone reflects signals of intrinsic hand muscles in *Homo sapiens* and *Pan troglodytes* across the metacarpus

Nadine G. Steer[1], Zewdi J. Tsegai[2], Mara G. Fields[1], Kevin M. Middleton[3], Casey M. Holliday[1], Carol V. Ward[1]

1 - Department of Pathology and Anatomical Sciences, University of Missouri · 2 - Department of Organismal Biology and Anatomy, University of Chicago · 3 - Division of Biological Sciences, University of Missouri

To improve our reconstructions of the manual behavioural capabilities of fossil hominins we need to fully grasp the functional disparities between the hands of humans and our closest living relatives, chimpanzees. Often soft tissues are overlooked, however, reconstructing the entire musculoskeletal system can provide novel insights into bone and joint functional morphology. However, both visualising and quantifying the many relevant soft and hard tissues simultaneously has proven challenging. Understanding muscle attachments and the biomechanical capacity of the hand musculature requires consideration of all muscles simultaneously, which is not possible when using traditional dissection [1-2] that is inherently destructive. This study employs a novel workflow to visualise muscles, and other relevant soft tissues, in 3D and *in silico*, alongside documenting muscle attachment anatomy, calculating muscle biomechanical potential, and then comparing these results to variation in whole bone cortical thickness and midshaft cross-sectional properties of the metacarpals.

Individual specimens of *Homo sapiens* (N=1) and *Pan troglodytes* (N=1) were fixed in standard anatomical position, stained with Lugol's iodine and μCT scanned at 50-62 μm. Muscles, tendons and bones were segmented in Avizo, and these data were used to describe and quantify muscle volumes, attachments and orientation vectors. Avizo Xfiber software was used to visualise individual muscle fascicles, and to calculate the force generating capacity of each muscle [3]. Moments of each muscle as well as muscles in aggregate act to effect movements about the trapeziometacarpal joint. Muscle attachment anatomy and biomechanical potentials were compared to cortical bone thickness distribution and cross-sectional properties of the metacarpals at 50% of bone length. Midshaft cross-sectional properties (I, J and Zpol) and cortical bone thickness of each metacarpal were calculated, mapped and visualised using Stradview software, and cortical thickness maps were generated from Morphomap [4]. Cross-sectional properties were scaled by bone length and cortical thickness maps by the average cortical thickness of each specimen.

Results show that human thenar and hypothenar muscles tend to be stronger and more mediolaterally oriented than those of the chimpanzee, and are capable of generating higher moments about the pollical bones. There are thicker cortices on the MC1 where muscles with larger PCSAs attach directly, especially those with more transverse fibers, for example the *Homo opponens pollicis*. The *Pan flexor pollicis brevis* and *adductor pollicis* also have large PCSAs, and attach directly to bone, with some degree of cortical thickening at these attachment sites. However, the *Homo adductor pollicis* also has a large PCSA compared to the *Pan* and other *Homo* muscles, but because it does not attach directly to bone, and as such, no causal association with cortical thickness can be inferred. Chimpanzees had thicker metacarpal cortical bone overall than the human, but with relatively smaller cross-sectional properties.

This research aims to visualise and directly test the relationship between muscle morphology, muscle attachment sites and cortical bone structure within the same individual. These results indicate that cortical bone may reflect muscle size and orientation, which suggests a potential new window into reconstruction of the manual behaviours of fossil hominins, however, to gain a better understanding future research will also focus on the incorporation of the extrinsic musculature.

We thank Callum Ross for providing the *Pan* specimen, the University of Missouri Gift of Body Program for the human donor, the staff of UTCT for scanning, and Taylor Mitchell for assistance. Research supported by the University of Missouri Research Council. This research was supported by the National Science Foundation [EAR 1631684 to Casey M. Holliday, BCS 0716244 & BCS 1551992 to Carol V. Ward].

References: [1] Diogo, R., Wood, B., 2012. Comparative anatomy and phylogeny of primate muscles and human evolution. Science Publishers, U.S. [2] Marzke, M.W., Marzke, R.F., Linscheid, R.L., Smutz, P., Steinberg, B., Reece, S., An, K.N., 1999. Chimpanzee thumb muscle cross sections, moment arms and potential torques, and comparisons with humans. American Journal of Physical Anthropology. 110, 163–178. [3] Sullivan, S.P., McGechie, F.R., Middleton, K.M., Holliday, C.M., 2019. 3D muscle architecture of the pectoral muscles of European starling (*Sturnus vulgaris*). Integrative Organismal Biology. 1, oby010. [4] Profico, A., Bondioli, L., Raia, P., O'Higgins, P., Marchi, D., 2021. Morphomap: An R package for long bone landmarking, cortical thickness, and cross-sectional geometry mapping. American Journal of Physical Anthropology. 174, 129–139.

Poster Presentation Number 105, Session 2, Friday 17:00 – 18:30

Digitising and reconstructing the Upper Palaeolithic infant twin burial from Krems-Wachtberg

Stefanie Stelzer[1], Veronika Kaudela[1,2], Thomas Einwoegerer[2], Anja Grebe[3], Marc Haendel[2], Dieter Pahr[1,4], Hannah Parow-Souchon[2], Max Resch[3], Maria Teschler-Nicola[6,7]

1 - Department of Anatomy and Biomechanics, Karl Landsteiner University of Health Sciences, Krems an der Donau, Austria · 2 - Austrian Archaeological Institute, Austrian Academy of Sciences, Austria · 3 - Department for Arts and Cultural Studies, University for Continuing Education Krems, Austria · 5 - Institute for Lightweight Design and Structural Biomechanics, Vienna University of Technology, Austria · 6 - Department of Anthropology, Natural History Museum Vienna, Austria · 7 - Department of Evolutionary Anthropology, University of Vienna, Austria

After its discovery and recovery as a block in 2005, the 31,000-year-old Upper Palaeolithic twin burial from Krems-Wachtberg had been carefully excavated under laboratory conditions in 2015. Structured light 3D surface scans were produced to document this exposure. In a preceding pilot study, these surface scans were combined with the µCT images of individual skeletal elements to verify the practicability of this approach for a virtual reconstruction of the burial. So far, the left hand and parts of the skull of individual 2 were successfully reconstructed in three dimensions.

In the current project (project title: Digitising and reconstructing an Upper Palaeolithic infant twin burial from Krems-Wachtberg), µCT scans of all skeletal remains recovered from the double burial (grave 1) will be prepared. Although more than 500 skeletal elements and fragments as well as numerous tooth germs were listed during the excavation, many of these are poorly preserved and unsuitable for the reconstruction process due to structural alterations, taphonomic changes and their porosity; hence, only well-preserved and anatomically well-identifiable skeletal elements will be considered for the virtual reconstruction of the two newborns by means of surface registration. The µCT data will be provided in a database to make the data available to the scientific community and the general public. The current contribution aims to present and discuss the structure of this µCT data repository. Through the virtual reconstruction of the burial, we seek to understand taphonomic processes and deduce the chronology of activities in the context of the burial. In this way we attempt to shed light on ritual behaviours of early modern humans in Central Europe. Since the Krems-Wachtberg double infant burial provides the rare opportunity to study different aspects of neonate anatomy in ontogenetic and phylogenetic settings, the digital data produced in this study will lay the groundwork for further research.

This research is funded by the GFF as part of the RTI Strategy Lower Austria 2027.

Podium Presentation, Session 9, Saturday 9:00–10:40

Spirals through time: evolutionary history of the modern human bony labyrinth

Alexander Stoessel[1,2,3], Fred Spoor[2,4], Victoria Gibbon[5], Romain David[2,4], Isabelle Crevecoeur[6], Hélène Rougier[7], Cosimo Posth[1,8], Annemarie Kaiser[1], Annekatrin Lippold[3], Barbara Tessmann[9], Kokou Azamede[10], Kristina Scheelen-Nováček[11], Rodrigo Barquera[1], Evelyn Guevara[12], Yvonne Karanja[5], Maxime Aubert[13], Rebeka Rmoutilová[14], Petr Velemínský[15], Jaroslav Brůžek[14], Jean-Jacques Hublin[1,16], Johannes Krause[1], Philipp Gunz[2]

1 - Department of Archaeogenetics, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 2 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 3 - Institute of Zoology and Evolutionary Research, Friedrich Schiller University Jena, Jena, Germany · 4 - Centre for Human Evolution Research, Natural History Museum, London, UK · 5 - Department of Human Biology, University of Cape Town, Cape Town, South Africa · 6 - UMR 5199 PACEA, CNRS, Université de Bordeaux, Ministère de la Culture, Pessac, France · 7 - Department of Anthropology, California State University Northridge, Northridge, CA, USA · 8 - Archaeo- and Palaeogenetics, Institute for Archaeological Sciences, Department of Geosciences, University of Tübingen, Tübingen, Germany · 9 - Museum für Vor- und Frühgeschichte Berlin, Stiftung Preussischer Kulturbesitz, Berlin, Germany · 10 - Département d'Etudes Germaniques, Université de Lomé, Togo · 11 - Federal Archaeological Office of Bremen, Bremen, Germany · 12 - Department of Forensic Medicine, University of Helsinki, Helsinki, Finland · 13 - Griffith Centre for Social and Cultural Research, Griffith University, Gold Coast, Queensland, Australia · 14 - Department of Anthropology and Human Genetics, Faculty of Science, Charles University, Prague, Czech Republic · 15 - Department of Anthropology, National Museum, Prague, Czech Republic · 16 - Chair of Paleoanthropology, CIRB1, Collège de France, Paris, France

The bony labyrinth inside the temporal bone houses the sensory organs of hearing and balance. It is fully formed before birth (in humans and most mammals) and remains unchanged through life. It can be studied even in ancient skeletal remains, making it an important source of evolutionary information, particularly when ancient DNA (aDNA) is not preserved. The shape of the bony labyrinth and the encasing temporal bone differ even between closely related groups: comparative analyses of linear dimensions [1] and geometric morphometrics have revealed, e.g., that the shape of the bony labyrinth can be used to distinguish between present-day humans, Upper Palaeolithic (UP) *Homo sapiens*, and Neanderthals. Moreover, within present-day humans the shape of the bony labyrinth carries a signal reflecting modern human dispersal out of Africa, likely because both the labyrinth and the temporal bone show a neutral pattern of global variation, e.g. [2-3].

Previous studies of the bony labyrinth have often been limited by insufficient representation of global human diversity, particularly from sub-Saharan Africa. Here, we studied 417 individuals from 17 Holocene modern human groups and divers global regions, including all major parts of sub-Saharan Africa, as well as 12 Upper Palaeolithic *H. sapiens*, 21 Neandertals, and 9 early *H. sapiens*, some of them not analysed before. We first extracted the 3D surface of the bony labyrinth from µCT scans of isolated temporal bones or whole skulls (resolution 0.02-0.07 mm). We then quantified the shape of the bony labyrinth using geometric morphometrics based on landmarks and sliding curve semilandmarks in Avizo™ and Mathematica™ [4].

Principal component analysis of bony labyrinth shape confirms that Neanderthals are distinct from both recent and fossil *Homo sapiens*, whereas Holocene human groups show substantial overlap. Notably, variations along PC1 suggest a geographic gradient from sub-Saharan Africa to Indigenous American groups, predominantly linked to variations in cochlear coiling. Early *H. sapiens* fall within the variation of sub-Saharan African Holocene humans suggesting that Holocene shape variation of the labyrinth in individuals from sub-Saharan Africa may include the morphology of early *H. sapiens*. UP modern humans form a cluster in shape space that shows some characteristic differences from all other *H. sapiens* groups. Our shape data analyses are in line with genetic evidence showing that the bony labyrinth of sub-Saharan African groups (in particular of Later Stone Age Southern African hunter gatherers-herders) show the highest shape variance, while variance decreases as one moves geographically away from Africa (e.g. Polynesia and the Americas.)

Our findings demonstrate the importance of morphological evidence from the bony labyrinth to obtain a deeper understanding of the evolutionary trajectories of *Homo sapiens*, complementing genetic studies and as a primary source where aDNA is not available.

We thank all the curators of extant and fossil individuals. This research was supported by the Max Planck Society.

References: [1] Spoor, F., Hublin, J.-J., Braun, M., Zonneveld, F., 2003. The bony labyrinth of Neanderthals. Journal of Human Evolution. 44, 141–165. [2] Harvati, K., Weaver, T.D., 2006. Human cranial anatomy and the differential preservation of population history and climate signatures. The Anatomical Record Part A: Discoveries in Molecular, Cellular, and Evolutionary Biology. 288A, 1225–1233. [3] Ponce de León, M.S., Koesbardiati, T., Weissmann, J.D., Milella, M., Reyna-Blanco, C.S., Suwa, G., Kondo, O., Malaspinas, A.-S., White, T.D., Zollikofer, C.P.E., 2018. Human bony labyrinth is an indicator of population history and dispersal from Africa. Proceedings of the National Academy of Sciences. 115, 4128–4133. [4] Gunz, P., Ramsier, M., Kuhrig, M., Hublin, J., Spoor, F., 2012. The mammalian bony labyrinth reconsidered, introducing a comprehensive geometric morphometric approach. Journal of Anatomy. 220, 529–543.

Pecha Kucha Presentation, Session 7, Friday 13:30 – 15:00

The genetic history of the Vindija Neandertals

Arev P Sümer[1], Stéphane Peyrégne[1], Helen Fewlass[2,3], Alba Bossoms Mesa[1], Anna Schmidt[1], Elena Essel[1], Petra Korlević[4], Laurits Skov[5], Sarah Nagel[1], Birgit Nickel[1], Julia Zorn[1], Divyaratan Popli[1], Leonardo N M Iasi[1], Jean-Jacques Hublin[1,6], Siniša Radović[7], Ivan Gušic[7], Pavao Rudan[7], Željko Kućan[7], Svante Pääbo[1], Matthias Meyer[1], Janet Kelso[1], Mateja Hajdinjak[1], Benjamin M Peter[1]

1 - Max Planck Institute for Evolutionary Anthropology, Germany · 2 - Francis Crick Institute, London, UK · 3 - University of Bristol, Bristol, UK · 4 - Wellcome Sanger Institute, Cambridge, UK · 5 - University of California, Berkeley, USA · 6 - Collège de France, Paris, France · 7 - Croatian Academy of Sciences and Arts, Croatia

Little is known about the fine-scale genetic history of Neandertals, or the population relationships within and between different Neandertal groups. Here, we screened 19 skeletal remains from Vindija Cave in Croatia for ancient DNA preservation, and detected Neandertal DNA in 15 of them. We present new genome-wide data from these specimens, directly dated to between 49,500 and 42,000 years cal. BP. Based on the carbon and nitrogen stable isotopic values, these individuals had similar diets with their protein intake derived primarily from terrestrial herbivores, consistent with other Late Neandertals across Europe. We used in-solution hybridisation captures of single-stranded DNA libraries [1] to obtain nuclear, mitochondrial and Y chromosome data, and found that these 15 specimens represented in total at least 11 individuals, nine of which were females. Based on their nuclear data, all of these Vindija Neandertals are more closely related to the Vindija33.19 Neandertal than they are to other Neandertals. We found a mother-daughter pair, with one of them having second degree relatedness to two other individuals [2], showing that at least some of these individuals lived around the same time. Compared to a group of Neandertals who lived ~60,000 years ago in the region of Chagyrskaya Cave in Siberia [3], the Vindija Neandertals show a high mitochondrial diversity that dates back to ~100,000 years ago and captures much of the diversity seen in other Late Neandertals from Europe. Using coalescent simulations, we show that the mitochondrial diversity of Vindija Neandertals is compatible with the population size estimates obtained from the high-coverage genome of Vindija33.19 [4], suggesting that these individuals stem from a single population. Consistent with the high mitochondrial diversity, one of the specimens, Vindija33.29, carries a Y chromosomal sequence which is more similar to the ~43,500-year-old Mezmaiskaya2 Neandertal from Southern Russia than to the ~45,330-year-old Spy94a Neandertal from Belgium [5]. The higher mitochondrial diversity found in Vindija and other western Neandertals is in stark contrast to the low diversity observed in Siberian Neandertals, suggesting that the level of genetic diversity of Neandertal populations was heterogeneous across Eurasia.

This work was supported by the Max Planck Society. We thank the members of the Bioinformatics Group, Genetic Diversity Through Space and Time Group and Core Unit at the MPI-EVA, Department of Evolutionary Genetics.

References: [1] Gansauge, M.-T., Aximu-Petri, A., Nagel, S., Meyer, M., 2020. Manual and automated preparation of single-stranded DNA libraries for the sequencing of DNA from ancient biological remains and other sources of highly degraded DNA. Nature Protocols. 15, 2279–2300. [2] Popli, D., Peyrégne, S., Peter, B.M., 2023. KIN: a method to infer relatedness from low-coverage ancient DNA. Genome Biology. 24, 10. [3] Skov, L., Peyrégne, S., Popli, D., Iasi, L.N.M., Devièse, T., Slon, V., Zavala, E.I., Hajdinjak, M., Sümer, A.P., Grote, S., Bossoms Mesa, A., López Herráez, D., Nickel, B., Nagel, S., Richter, J., Essel, E., Gansauge, M., Schmidt, A., Korlević, P., Comeskey, D., Derevianko, A.P., Kharevich, A., Markin, S.V., Talamo, S., Douka, K., Krajcarz, M.T., Roberts, R.G., Higham, T., Viola, B., Krivoshapkin, A.I., Kolobova, K.A., Kelso, J., Meyer, M., Pääbo, S., Peter, B.M., 2022. Genetic insights into the social organization of Neanderthals. Nature. 610, 519–525. [4] Prüfer, K., de Filippo, C., Grote, S., Mafessoni, F., Korlević, P., Hajdinjak, M., Vernot, B., Skov, L., Hsieh, P., Peyrégne, S., Reher, D., Hopfe, C., Nagel, S., Maricic, T., Fu, Q., Theunert, C., Rogers, R., Skoglund, P., Chintalapati, M., Dannemann, M., Nelson, B.J., Key, F.M., Rudan, P., Kućan, Ž., Gušić, I., Golovanova, L.V., Doronichev, V.B., Patterson, N., Reich, D., Eichler, E.E., Slatkin, M., Schierup, M.H., Andrés, A.M., Kelso, J., Meyer, M., Pääbo, S., 2017. A high-coverage Neandertal genome from Vindija Cave in Croatia. Science. 358, 655–658. [5] Petr, M., Hajdinjak, M., Fu, Q., Essel, E., Rougier, H., Crevecoeur, I., Semal, P., Golovanova, L.V., Doronichev, V.B., Lalueza-Fox, C., de la Rasilla, M., Rosas, A., Shunkov, M.V., Kozlikin, M.B., Derevianko, A.P., Vernot, B., Meyer, M., Kelso, J., 2020. The evolutionary history of Neanderthal and Denisovan Y chromosomes. Science. 369, 1653–1656.

Poster Presentation Number 106, Session 2, Friday 17:00 – 18:30

Postnatal cortical bone restructuring in chimpanzees and modern humans during locomotor development

Karen R Swan[1], Zewdi J Tsegai[2], Rachel Ives[3], Louise T Humphrey[1]

1 - Centre for Human Evolution Research (CHER), Natural History Museum, London, UK · 2 - Department of Organismal Biology and Anatomy, University of Chicago, Chicago, Illinois, USA · 3 - Vertebrates and Anthropology collections, Natural History Museum, London, UK

As our closest living relative, chimpanzees, provides an important comparative role when considering the reconstruction and interpretation of life history traits in extinct hominins. The amount and distribution of cortical bone of long bones changes throughout life and is highly influenced by multiple factors including genetics, hormonal status, and a changing mechanical environment [1]. As both humans and chimpanzees are behaviourally altricial, the first few years following birth are characterised by distinct shifts in locomotor behaviours and loading regimes prior to the adoption of adultlike locomotion. From a non-mobile state at birth, humans transition from a range of postural and locomotor behaviours such as crawling and standing to eventually walking bipedally [2], while chimpanzees engage mostly in suspensory and arboreal behaviours prior to becoming increasingly terrestrial knuckle-walkers [3]. Yet, with notable differences in locomotor specialism and anatomy, it is not clear whether chimpanzees undergo a similar pattern of development of cortical bone structure to humans or how these may differ in terms of timing. Here, we aim to compare developmental trajectories of femoral cortical bone structure in chimpanzees and humans during growth and locomotor development.

Cortical bone structure was examined in an archaeological sample of humans aged between birth and 14 years (N=98) and a sample of wild western chimpanzees (*P. t. verus*) aged from 2 weeks to 13 years (N=20), with most of the sample being of known age and sex. Unfused femora were micro-CT scanned and diaphyseal cross-sections were extracted at 50% of total intermetaphseal length. Outlines approximating the sub-periosteal and endocortical borders were automatically generated and cross-sectional area (cortical area, medullary area and total area), shape (Ix/Iy) and intracortical porosity metrics were recorded.

The results reveal both similarities and differences in the structural properties of cortical bone between the two groups. The relative amount of cortical porosity in chimpanzees was shown to closely follow the human trend, which is defined by a sharp increase during the first year, followed by a rapid decline and stabilization with increasing age suggesting a transient period of porosity during infancy in both species. Both humans and chimpanzees present an expansion of relative medullary cavity area during early growth followed by a stabilization. Chimpanzee values are initially higher than humans and exhibit a smaller increase in relative medullary area and a later age of stabilisation likely reflecting differences in the age of commencement of knuckle-walking in chimpanzees at 2 years and independent walking in humans at 1 year. Diaphyseal shape presented two very different ontogenetic trends, which likely reflect differences in locomotor mode and behavioural development. Humans demonstrate an increase in mediolateral reinforcement during the first 2 years which becomes progressively more anteroposterior shaped with increasing age and bipedal proficiency. In contrast, chimpanzees are born with a slightly anteroposterior shaped diaphysis which becomes consistently more mediolaterally reinforced with age. The amount of variation in Ix/Iy values, particularly in older subadults with mature locomotion, is notably higher in humans than chimpanzees and may result from a greater variability in both the amount and type of physical activity between individuals due to social influences.

We are grateful to colleagues at the Taï Chimpanzee Project, The Department of Human Origins, MPI-EVA, Natural History Museum, London and the Centre for Human Bioarchaeology, Museum of London for the curation, collections access, CT scans and advice on the samples used in this study. This project was supported by the Calleva Foundation (KRS, LTH) and the European Union's Horizon 2020 research and innovation programme for Marie Sklodowska-Curie Action #101025719 (ZJT).

References: [1] Seeman, E., 2008. Bone quality: the material and structural basis of bone strength. Journal of Bone and Mineral Metabolism. 26, 1-8. [2] Swan, K. R., Ives, R., Wilson, L. A. B., Humphrey, L. T., 2020. Ontogenetic changes in femoral cross-sectional geometry during childhood locomotor development. American Journal of Physical Anthropology. 173, 80-95. [3] Doran, D. M., 1992. The ontogeny of chimpanzee and pygmy chimpanzee locomotor behavior: a case study of paedomorphism and its behavioral correlates. Journal of Human Evolution. 23, 139-157.

Podium Presentation, Session 5, Friday 8:30 – 10:10

Early evidence for prepared core technology ~760 Kyr at Nadung'a 13, West Turkana (Kenya)

Nicholas Taylor[1,2], Sonia Harmand[3,4,1,2],Xavier Boës[5,6,2],Vincent Arrighi[7,2], Bert Van Bocxlaer[8,2], Camille Thabard[3,2], Medina Lubisia[9,2]

1 - Turkana Basin Institute and Department of Anthropology, Stony Brook University, USA · 2 - West Turkana Archaeological Project, Nairobi, Kenya · 3 - Laboratoire TRACES-UMR 5608, Universite Toulouse Jean Jaures, Toulouse, France · 4 - Institut Français de Recherche en Afrique (IFRA), UMIFRE, USR 3336, CNRS, Nairobi, Kenya · 5 - Institut National de Recherches Archeologiques Preventives (INRAP), Bordeaux-Begles, France · 6. CNRS/MNHN/UPVD, Alliance Sorbonne Universite, UMR 7194, Musee de L'Homme, France · 7 - Institut National de Recherches Archeologiques Preventives (INRAP), Orens de Gameville, France · 8. - CNRS, Univ. Lille, UMR 8198, Lille, France ·9 - Turkana University College, Lodwar, Kenya

The emergence in the African archaeological record of prepared core technology (PCT) has historically been linked to the abandonment of the large, handheld (Mode 2) bifaces that are characteristic of the Early Stone Age (ESA) Acheulean industry, in favour of smaller flake-based Middle Stone Age (MSA) tools that are suitable for hafting (Mode 3). Dates for the ESA-MSA transition across the continent coalesce in the range ~400-200 ka, and map chronologically on to the anatomical appearance of *Homo sapiens* in the fossil record ~300 ka, implying that the roots of our species' cognition may be linked to this technological shift. However, an increasing corpus of evidence suggests some characteristic MSA behaviours including stone tool manufacture based on PCT may have accumulated gradually through the later Acheulean (~900-400 ka). This temporal span is therefore of significant interest as a potential source of the cognitive and behavioural changes underlying the evolution of *H. heidelbergensis*/archaic *H. sapiens* in the Middle Pleistocene.

The cognitive and behavioural importance of PCT lies in the fact that it involves the creation and maintenance of hierarchically organised core surfaces, and extended *chaînes opératoires* that necessitate significantly increased planning depth. The removal of products of a predictable size and shape is often contingent upon one or more skilful final strikes that are themselves a delayed return on effort. On a global scale, the earliest widely accepted evidence for PCT now comes from Canteen Kopje (1.1-0.8 Ma) in South Africa, Gesher Benot Ya'aqov in Israel (700 ka) and the Kapthurin Formation (~400 ka) in Kenya. In each of these cases, hominin knappers used prepared methods to make very large cores and flake blanks as part of a technological trajectory directly related to Acheulean biface manufacture (Mode 2).

Here we report new evidence from the ~760 ka site of Nadung'a 13 (West Turkana, Kenya) which reveals the early adoption of well-elaborated PCT reduction that was directed toward the production of small flakes that are reminiscent of the MSA (Mode 3). Refitting sets attest to their manufacture on-site and alongside - but unrelated to - the production of larger bifaces. We present a refined geological and chronostratigraphic assessment of the Nadung'a site complex, followed by the analysis of the 1101 *in situ* artefact assemblage. We foreground evidence for the co-existence of biface and PCT reduction as distinctive technological strategies and discuss the implications for the evolution of Middle Pleistocene hominin cognition and definitions of the ESA-MSA transition.

Podium Presentation, Session 6, Friday 10:30 – 12:10

All grown up: the adult Turkana boy pelvis and its implications for the taxonomic assignation of East African Early Pleistocene hominins

Nicole Torres-Tamayo[1,2], Cinzia Fornai[1,3,4,5], Nicole M. Webb[1,6], Mirella Woodert[1], Guillermo Bravo Morante[1], Viktoria Krenn[1,4,7], Milo Kistler[1], Martin Haeusler[1]

1 - Institute of Evolutionary Medicine, University of Zürich, Switzerland · 2 - Department of Anthropology UCL, London, United Kingdom · 3 - Department of Research in Occlusion Medicine, Vienna School of Interdisciplinary Dentistry - VieSID, Klosterneuburg, Austria · 4 - Department of Evolutionary Anthropology, University of Vienna, Vienna, Austria · 5 - Centre of Clinical Research, University Clinic of Dentistry, Medical University of Vienna, Vienna, Austria 6 - Department of Palaeoanthropology, Senckenberg Gesellschaft für Naturforschung, Frankfurt am Main, Germany · 7 - Fraunhofer Innovation Center for Digitalization and Artificial Intelligence - KI4LIFE, Klagenfurt, Austria

Since its discovery in 1984, the skeleton of the juvenile *H. erectus* specimen KNM-WT 15000 (also known as 'Turkana boy') has provided valuable insights into the body shape of this species. However, its pelvic morphology is enigmatic due to its fragmentary nature and the fact that it represents a subadult individual with pelvic bones still not fully fused. Multiple reconstructions of its pelvis using different methodologies have been attempted, often yielding different interpretations. For instance, the initial reconstruction suggested a narrow pelvis similar to that of modern humans [1], while the most recent one indicated a wide bi-iliac breadth and marked iliac flaring also present in other early *Homo* pelves [2]. In this regard, the adult pelvic morphology of this specimen could shed light on the uncertain taxonomic attribution of other East African Early Pleistocene specimens without associated craniodental remains (e.g., KNM-ER 3228, OH 28). However, its adult pelvic morphology remains unknown because this individual died at an estimated age of 8-15 years. For this reason, the aims of this work are 1) to predict the hypothetical male and female adult pelvic morphology of the Turkana boy specimen by performing simulations of sexual dimorphism and growth using the most recent pelvic reconstruction based on modern human samples, and 2) to compare the projected adult Turkana boy pelvis with the potential *H. erectus* hipbones KNM-ER 3228 and OH 28 [3-4] to contribute to the discussion of the taxonomic attribution of these specimens based on phenetic affinities.

We segmented >300 modern human CT scans aged from 8 to 47 years. Given the uncertainty surrounding the age-at-death estimates of KNM-WT 15000, we computed ontogenetic trajectories for growth simulations between the mean pelvic morphology of adult modern humans and the mean morphologies of our sample across hypothetical ages from 8 to 15 years, encompassing the possible age-at-death of the Turkana boy. For the female pelvic morphology simulation, we applied a sexual dimorphism vector based on modern humans of the same age to our Turkana boy reconstruction to generate a hypothetical "Turkana girl". Then, we grew this pelvis along a modern human female ontogenetic trajectory to simulate the adult female morphology of *Homo erectus*. This was compared then to three differently fragmentary fossils using different landmark configurations: 64 landmarks for the entire pelvic morphology, 23 landmarks for KNM-ER 3228 and 18 landmarks for OH 18.

Our analyses revealed that the size of our Turkana boy pelvis reconstruction corresponds best to a 13-year-old individual based on modern human standards. Assuming a similar growth rate in *H. erectus* as in modern humans, our results suggest that almost 90% of adult pelvic size had been reached when this individual died. Both the adult male and female pelvic morphologies are relatively wide and show marked iliac flaring. The projected adult female pelvic morphology also reveals an expanded birth canal, a relatively wider bi-acetabular breadth and a relatively wider sub-pubic angle compared to the male version. The adult male and female projections of the Turkana boy show phenetic affinities with KNM-ER 3228 and OH 28, respectively, especially in the exaggerated iliac flaring. However, the robust iliac pillar characterizing those specimens is not present in our projections, likely because our landmark configuration does not capture this feature. Interestingly, the differences between our Turkana boy projections and the morphologies of these fossils are not larger than the intra-specific variation shown by modern humans, although it would be interesting to include other potential *H. erectus* specimens such as the pelvis from Gona BSN49/P27 [5]. Our results warrant a broader appreciation for the degree of potential morphological variation within and across hominin species and has major implications for accurate taxonomic assignation.

Financial support comes from the Swiss National Science Foundation Grant Nos. 310030_212984 and 31003A_176319. This work is also part of the Leibniz-Kooperative Exzellenz project K438/2022.

References: [1] Walker, A., Ruff, C., 1993. The reconstruction of the pelvis. In: Walker, A., Leakey, R. (Eds.), The Nariokotome *Homo erectus* Skeleton. Harvard University Press, Cambridge, MA, pp. 221e233. [2] Haeusler, M., Bonneau, N., Fornai, C., 2017. The morphology of the *Homo erectus* pelvis. Proceedings of the European Society for the Study of Human Evolution. 6:82. [3] Rose, M. D. (1984). A hominine hip bone, KNM-ER 3228, from East Lake Turkana, Kenya. American Journal of Physical Anthropology, 63, 371-378. [4] Ruff, C., 2010. Body size and body shape in early hominins–implications of the Gona pelvis. Journal of Human Evolution, 58, 166-178. [5] Simpson, S. W., Quade, J., Levin, N. E., Butler, R., Dupont-Nivet, G., Everett, M., Semaw, S., 2008. A female *Homo erectus* pelvis from Gona, Ethiopia. Science, 322, 1089-1092.

Poster Presentation Number 107, Session 2, Friday 17:00 – 18:30

Re-assessing toothpick grooves in fossil hominins: insights from a wild orangutan

Ian Towle[1,2], Kristin L. Krueger[3], Raquel Hernando[1,4], Marina Martínez de Pinillos[1], Luca Fiorenza[2], Leslea J. Hlusko[1]

1 - Centro Nacional de Investigación sobre la Evolución Humana (CENIEH), Burgos, Spain · 2 - Universidad de Burgos, Burgos, Spain · 3 - Universidad Internacional de La Rioja (UNIR), Logroño, Spain ·4 - Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA), Tarragona, Spain

This study reassesses the interpretation of ´toothpick grooves´, non-carious cervical lesions (NCCLs) found commonly on the interproximal regions of posterior teeth in fossil hominins [1-2]. Today, almost universally, these grooves are considered indicative of tool use behaviour, for dental hygiene purposes or for alleviating discomfort associated with oral pathologies, supported by experimental studies [3]. In this study, we describe a wild orangutan (*Pongo pygmaeus*), curated at the Field Museum (Chicago, US), that exhibits a typical 'toothpick' groove on the mesial surface of a lower left second molar. This case provides a novel opportunity to reconsider these dental features not just as products of unique human cultural behaviour, but possibly also as outcomes of natural masticatory behaviours and dietary/environmental influences. Analyses of microscopic features of the orangutan root groove were undertaken, and dental tissue loss was estimated with an intraoral scanner. Comparisons with fossil *Homo* and archaeological human samples were then carried out. This includes NCCLs found in a variety of *Homo* species (*H. sapiens*, *H. neanderthalensis*, *H. heidelbergensis*, *H. erectus*, *H. antecessor* and *H. habilis*), and archaeological human samples from around the world (Americas, Australia, Africa and Eurasia). The orangutan case shows hallmark features of ´toothpick´ grooves, including buccal-lingual fine striations and a tapered profile from the buccal towards the lingual root surface, accompanied by a carious lesion beneath it. However, rather than toothpick-type behaviour to alleviate the discomfort associated with the carious lesion, this NCCL is likely caused by normal masticatory processes, supported by the presence of steep and severe wear on the adjacent first molar and associated periodontal disease. Such observations challenge the automatic attribution of similar grooves in fossil hominins to tool use, since if this tooth was found isolated in the fossil record a ´toothpick´ aetiology would likely have been proposed. Our findings invite a re-evaluation of the conventional understanding of toothpick grooves in fossil hominins, and support some earlier studies that suggested at least some of these interproximal root grooves may have a multifactorial aetiology, that does not always involve tool-use [4].

This research was supported with funding from the European Research Council within the European Union's Horizon Europe (ERC-2021-ADG, Tied2Teeth, project number 101054659). R.H is funded by Juan de la Cierva postdoctoral fellowship (JDC2022-048511-I). We thank Adam Ferguson and Lauren Johnson at the Field Museum of Natural History for access to their collections and permission to mold the orangutan dentition.

References: [1] Estalrrich, A., Alarcón, J.A., Rosas, A., 2016. Evidence of toothpick groove formation in Neandertal anterior and posterior teeth. American Journal of Physical Anthropology. 162, 747–756. [2] Frayer, D.W., Russell, M.D., 1987. Artificial grooves on the Krapina Neanderthal teeth. American Journal of Physical Anthropology. 74, 393–405. [3] Hlusko, L.J., 2003. The oldest hominid habit? Experimental evidence for toothpicking with grass stalks. Current Anthropology. 44, 738–741. [4] Wallace, J.A., 1974. Approximal grooving of teeth. American Journal of Physical Anthropology. 40, 385–390.

Poster Presentation Number 108, Session 2, Friday 17:00 – 18:30

Microtomographic analysis of fossil dental tissue of Neanderthal in situ maxillary and mandibular teeth from Krapina (Croatia, 130 ka)

Martina Trocchi[1], Paola Cerrito[2], Antonio Profico[3], David Frayer[4], Luca Bondioli[5], Patrick Mahoney[6], Lucia Mancini[7], Silvia Capuani[8,9], Diego Dreossi[10], Federico Bernardini[11], Davorka Radovčić[12], Alessia Nava[13]

1 - Earth Science Department, Sapienza University of Rome, Rome, Italy · 2 - Department of Evolutionary Anthropology, University of Zurich, Zürich, Switzerland · 3 - Department of Biology, University of Pisa, Pisa, Italy · 4 - Department of Anthropology, University of Kansas, Lawrence, USA · 5 - Department of Cultural Heritage: Archaeology and History of Art, Cinema and Music, University of Padua, Padua, Italy · 6 - School of Anthropology and Conservation, University of Kent, Canterbury, UK · 7 - Slovenian National Building and Civil Engineering Institute ZAG, Ljubljana, Slovenia · 8 - National Research Council, Institute for Complex Systems ISC-CNR, Department of Physics, Sapienza University of Rome, Rome, Italy · 9 - Enrico Fermi Study and Research Center CREF, Rome, Italy · 10 - Elettra-Sincrotrone Trieste S.C.P.A., Basovizza, Trieste, Italy · 11 - Department of Humanities, Ca' Foscari University of Venice, Venice, Italy · 12 - Department of Geology and Paleontology, Croatian Natural History Museum, Zagreb, Croatia · 13 - Department of Odontostomatological and Maxillofacial Sciences, Sapienza University of Rome, Rome, Italy

Comparative morphometric analysis of the Neanderthal dentition has contributed significantly to our understanding of the biology and phylogenetic relationships of this extinct hominin taxon which displays a species-specific pattern of dental traits, in terms of both morphology and ontogeny. Specifically, enamel thickness and dental tissue proportions have been widely used traits in making taxonomic decisions and subsequent phylogenetic inferences among hominins and within the genus *Homo* [1-2]. This preliminary work presents results of volumetric analysis on a sample of 43 in situ permanent teeth from 5 mandibles and 3 maxillae, belonging to 8 different individuals from the site of Krapina (Croatia, 130 ka) [3]. The remains were discovered in 1899 AD and yielded, to date, the largest collection of fossils attributed to *H. neanderthalensis* from a single locality [4].

The fossil specimens were measured by X-ray computed microtomography (XμCT) at Elettra Synchrotron facility in Basovizza (Trieste, Italy) using the FAITH instrument equipped with a microfocus source. Volumes were reconstructed with pixel sizes of 35 μm and 55 μm, and subsequently partitioned by semi-automatic segmentation. A subsample (N=23) of unworn teeth were selected for dental tissue proportions (DTP) analysis. Following protocols previously reported in the literature, bucco-lingual diameters, coronal tissue volumes and topographic changes in enamel thickness were calculated [5]. The indices obtained were then compared with a large comparative set for Neanderthals obtained from the literature.

Preliminary results suggest considerable intra-population variability among the Krapina individuals and, in general, the average tooth dimensions exceed the average of the Neanderthal comparative set. In particular, the analysis of the maxillary and mandibular dentition reveals that almost all teeth analysed exhibit greater volume in the tissues' coronal portion and enamel, as well as a greater diameter. The relative enamel thickness also follows a similar pattern, although there are differences between the anterior and posterior maxillary dentition. This is due to the Krapina specimens having larger molars and premolars, but smaller incisors when compared to the Neanderthal average. This places the Croatian sample at the upper end of Neanderthal phenotypic variation, as well as substantially enriching the high-resolution digital documentation of Neanderthal fossil dental specimens. Furthermore, our preliminary results highlight the importance of integrated morphological analyses for the purpose of taxonomic inferences, as it is the "whole package" of anterior and posterior dental proportions that most strongly distinguishes the Krapina group from the rest of the Neanderthals. Finally, our findings seem to underscore a significant between-group variability in *H. neanderthalensis*, possibly the result of strong genetic isolation between groups, as extensively highlighted by recent aDNA research.

References: [1] Olejniczak, A.J., Smith, T.M., Feeney, R.N.M., Macchiarelli, R., Mazurier, A., Bondioli, L., Rosas, A., Fortea, J., de la Rasilla, M., Garcia-Tabernero, A., Radovčić, J., Skinner, M.M., Toussaint, M., Hublin, J.-J., 2008. Dental tissue proportions and enamel thickness in Neandertal and modern human molars. Journal of Human Evolution. 55, 12–23. [2] Macchiarelli, R., Bondioli, L., Debénath, A., Mazurier, A., Tournepiche, J.-F., Birch, W., Dean, M.C., 2006. How Neanderthal molar teeth grew. Nature. 444, 748–751. [3] Rink, W.J., Schwarcz, H.P., Smith, F.H., Radovčić, J., 1995. ESR ages for Krapina hominids. Nature. 378, 24–24. [4] Wolpoff, M.H., 1979. The Krapina dental remains. American Journal of Physical Anthropology. 50, 67–113. [5] Macchiarelli, R., Bayle, P., Bondioli, L., Mazurier, A., Zanolli, C., 2013. From outer to inner structural morphology in dental anthropology: integration of the third dimension in the visualization and quantitative analysis of fossil remains. In: Scott, G.R., Irish, J.D., (Eds.), Anthropological Perspectives on Tooth Morphology: Genetics, Evolution, Variation. Cambridge Studies in Biological and Evolutionary Anthropology. Cambridge University Press, Cambridge, pp. 250–277.

Podium Presentation, Session 9, Saturday 9:00–10:40

More than a deme: semicircular canal shape reveals local evolution in Neanderthal paleodemes

Alessandro Urciuoli[1,2,3,4], Brian A. Keeling[4,5], Nicole M. Webb[2,6], Julia Diez-Valero[4], Ignacio Martínez[4], Rolf Quam[4,5,7,8], Juan Luis Arsuaga[7,9], Mercedes Conde-Valverde[4,5]

1 - Universitat Autònoma de Barcelona, Campus de la UAB, Barcelona, Spain · 2 - Division of Palaeoanthropology, Senckenberg Research Institute and Natural History Museum Frankfurt, Frankfurt am Main, Germany · 3 - Institut Català de Paleontologia Miquel Crusafont, Universitat Autònoma de Barcelona, Edifici ICTA-ICP, c/ Columnes s/n, Campus de la UAB, Barcelona, Spain · 4 - Universidad de Alcalá, Cátedra de Otoacústica Evolutiva y Paleoantropología (HM Hospitales-UAH), Departamento de Ciencias de la Vida, Madrid, Spain · 5 - Department of Anthropology, Binghamton University (SUNY), Binghamton, NY, USA · 6 - Institute of Evolutionary Medicine, University of Zurich, Zurich, Switzerland · 7 - Centro de Investigación UCM-ISCIII sobre la Evolución y Comportamiento Humanos, Madrid, Spain · 8 - Division of Anthropology, American Museum of Natural History, New York, USA · 9 - Departamento de Geodinámica, Estratigrafía y Paleontología, Facultad de Ciencias Geológicas, Madrid, Spain

Two main hypotheses have been proposed to explain the evolution of the derived Neanderthal cranial morphology, with some scholars arguing for a gradual emergence [1] and others proposing distinct phases [2]. However, several Middle Pleistocene specimens show an incipient Neanderthal morphology characterized by a mosaic of derived and primitive characters. Two Middle Pleistocene European fossils, Reilingen (Re) and Ehringsdorf H3 (EH3), retain several archaic characters shared with individuals from the Sima de los Huesos and Steinheim [3]. Nevertheless, Re and EH3 are considered more Neanderthal-derived than the Sima de los Huesos (SH) fossils, but still lack some derived features characteristic of Late Pleistocene Neanderthal [3-4].

We assessed the potential phylogenetic affinities of Re and EH3 by analyzing their semicircular canal and vestibule morphology using a deformation-based geometric morphometric method (diffeomorphometrics). This approach is a more powerful alternative than landmark-based geometric methods due to its ability to discriminate subtle changes in continuous morphological shapes [5]. The semicircular canal and vestibule of Re and EH3 individuals were compared to a fossil sample including SH humans (n=13), Krapina Neanderthals (Kr; n=10), and Eurasian Late Pleistocene Neanderthals (LN; n=9), as well as Upper Paleolithic (Cro-Magnon 1) and recent modern humans (RMH; n=18). The aligned, raw shape data was investigated using principal component analysis (PCA) to assess patterns of shape variation in the sample. Group classification accuracy and the group memberships for Re and EH3 were tested using a cluster analysis approach through a K-means unsupervised machine learning classification algorithm. For classification comparisons and verification, we also performed Neighbor-Joining (NJ) analyses on Mahalanobis (D^2) and Euclidean distance matrices between Re, EH3, and the comparative sample. D^2 was computed on PCA scores, whereas Euclidean distances were calculated from the raw shape data.

Our results highlight close morphological affinities between Re, EH3, and LN, particularly in the presence of an inferiorly positioned posterior canal, and a large, superiorly positioned lateral canal. Their semicircular canals are also more slender than in both SH and Kr. The SH sample shows an oval, latero-superiorly projecting posterior canal, and entirely overlaps with Kr in the morphospace. Our cluster analyses (D^2 and Euclidean distances) largely separated SH, Kr, LN, and RMH and grouped Re and EH3 with LN. SH individuals clustered separately from LN and Kr in both approaches, whereas Kr were either identified as a separated cluster or nested within LN as a single cluster. The K-means cluster analysis also accurately partitioned the known group clusters (94% classification accuracy) and classified both Re and EH3 as LN, reflecting small phenetic distances between these specimens and LN.

This study suggests that the bony labyrinth morphology in Re and EH3 is most similar to LN, indicating a stronger phenetic affinity with LN than previously considered, and implies that they might represent better candidates than Kr for the ancestral morphology to LN. The Kr sample instead appears rather primitive and may show features that evolved locally, suggesting that this sample represents a distinct deme within the Neanderthal lineage. The results of the present study support a mosaic pattern of evolution in Neanderthals and implies that a LN-like bony labyrinth emerged as early as 250 kya.

Funded by R+D+I project PID2020-116908GB-I00, PID2021-122355NB-C31 (MCIN/AEI/10.13039/501100011033/FEDER, UE), CERCA Programme/Generalitat de Catalunya, European Union-NextGenerationEU, Leibniz Collaborative Excellence Grant no. K438/2022.

References: [1] Hublin, J.J., 2009. The origin of Neandertals. Proceedings of the National Academy of Sciences. 106, 16022–16027. [2] Rosas, A., Bastir, M., Alarcón, J.A., 2019. Tempo and mode in the Neandertal evolutionary lineage: A structuralist approach to mandible variation. Quaternary Science Reviews. 217, 62–75. [3] Dean, D., Hublin, J.-J., Holloway, R., Ziegler, R., 1998. On the phylogenetic position of the pre-Neandertal specimen from Reilingen, Germany. Journal of Human Evolution. 34, 485–508. [4] Tattersall, I., Schwartz, J.H., 2006. The distinctiveness and systematic context of *Homo neanderthalensis*. Vertebrate Paleobiology and Paleoanthropology. 9–22. [5] Urciuoli, A., Zanolli, C., Almécija, S., Beaudet, A., Dumoncel, J., Morimoto, N., Nakatsukasa, M., Moyà-Solà, S., Begun, D.R., Alba, D.M., 2021. Reassessment of the phylogenetic relationships of the late Miocene apes *Hispanopithecus* and *Rudapithecus* based on vestibular morphology. Proceedings of the National Academy of Sciences. 118, e2015215118.

Poster Presentation Number 109, Session 2, Friday 17:00 – 18:30

Can scapular origin area predict rotator cuff muscle volume in hominoids?

Julia van Beesel[1,2,3], Evie Vereecke[1], Stephanie Melillo[4]

1 - Department of Development and Regeneration, KU Leuven, Belgium · 2 - Biomechanical Engineering, TU Delft, Netherlands · 3 - Department of Human Origins, Max Plank Institute for Evolutionary Anthropology, Germany · 4 - Department of Applied Forensic Sciences, Mercyhurst University, PA, USA

Humans are the only extant hominoid species in which the upper limb has no weight-bearing or propulsive function. While obligated bipedalism defines our species today, it is only a couple of million years old. Hominin forerunners are thought to have relied heavily on the shoulder and upper limb for vertical climbing and arm-swinging when navigating arboreal environments [1]. These locomotor modes are still employed to different degrees in extant hominoids. As climbing is functionally demanding, especially for the largest-bodied apes, there is a common understanding that all non-human hominoids possess adaptations to arboreal locomotion in their musculoskeletal morphology. However, the precise nature of these adaptations in the hominoid shoulder is still shrouded in mystery.

Previous research investigating climbing adaptations in non-human hominoids has focused on the identification of advantageous traits in skeletal and muscle morphology. Great emphasis was put on certain skeletal traits in the scapula, which distinguish extant humans from non-human apes. These include the relative sizes of the scapular fossa areas, with the supraspinous fossa being generally greater in apes compared to humans [2]. These fossae constitute the origin sites of the rotator cuff muscles, which are important to counteract the forces applied on the shoulder during arm-swinging. However, past studies were unsuccessful in establishing direct correlations between fossa size and muscle volume [3].

This study aims to bridge these knowledge gaps by investigating the link between shoulder musculoskeletal morphology and locomotor behaviour in the Hominoidea. Using virtual 3D reconstructions of bones (from CT) and muscles (from surface scans), we estimate functionally and biomechanically relevant parameters of the rotator cuff muscles, including length, volume and attachment area [4]. The focus hereby lies on the conclusions that can be drawn from single bones, such as predicting muscle volume from attachment area, to enhance functional interpretations of the fossil record. By comparing these parameters across hominoid genera, our study aims to encompass a wide range of shape and locomotor variations.

Through this interspecific comparison we aim to provide valuable insights into hominoid evolution and contribute to our understanding of the functional morphology of the primate shoulder complex. The findings also have broader implications for biomechanics and biological anthropology, and will contribute to an evidence-based interpretation of the hominin fossil record.

Funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Project number 517064266. Further funds were provided by the Jan Palfijn lab, KU Leuven, by the Mercyhurst University, PA, USA, and by the former Department of Human Evolution, MPI EVA. Our gratitude goes to all participating zoos and museums, especially the Twycross Zoo, UK, the Eerie Zoo, USA, the DierenPark Amersfoort, NL and the Réserve Africaine de Sigean, FR. We would also like to thank the Visible Human Project for providing access to their valuable dataset.

References: [1] Larson, S.G., 2013. Shoulder morphology in early Hominin evolution. In: Reed, K., Fleagle, J., Leakey, R. (Eds) The Paleobiology of *Australopithecus*. Vertebrate Paleobiology and Paleoanthropology. Springer, Dordrecht, pp. 247–261. [2] Bello-Hellegouarch, G., Potau, J.M., Arias-Martorell, J., Pastor, J.F., Pérez-Pérez, A., 2013. A comparison of qualitative and quantitative methodological approaches to characterizing the dorsal side of the scapula in Hominoidea and its relationship to locomotion. International Journal of Primatology. 34, 315–336. [3] Larson, S.G., Stern, J.T., 2013. Rotator cuff muscle function and its relation to scapular morphology in apes. Journal of Human Evolution. 65, 391–403. [4] Eigen, L., Nyakatura, J.A., 2021. Architectural properties of the musculoskeletal system in the shoulder of two callitrichid primate species derived from virtual dissection. Primates. 62, 827–843.

Poster Presentation Number 110, Session 2, Friday 17:00 – 18:30

Advanced radiocarbon dating methods for palaeolithic samples in new pre-treatment laboratory at the University of Vienna

Laura van der Sluis[1,2], Maddalena Gianni[1,2], Katerina Douka[1,2], Tom Higham[1,2]

1 - Department of Evolutionary Anthropology, University of Vienna, Vienna, Austria · 2 - Human Evolution and Archaeological Science (HEAS) Network, Vienna, Austria

Bone collagen is one of the most used materials for radiocarbon dating of archaeological contexts, but also one of the most challenging ones. Rigorous pretreatment protocols are required to remove all possible contamination and obtain an accurate age, which is especially acute when dating complicated (i.e. contaminated) samples that are in age close to the limit of the method. In our new laboratory at the University of Vienna, we have been chemically pretreating samples since the start of 2023. Our standard protocol for bone collagen focuses on using the ultrafiltration method after Higham et al. [1] and Brock et al. [2]. In addition, we have also developed further a method of purifying bone collagen amino acids using an XAD-2 resin approach. We quantified the background limit for these methods using repeat dates of a mammoth bone standard (the "Hollis" bone) which comes from a >50,000 year old specimen. The collagen blanks from this standard are consistently in the range of ~50,000 BP (with an error of <1%), for both ultrafiltered and non-ultrafiltered bone collagen samples. For the XAD method our Hollis bone collagen blank yields ages of 45-46,000 BP. We are currently working to get even lower blank values.

The XAD method enables us to process, in a reliable manner without compromising on sample size, challenging old and contaminated samples, whether this contamination originates from the burial environment (e.g. humic acids) or conservation treatments (e.g. glues and consolidants). Crosslinked contaminants are known to affect ^{14}C ages, because these are often not effectively removed through the traditional ABA chemistry with ultrafiltration, and a hydrolysis step is required to release this contamination from the collagen. We combust and graphitise our samples at the VERA (Vienna Environmental Research Accelerator) AMS facility in Vienna, and measure AMS samples there and at the Keck AMS facility, University of California at Irvine. We will outline the XAD setup implemented in the laboratory and present the ^{14}C results of standards and blanks, as well as contaminated bone samples analysed using both ultrafiltration and the XAD treatment.

References: [1] Higham, T.F.G., Jacobi, R.M., Ramsey, C.B., 2006. AMS Radiocarbon Dating of Ancient Bone Using Ultrafiltration. Radiocarbon. 48, 179-195. [2] Brock, F., Higham, T., Ditchfield, P., Ramsey, C.B., 2010. Current pretreatment methods for AMS radiocarbon dating at the Oxford Radiocarbon Accelerator Unit (Orau). Radiocarbon. 52, 103-112.

Poster Presentation Number 111, Session 2, Friday 17:00 – 18:30

Piercing wounds or blunt force trauma: testing the efficacy of different hafting configurations

Alex van Harderwijk[1], Alessandro Aleo[2], Gerrit Dusseldorp[3]

1 - Faculty of Archaeology, Leiden University · 2 - Faculty of Mechanical Engineering, Delft University of Technology and Faculty of Archaeology, Leiden University · 3 - Faculty of Archaeology, Leiden University & Palaeo-Research Institute, University of Johannesburg

A variety of lithic technocomplexes across Europe and Africa contains semi-circular backed artefacts variously termed crescents, lunates or segments and often interpreted as functioning as part of projectile weapons. Here, we focus on the backed segments characteristic of the southern African Howiesons Poort technocomplex (~65–60 ka; [1]). Based on use-trace evidence, they have been interpreted as arrowheads, yet various hafting configurations have been proposed (e.g. [2]). We decided to experimentally compare the efficacy of penetration and the amount of damage caused by two of the proposed hafting configurations. For our experimental lithic tools, we base ourselves on the segments from the Howiesons Poort phase of Umhlatuzana rockshelter (KwaZulu-Natal, South Africa). This site has yielded quartz segments interpreted as arrowheads [3] and is the focus of ongoing research of one of us (see e.g. [4]). We use the dimensions of the quartz segments recorded by Lombard [2] from the site.

We commissioned arrows, tipped with segments in flint replicating the dimensions of the quartz backed segments from Umhlatuzana. We compared two different hafting configurations, transversal and oblique (with the segment angle ~45°). We used an installation to ensure uniformly drawing the bow for the different shots and shot the arrows into a gelatine block. We measured if there is a difference between these hafting configurations in penetration depth and size of entry and exit wounds. Our results show that transversally hafted arrows penetrate much better than obliquely hafted arrows. The size of entry and exit wounds shows more variation, but on balance, transversally hafted arrows appear to create larger wounds. Our results confirm observations in earlier experiments not specifically aimed to record penetration effectivity (e.g. [5]), but more realistic conditions with arrows needing to penetrate animal hide are needed to confirm the results.

We thank Dr. Morgan Roussel for producing the arrows for the experiment and Dr. Paul Kozowyk for the use of and assistance with his arrow shooting equipment. The experimental materials were funded by NWO Vidi grant 276-60-004 to Dusseldorp.

References: [1] Lombard, M., Bradfield, J., Caruana, M.V., Makhubela, T., Dusseldorp, G.L., Kramers, J.D., Wurz, S., 2022. The South African Stone Age updated (II). South African Archaeological Bulletin 77, 172-177. [2] Lombard, M., 2020. Testing for poisoned arrows in the Middle Stone Age: A tip cross-sectional analysis of backed microliths from southern Africa. Journal of Archaeological Science: Reports. 34, 102630.[3] Lombard, M., Phillipson, L., 2010. Indications of bow and stone-tipped arrow use 64 000 years ago in KwaZulu-Natal, South Africa. Antiquity. 84, 635–648. [4] Sifogeorgaki, I., Klinkenberg, V., Esteban, I., Murungi, M., Carr, A.S., van den Brink, V.B., Dusseldorp, G.L., 2020. New Excavations at Umhlatuzana Rockshelter, KwaZulu-Natal, South Africa: a Stratigraphic and Taphonomic Evaluation. African Archaeological Review. 37, 551–578. [5] Goldstein, S.T., Shaffer, C.M., 2016. Experimental and archaeological investigations of backed microlith function among Mid-to-Late Holocene herders in southwestern Kenya. Archaeological and Anthropological Sciences. 9, 1767–1788.

Poster Presentation Number 112, Session 2, Friday 17:00 – 18:30

Perspectives on possible and probable *Paranthropus* pelves

Caroline VanSickle[1], Martin Haeusler[2], Mirella Woodert[2], Stefan Schlager[3], Nicole Torres-Tamayo[2]

1 - Department of Anatomy, Des Moines University, Iowa, USA · 2 - Institute of Evolutionary Medicine, University of Zürich, Zürich, Switzerland · 3 - Klinik für Mund-, Kiefer- und Gesichtschirurgie Universitätsklinikum, Freiburg, Germany

Until now, there has never been a full reconstruction of a *Paranthropus* os coxae, owing to the crushed and incomplete pelvic fossils of this genus. While this genus is found in both eastern and southern Africa, the hipbone fossils most clearly associated with it are attributed to the South African hominin, *P. robustus*. These pelvic remains are represented by fossils from multiple sites, with most preserving some aspects of the ilium and ischium. However, most are also crushed or deformed with almost no preservation of the ischiopubic region, making reconstruction of this species' pelvic anatomy a challenge that has thus far been unsurmountable.

This state of preservation is particularly unfortunate given the debate over the taxonomy of the eastern African fossil, BSN49/P27. This nearly complete pelvis was found in isolation in the Busidima formation at Gona, Ethiopia. Initial analysis attributed it to *Homo erectus* [1]; however, Ruff [2] suggested that based on its seemingly small body size, it might instead be the contemporaneous and smaller bodied *P. boisei*. It is difficult to test the hypothesis that the Busidima pelvis is *Paranthropus* without knowing what a *Paranthropus* pelvis looks like.

To address the issue of what a *Paranthropus* pelvis looks like, we sought to reconstruct the *P. robustus* os coxae, SK 3155b. This right partial hipbone preserves most of the iliac blade, a nearly complete acetabulum, and part of the ischial body. Brain et al. [3] refit the three recovered pieces that make up this fossil with minor displacement due to their close proximity in the breccia and lack of distortion. The anterior superior iliac spine was lost during excavation. We chose this fossil because it has the best preserved and undistorted iliac blade of the *P. robustus* pelvic fossils, which is required in our method. However, the SK 3155b iliac crest is not complete, so we used the measurements of the reconstruction presented in McHenry [4] to estimate the missing regions of the ilium, including the anterior superior iliac spine. We then reconstructed the ischiopubic region of SK 3155b using statistical shape modeling. This machine learning approach is used to predict absent morphology during surgeries reconstructing skeletal anatomy; here, we adapted it to predict hominin pelvic anatomy. Our version was based on samples of fully preserved human (*Homo sapiens*), chimpanzee (*Pan troglodytes*), and gorilla (*Gorilla gorilla*) ossa coxae. We previously validated that the method accurately predicts the most probable ischiopubic anatomy from preserved iliac landmarks in *Australopithecus africanus* (Sts 14; mean error = 2.1 mm) and *A. afarensis* (A.L. 288-1; mean error=1.7 mm).

Using the iliac landmarks and semilandmarks developed from the measurements in McHenry [4] and a 3D scan of the original fossil, we applied different versions of the statistical shape modeling to SK 3155b, which each predicted different ischiopubic anatomy. Since reconstructing incomplete fossils always includes some subjectivity, we decided it would be best to discuss multiple possible predicted reconstructions of the *Paranthropus* hipbone rather than focus on a single version. Here, we compare the anatomy of the different predicted ischiopubic regions for SK 3155b. Overall, all models predicted a relatively long pubis that is straight and oriented anteriorly, which may indicate a heart-shaped pelvic inlet. The different reconstructions varied in the length and robusticity of the superior pubic ramus, as well as the robusticity and curvature of the ischiopubic ramus. It is noteworthy that at least some of the reconstructions resembled the Busidima pelvis, with its fairly robust ischiopubic ramus, which means our results cannot reject the hypothesis that this pelvis is indeed *Paranthropus*.

This research received financial support from the Swiss National Science Foundation grants, No. 310030_212984 and 31003A_176319.

References: [1] Simpson, S.W., Quade, J., Levin, N.E., Butler, R., Dupont-Nivet, G., Everett, M., Semaw, S., 2008. A Female *Homo erectus* pelvis from Gona, Ethiopia. Science. 322, 1089–1092. [2] Ruff, C., 2010. Body size and body shape in early hominins – implications of the Gona pelvis. Journal of Human Evolution. 58, 166–178. [3] Brain, C.K., Vrba, E.S., Robinson, J.T., 1974. A New hominid innominate bone from Swartkrans. Annals of the Transvaaal Museum. 29, 55–63. [4] McHenry, H.M., 1975. A new pelvic fragment from Swartkrans and the relationship between the robust and gracile australopithecines. American Journal of Physical Anthropology. 43, 245–261.

Pecha Kucha Presentation, Session 7, Friday 13:30 – 15:00

Femoral cortical bone and cross-sectional properties in gorilla subspecies: implications for inferences regarding hominin locomotor behaviors

Alessandra Vecino Gazabón[1,2,3], Ashley S. Hammond[1,2], Eva-Mercé Fuentes[1,4], Frederick Grine[5,6], Carrie S. Mongle[5,7], Marine Cazenave[1,8,9], Christopher B. Ruff[10]

1 - Division of Anthropology, American Museum of Natural History, New York, USA · 2 - New York Consortium in Evolutionary Primatology, New York, USA · 3 - Richard Gilder Graduate School at the American Museum of Natural History, New York, USA · 4 - Department of Anthropology, New York University, New York, USA · 5 - Department of Anthropology, Stony Brook University, New York, USA · 6 - Department of Anatomical Sciences, Stony Brook University, New York, USA · 7 - Turkana Basin Institute, Stony Brook University, New York, USA · 8 - Department of Human Origins, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 9 - Department of Anatomy, Faculty of Health Sciences, University of Pretoria, South Africa · 10 - Center for Functional Anatomy and Evolution, Johns Hopkins University School of Medicine

Gorilla populations inhabit a range of high and low elevation environments and exhibit habitat-specific variation in locomotor behavior, likely reflecting differences in access to trees and climbing opportunities in different locations. The behavioral differences in closely related populations make gorillas a good model for studying how early hominin femoral morphology may track ecogeographic differences in locomotor behavior in closely related taxa. Here, we examine femoral diaphyseal cortical bone thickness distribution and cross-sectional properties (CA, MA, %CA, J, IxIy) across gorilla subspecies known to inhabit a range of environments.

Medical CT or micro-CT scans were obtained for 36 adult femora from three gorilla groups [lowland gorillas, *Gorilla gorilla gorilla* n=12; mountain gorillas, *Gorilla beringei beringei* n=10; grauer gorillas, *Gorilla beringei graueri* n=14, high elevation (majority) and low elevation]. A landmark-based automatic orientation was applied to align all femora in the same way and all diaphyses were automatically segmented to extract the cortical bone. In the R package *morphomap* [1], 180 cortical thicknesses were measured on 61 cross-sections extracted from distal (20%) to proximal (80%) of the femoral biomechanical length, and cortical thickness maps were produced for each individual and for the mean of each subspecies. Cross-sectional properties were calculated for each of the 61 slices. A body mass proxy was estimated from distal femoral articular M-L breadth, and data were size-standardized following standard methods [2]. Cortical bone thickness distribution among gorilla groups was analyzed by a principal component analysis and Bonferroni-adjusted MANOVA pairwise comparison tests were performed on PC1, PC2 and PC3 scores. Differences in selected cross-sectional properties among gorilla groups was evaluated through bivariate plots and BH-adjusted pairwise Wilcoxon comparison tests.

PCA results for PC1 and PC2 found overlap between all groups, with lowland gorillas being the most distinct from other groups. Mean maps of diaphyseal cortical bone for each gorilla group showed posterior thickening of the femoral diaphysis in both *G. beringei* subspecies, with posterior thickening not present in *G. gorilla.* Additionally, we found that the lateral portion became increasingly thickened proximally going from *G. gorilla* (lowland) to *G. b. graueri* (grauer) to *G. b. beringei* (mountain), potentially tracking changes in behavior across these groups. In cross-sectional geometry, *G. b. beringei* was found to exhibit higher femoral rigidity relative to body size than the other two groups, which is consistent with its greater terrestriality (increased loading of the hindlimb in quadrupedal locomotion than in arboreality). Ix/Iy (A-P/M-L bending rigidity) showed statistically significant differences between *G. gorilla* and *G. b. beringei.* Overall, differences in the cortical bone distribution and cross-sectional geometry of the femoral diaphysis appear to be aligning with behavioral differences between the gorilla groups, providing evidence for behavioral effects on internal morphology of the femur. Furthermore, these differences are found predominantly from about midshaft towards the proximal end of the diaphysis and less so in the distal end. This location is important for future research on the internal structure of hominin femora as several fossil hominin specimens preserve only the proximal end of the diaphysis [3].

We gratefully acknowledge the AMNH Mammalogy Department, NMNH Division of Mammalogy, RMCA Department of Biology, AMNH Microscopy and Imaging Facility, and Department of Radiology at Stony Brook University Hospital for their assistance. Funding sources: NSF- GRFP Fellowship, No. 1938103 (AVG).

References: [1] Profico, A., Bondioli, L., Raia, P., O'Higgins, P., Marchi, D., 2020. morphomap: An R package for long bone landmarking, cortical thickness, and cross-sectional geometry mapping. American Journal of Physical Anthropology. 174, 129–139. [2] Ruff, C.B., 2019. Biomechanical analyses of archaeological human skeletons. In: Katzenberg, M.A. Grauer, A.L. (Eds.) Biological Anthropology of the Human Skeleton. John Wiley & Sons, Inc., pp. 189–224. [3] Grine, F.E., Mongle, C.S., Fleagle, J.G., Hammond, A.S., 2022. The taxonomic attribution of African hominin postcrania from the Miocene through the Pleistocene: Associations and assumptions. Journal of Human Evolution. 173, 103255.

Podium Presentation, Session 6, Friday 10:30 – 12:10

Homo habilis as prey: a taphonomic study of OH 7 using Artificial Intelligence tools

Marina Vegara-Riquelme[1,2], Enrique Baquedano[2,3], Manuel Domínguez-Rodrigo[1,2,4]

1 - University of Alcalá, Department of History and Philosophy, Alcalá de Henares, Spain · 2 - Institute of Evolution in Africa (IDEA), University of Alcalá and Archaeological and Paleontological Museum of the Community of Madrid, Madrid, Spain · 3 - Archaeological and Paleontological Museum of the Community of Madrid, Alcalá de Henares, Spain · 4 - Rice University, Department of Anthropology, Houston, TX, USA

Understanding carnivore-hominin interactions during Plio-Pleistocene has been one of the main questions addressed in taphonomic and archaeological research for years. Following the archaeological record, at least during the first half of the span of hominin evolution, hominins played a subordinate position with respect to large mammal carnivorans. However, at some point during the human evolution process this changed with a hominin shift in the balance of power. This change has been linked with the genus *Homo* and the irruption of this group in the predatory guild. On the other hand, the primary and regular hominin access to carcasses has been documented from ~2-million-year-old (Ma) anthropogenic sites at Olduvai Gorge (Tanzania) [1-2]. For years, *Homo habilis*, who is at the base of the genus *Homo*, has been proposed as the hominin responsible for the changes which lead to that shift in the balance of power between carnivores and hominins. Here, we analyze from a taphonomic perspective the holotype of *Homo habilis* to test if around 2 Ma ago a hominin shift in the balance of power occurred. In that case, it would be expected that the modifying agent of OH 7 was a scavenger instead of a felid carnivore. Determining the taphonomic agent responsible for the modification of OH 7 hominin remains is of utmost relevance for understanding this issue. In the taphonomic analysis of OH 7 tooth marks Artificial Intelligence (AI) tools through Deep Learning (DL) and Computer Vision (CV) methods have been used. In the recent few years, these tools have yielded high accuracy in the classification of Bone Surface Modifications (BSM) through the analysis of bidimensional images of these BSM [3-4]. The results obtained after the analyses of the two tooth pits documented on the OH 7 mandible show with high accuracy that OH 7 was modified and consumed by a felid, and specifically, by a leopard, shedding light on the role played by *Homo habilis* 2 Ma ago, if we understand OH 7 as representative of the species to which it belongs [5]. Taking these results into consideration, it can be proposed that *Homo habilis* would have been a prey instead of a predator as it has been assumed during years of research.

M. V. R. has been funded by the Spanish Ministry of Universities with an FPU predoctoral grant (FPU18/05632) to conduct research on her Ph.D., being this work part of her Doctoral Thesis. We thank the Spanish Ministry of Science and Innovation (PID2020-115452 GB-C21), the Spanish Ministry of Culture for their funding through the program of Archaeology Abroad, the Ministry of Culture of the Community of Madrid for financial support, and Palarq Foundation for their support. We thank Commission for Science and Technology (COSTECH), the Ngorongoro Conservation Area Authorities (NCAA), the Division of Antiquities, and the Tanzanian Ministry of Natural Resources and Tourism for their permission to conduct research in Tanzania. We also thank the personal staff of the Museum and House of Culture of Dar es Salaam (National Museum of Tanzania). The authors are extremely thankful to Edgard Camarós for having allowed one of us (M. V. R.) access to the Altamira Zoo crocodile collection. We are grateful to The Olduvai Paleoanthropology and Palaeoecology Project (TOPPP), especially to Lucía Hernández, Elena Cubedo, Gabriel Cifuentes, and Blanca Jiménez.

References: [1] Domínguez-Rodrigo, M., Barba, R., Egeland, C. P., 2007. Deconstructing Olduvai: A Taphonomic Study of the Bed I Sites. Springer Netherlands. [2] Domínguez-Rodrigo, M., Baquedano, E., Organista, E., Cobo-Sánchez, L., Mabulla, A., Maskara, V., Gidna, A., Pizarro-Monzo, M., Aramendi, J., Galán, A.B., Cifuentes-Alcobendas, G., Vegara-Riquelme, M., Jiménez-García, B., Abellán, N., Barba, R., Uribelarrea, D., Martín-Perea, D., Diez-Martin, F., Maíllo-Fernández, J.M., Rodríguez-Hidalgo, A., Courtenay, L., Mora, R., Maté-González, M.A., González-Aguilera, D., 2021. Early Pleistocene faunivorous hominins were not kleptoparasitic, and this impacted the evolution of human anatomy and socio-ecology. Scientific Reports. 11, 16135. [3] Domínguez-Rodrigo, M., Cifuentes-Alcobendas, G., Jiménez-García, B., Abellán, N., Pizarro Monzo, M., Organista, E., Baquedano, E., 2020. Artificial intelligence provides greater accuracy in the classification of modern and ancient bone surface modifications. Scientific Reports. 10(1), 18862. [4] Domínguez-Rodrigo, M., Pizarro-Monzo, M., Cifuentes-Alcobendas, G., Vegara-Riquelme, M., Jiménez-García, B., Baquedano, E., 2024. Computer vision enables taxon-specific identification of African carnivore tooth marks on bone. Scientific Reports. 14, 6881. [5] Vegara-Riquelme, M., Baquedano, E., Domínguez-Rodrigo, M., under review, Early humans and the balance of power: *Homo habilis* as prey.

Poster Presentation Number 113, Session 2, Friday 17:00 – 18:30

Morphological patterns of middle meningeal vessels and dural venous sinuses in the individual from Zlatý Kůň (Czech Republic) and other Upper Paleolithic humans

Petr Velemínský[1], Stanislava Eisová[1,2,3], Rebeka Rmoutilová[4], Šárka Bejdová[4], Jana Velemínská[4], Jaroslav Brůžek[4], Emiliano Bruner[5,6]

1 - Department of Anthropology, Natural History Museum, National Museum, Prague, Czech Republic · 2 - The Department of Anatomy and Anthropology, School of Medicine, Faculty of Medical & Health Sciences, Tel-Aviv University, Israel · 3 - The Dan David Center for Human Evolution and Biohistory Research, Faculty of Medical & Health Sciences, Tel-Aviv University, Israel · 4 - Department of Anthropology and Human Genetics, Faculty of Science, Charles University, Prague, Czech Republic · 5 - Centro Nacional de Investigación en Evolución Humana, Burgos, Spain · 6 - Centro de Investigación en Enfermedades Neurológicas, Madrid, Spain

The middle meningeal artery, toghether with its parallel middle meningeal veins (here Middle Meningeal Vessels, MMV) and the dural venous sinuses (DVS), are located within the dura mater between the skull and the brain. They leave imprints on the endocranial surface of cranial vault bones due to intracranial pressure and constant process of bone modelling and remodelling. Thus, the traces of MMV and DVS can be studied in osteological samples in the context of biological, forensic, and evolutionary anthropology, providing information about physiological processes in individuals of past populations, evolutionary adaptations, and individual life history [1-2]. In this study, the vascular traces of MMV and DVS were evaluated in the 45,000 years old skull from Zlatý Kůň (Koněprusy caves, Czech Republic) [3-4], and then compared to MMV and DVS morphological patterns in Upper Palaeolithic and recent cranial samples. Additionally, differences in vascular patterns between the Upper Paleolithic and present-day populations were tested. The sample included Early Upper Paleolithic (EUP) (N=8) and Epipalaeolithic (N=105) crania, and a control sample of recent population from the Czech Republic (N=160). Vascular morphology was visualized through CT scans in 3DSlicer, following a previously established methodology [5]. Zlatý Kůň crania displayed traces of the MMV that were distributed in more posterior parts of the endocranial cavity and showed very high degree of reticulation of the vascular network. The DVS in Zlatý kůň had quite atypical pattern, in which the superior sagittal sinus runs into the right transverse sinus, quite far from the internal occipital protuberance, and also presented imprints of paired large occipital sinuses. Regarding the comparison of the Upper Paleolithic and recent samples, there were significant differences between the EUP, Epipalaeolithic and present-day samples in MMV pattern, but not in DVS pattern. However, all groups most frequently showed more developed MMV in the anterior region of the endocranial cavity and a complex branching pattern of the vascular network. The DVS pattern in all samples most often included the superior sagittal sinus running into the right transverse sinus, which was also most often larger than the left one. Traces of occipito-marginal sinuses were detected in few well-preserved crania of EUP, Epipalaeolithic, and recent crania, but the frequency was very similar in each group (50%, 42%, and 30% respectively). Globally, the vascular morphology of Zlatý kůň seems to be most similar to the EUP sample, which is in accordance with its estimated age, falling into EUP period. This study also provides further evidence that craniovascular features differed across the time and region.

This study was funded by the Czech Science Foundation (grant number GA23-06822S) and by the Ministry of Culture of the Czech Republic (grant number DKRVO 2024-2028/7.I.a, 00023272, National Museum).

References: [1] Píšová, H., Rangel de Lazaro, G., Velemínský, P., Bruner, E. (2017). Craniovascular traits in anthropology and evolution: from bones to vessels. Journal of Anthropological Sciences, 95, 35–65. [2] Eisová, S., Píšová, H., Velemínský, P., Bruner, E., 2019. Normal craniovascular variation in two modern European adult populations. Journal of Anatomy. 235, 765–782. [3] Prüfer, K., Posth, C., Yu, H., Stoessel, A., Spyrou, M.A., Deviese, T., Mattonai, M., Ribechini, E., Higham, T., Velemínský, P., Brůžek, J., Krause, J., 2021. A genome sequence from a modern human skull over 45,000 years old from Zlatý kůň in Czechia. Nature Ecology & Evolution. 5, 820-825. [4] Rmoutilová, R., Guyomarc'h, P., Velemínský, P., Šefčáková, A., Šamsel, M., Santos, F., Maureille, B., Brůžek, J., 2018. Virtual reconstruction of the Upper Palaeolithic skull from Zlatý Kůň, Czech Republic: Sex assessment and morphological affinity. PLOS ONE. 13, e0201431.
[5] Rangel de Lázaro, G., Eisová, S., Píšová, H., Bruner, E., 2018. The endocranial vascular system: tracing vessels. In Bruner, E., Ogihara, N., Tanabe, H. (Eds.), Digital endocasts, Springer, pp. 71–91.

Podium Presentation, Session 8, Friday 15:20 – 17:00

Reconstructing the tongue in the oral cavity. The first step towards application to fossils

Amélie Vialet[1], Maxime Calka[2,3], Pablo Alvarez[2], Marouane El Mouss[2], Anca Belme[4], Gilles Berillon[1], Pauline Brige[5], Yohan Payan[3], Pascal Perrier[3]

1 - Muséum national d'Histoire naturelle, UMR 7194, UPVD, Paris, France · 2 - Sorbonne Université, Institut des Sciences du Calcul et des Données, Paris, France · 3 - Université Grenoble Alpes, CNRS, Grenoble INP, TIMC, Grenoble, France · 4 - Sorbonne Université, Institute Jean Le Rond d'Alembert, UMR 7190, Paris, France · 5 - Laboratoire d'Imagerie Interventionnelle Expérimentale, CERIMED, Marseille, France

The emergence of the capacity for spoken language in humans during the course of evolution is a widely debated question. It has been renewed recently by the paradigm shift undermining Lieberman's 1960s theory of laryngeal descent, as studies have shown that non-human primates are capable of producing vocal tract shapes compatible with the articulation of speech sounds [1] and of pronouncing differentiated sounds covering a vowel spectrum similar to that of humans [2].

For fossil hominines, the complexity of this question lies in the difficulty of studying their phonatory apparatus due to the poor preservation. Soft tissues and cartilage do not fossilize, while bones can be damaged, deformed, or eroded. For this reason, the capacity for language in fossil hominins is often estimated indirectly, by considering that a faculty for abstraction is necessary, and by identifying tangible evidences of the latter in various productions (carved tools, burials, cave paintings...).

For the first time, we have attempted a direct approach, aiming to reconstruct the soft tissues making up the vocal apparatus, starting with the tongue. This work benefits from long-term research carried out at the TIMC & Gipsa-lab laboratories (University Grenoble Alpes, France), which has generated a fine model of the organs of the vocal apparatus in a present-day *Homo sapiens* used as a reference. This model accurately reflects the morphology and the constitutive behaviors of tongue soft tissue (including its muscular structures) and simulates tongue deformations due to muscles activations and/or to the mechanical interactions with the mandible, palate and hyoid bone.

Here, we present the results of the first stage of this project predicting the morphology of the missing tongue and surrounding soft tissues in the oropharyngeal cavity from the geometries of the skull, mandible, and vertebrae (i.e. based only on the bone structure). To test the effectiveness of our protocol, data from a Baboon head were used because of its significant morphological differences from humans. 3D CT images enabled us to consider only the bone structure to predict the tongue of this individual from one side and to control this prediction thanks the actual soft tissues from the other side. The method generates a geometric deformation field from the reference model to build up a 3D Finite Element mesh of the baboon tongue using mathematical tools combining rigid transformations (translations, homotheties, rotations) and non-rigid transformations (i.e. non-uniform over the entire volume, with localized refinements).

The results are very encouraging [3] and will allow us to consider an application to fossil hominins with two objectives: (1) constructing a biomechanical model of the predicted fossil tongue and its surrounding structures in the oral cavity, incorporating the muscles responsible for its movements and shaping; (2) using this model to evaluate the maximal movement magnitudes of the tongue in the antero-posterior and vertical dimensions, the range of variation of achievable vocal tract shapes, and the capacity of fossil hominins to maintain stable, differentiated tongue postures, providing a basis for the production of distinctive articulated sounds.

References: [1] Fitch, W.T., de Boer, B., Mathur, N., Ghazanfar, A.A., 2016. Monkey vocal tracts are speech-ready. Science Advances. 2, e1600723. [2] Boë, L.-J., Berthommier, F., Legou, T., Captier, G., Kemp, C., Sawallis, T.R., Becker, Y., Rey, A., Fagot, J., 2017. Evidence of a Vocalic Proto-System in the Baboon (Papio papio) Suggests Pre-Hominin Speech Precursors. PLOS ONE. 12, e0169321. [3] Fitch, W.T., de Boer, B., Mathur, N., Ghazanfar, A.A., 2016. Monkey vocal tracts are speech-ready. Science Advances. 2, e1600723

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

Were they eating meat? First nitrogen isotope data of *Paranthropus* and early *Homo* from Sterkfontein (South Africa)

Marissa Vink[1], Jennifer Leichliter[1,2], Hubert Vonhof[3], Recognise Sambo[4], Dominic Stratford[4], Marion Bamford[2], Alfredo Martinez-Garcia[3], Tina Lüdecke[1,2]

1 - Emmy Noether Group for Hominin Meat Consumption, Max Planck Institute for Chemistry, Mainz, Germany · 2 - Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, South Africa · 3 - Department for Climate Geochemistry, Max Planck Institute for Chemistry, Mainz, Germany · 4 - School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, Johannesburg, South Africa

The dietary niches of extinct animals can be reconstructed using stable isotope ratios in diagenetically robust fossil tooth enamel. Herbivore stable carbon isotope ($\delta^{13}C_{enamel}$) values reflect dietary intake of plants and are used to differentiate grazers (C4-feeders) and browsers (C3-feeders) in African ecosystems. Carnivore δ^{13}Cenamel data indicate which type of prey (i.e., grazers, browsers, or mixed-feeders) were predominantly consumed. Nitrogen isotope ($\delta^{15}N_{enamel}$) values reveal information about the trophic position of an organism within its local food-web. Due to isotopic fractionation during metabolism, which results in an increase in δ^{15}N of the organism with respect to their diet, carnivore tissues are ca. 3 to 6‰ higher in δ^{15}N than the herbivore tissues they consume. The combination of $\delta^{13}C_{enamel}$ and $\delta^{15}N_{enamel}$ can therefore be used to reconstruct modern and past dietary patterns, food web structures, and the trophic position of an individual [1-2].

Previous analyses of mammalian tooth enamel from Pliocene Sterkfontein Member 4 fauna, including seven *Australopithecus* sp. individuals, show that *Australopithecus* $\delta^{15}N_{enamel}$ values vary greatly between individuals, but are consistently lower than sympatric carnivores. This suggests a variable, but largely plant-based diet for this group of Pliocene hominins. $\delta^{13}C_{enamel}$ from the same enamel indicates that C3 plants represented the greater part of this diet.

The Pleistocene hominin-bearing fossil Member 5 (~2.2 to 1.4 Ma) of Sterkfontein Cave, South Africa, have yielded a rich and diverse faunal assemblage, including *Paranthropus robustus* associated with Oldowan tools, and early *Homo* associated with Acheulean tools. We measured carbon and nitrogen stable isotope ratios in a single aliquot (~5 mg) of fossil tooth enamel of fauna (grazers, mixed-feeders, browsers, and carnivores), including hominins and other primates, from these deposits to expand our understanding of the trophic structure at Sterkfontein.

In herbivore taxa, $\delta^{13}C_{enamel}$ shows the expected separation between browsers, grazers, and mixed-feeders. Carnivore $\delta^{15}N_{enamel}$ values are significantly higher than the values of coexisting herbivores and show a trophic enrichment within the expected range of 3-6‰. The analysed fauna coexisted with our early ancestors and represent potential competitors and/or food sources, thus serving as an isotopic baseline for the interpretation of stable carbon and nitrogen isotope values of non-hominin and hominin primate tooth enamel from Sterkfontein Member 5.

We present the first nitrogen stable isotope measurements of fossil tooth enamel from *Paranthropus* and early *Homo* specimens and thus provide insights on the onset and intensification of animal resource consumption (or lack thereof) by our early ancestors at this locality. The presence of all three hominin genera (*Australopithecus*, *Paranthropus* and early *Homo*) at Sterkfontein makes this site exceptionally valuable for assessing potential changes in ancient food webs within Plio-Pleistocene faunal communities and permits examination of the dietary behaviour of our early ancestors over time within a single locality.

This study was funded by the Deutsche Forschungsgemeinschaft (DFG) Emmy Noether Fellowship LU 2199/2-1 to TL, and by the Max Planck Society (MPG).

References: [1] Leichliter, J., Lüdecke, T., Foreman, A., Bourgon, N., Duprey, N., Vonhof, H., Souksavatdy, V., Bacon, A.-M., Sigman, D., Tütken, T., Martinez-Garcia, A., 2023. Tooth enamel nitrogen isotope composition records trophic position: a tool for reconstructing food webs. Communications biology 6, 373. [2] Lüdecke, T., Leichliter, J.N., Aldeias, V., Bamford, M.K., Biro, D., Braun, D.R., Capelli, C., Cybulski, J.D., Duprey, N.N., Ferreira da Silva, M.J., Foreman, A.D., Habermann, J.M., Haug, G.H., Martínez, F.I., Mathe, J., Mulch, A., Sigman, D.M., Vonhof, H., Bobe, R., Carvalho, S., Martínez-García, A., 2022. Carbon, nitrogen, and oxygen stable isotopes in modern tooth enamel: A case study from Gorongosa National Park, central Mozambique. Frontiers in Ecology and Evolution. 10.

Poster Presentation Number 115, Session 2, Friday 17:00 – 18:30

The adaptive differentiation of paleontological material as a method for reconstructing phylogeny (Darwin's genealogical classification) in paleoanthropology

Sergey Vyrskiy[1]

1 - Independent

There is no common understanding of the phylogeny (or genealogy, according to Ch. Darwin) [1] of early bipedal primates in paleoanthropology. Despite a large number of cladograms, phylograms, and dendrograms published, they are mainly based on the similarity of the metric characteristics of the respective holotypes, and thus inevitably probabilistic in nature and often inconsistent with each other. The existing studies are focused on the relationship between species, while the connections between their respective genera are not taken into account. This contradicts the classification posited by C. Linnaeus which assigns the category of a genus to the initial form, while a species is a category of its current state, changed over time in response to various external conditions [2].

Methods

In phylogeny, a genus is understood to be equivalent to a species, though reproductively maternal to the one under study. Therefore, if we are to reconstruct the species system, what we need is a characteristic that would reflect the current state of the species and at the same time indicate its phyletic relationship with the parent one. It is hereby proposed to use adaptability to the environment as the sought-for characteristic. It encompasses a set of functional adaptive characters, both newly acquired and inherited from ancestors [3]. The proposed method consists of adaptive differentiation of the paleoanthropological material into sympatric reproductive lines which are further divided into intervals where sets of adaptive characters remain unchanged. This can be achieved, firstly, by studying the value fields of metric features of fossils. If any feature shows two fields of values on the paleontological scale, this will mean that the material includes individuals featuring dichotomously different adaptability to the environment. Therefore, such individuals can be distributed into different adaptive lines showing sympatric coexistence. Secondly, the medians of the value fields on these lines clearly indicate that they represent continuous piecewise linear functions which consist of linear intervals connected by changepoints. The linear part of the median, limited by two changepoints, points at constant sets of adaptive characters of its individuals and thus serves as a basic adaptive phyletic element of the phylogeny, which in the Darwin's genealogical classification can be assigned the category of an adaptive paleospecies. Each changepoint between two paleospecies establishes their mutual mother-filial hierarchy in the genealogical classification. If the said adaptive paleospecies are arranged as segments on a paleontological scale and form a hierarchy with their maternal species, then we can obtain a phylogenetic (genealogical) system of paleospecies.

Results

When applied to samples of African bipedal primates from 6.0-1.0 Mya deposits, the method of adaptive differentiation allowed us to construct a phylogenetic scheme that revealed the coexistence of two sympatric adaptive paleospecies. One of them became extinct 1.34 Mya, while the other died out 2.6 Mya having formed a filial paleospecies 2.5 Mya. In addition, extrapolation of the median lines of features into deeper sediments showed their possible origin from a certain hypothetical mother paleospecies that already had bipedalism in the interval of 9.0-8.0 Mya.

Conclusion

The proposed method of adaptive differentiation has proved efficient in reconstructing the phylogeny (Darwin's genealogical classification) of African bipedal primates from 6-1 Mya deposits. The method can be applied in other areas of paleontology. Moreover, further study of bipedal primates from deeper deposits will allow us to assess the predictive value of the proposed method.

References: [1] Darwin ChR (1859) On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life. London: John Murray, Albemarle Street. [2] Linnaeus C (1751) Caroli Linnaei, Botanicorum Principis, Philosophia Botanica, Matriti: ex Typogr. Viduae, et Filii Petri Marin. Anno M.Dcc.Xcii. [3] Vyrskiy, S. 2021. Reconstruction of African Bipedal Primates' Phylogeny Based on the Adaptive Species Axiom. J Anthro & Archeo Sci 5(2). JAAS.MS.ID.000207. DOI: 10.32474/JAAS.2021.05.000207.

Poster Presentation Number 116, Session 2, Friday 17:00 – 18:30

Examining human-animal interaction of the Late Pleistocene and early Holocene in Zagros Mountains using ZooMS

Naihui Wang[1,2], Mario Mata-González[1,5], Britt M. Starkovich[1,3], Mohsen Zeidi[3,4], Angel Blanco-Lapaz[1,3], Nicholas J. Conard[1,3,4]

1 - Institute for Archaeological Sciences, University of Tübingen, Tübingen, Germany · 2 - Max Planck Institute of Geoanthropology, Jena, Germany · 3 - Senckenberg Centre for Human Evolution and Paleoenvironment (SHEP), Tübingen, Germany · 4 - Department of Early Prehistory and Quaternary Ecology, University of Tübingen, Tübingen, Germany · 5- Department of Classics and Archaeology, University of Malta, Malta

The Zagros Mountains, situated to the east of the Fertile Crescent, serve as a key locus for investigating Paleolithic economies and the origins of agriculture. Excavations at sites such as Ganj Dareh, Ali Kosh, and Sheikh-e Abad have yielded invaluable insights into Neolithic lifeways and the processes of animal and plant domestication.

Our comprehension of Stone Age economies undergoes continuous refinement with advancements in excavation techniques and zooarchaeological methodologies. Researchers have developed Zooarchaeology by Mass Spectrometry (ZooMS) as a new technique, offering a biomolecular approach to identifying faunal remains. The method is particularly adept at identifying previously unidentifiable bones that contain collagen. The method has numerous applications in Paleolithic and Neolithic contexts. In the deep deposits characteristic of the aceramic Neolithic sites in the Zagros like Chogha Golan, roughly 3% of the faunal remains could be identified using morphological criteria, hindering interpretations that rely on changes in species representation and relative abundances [1]. Similarly, ZooMS can help to augment our knowledge of Paleolithic economies at sites like Ghar-e Boof [2]. Furthermore, ZooMS analyses have revealed that classifications of body sizes of unidentifiable bones can be problematic [3], particularly in regions like the Zagros where gazelles, cervids and caprines share similar body sizes. Given that changes in body size can serve as proxies for domestication, the application of ZooMS in this context holds promise for enhancing our understanding the dynamics of animal domestication.

While a successful ZooMS attempt has been reported at the Neolithic open-air site in Iran [4], another endeavour in the Zagros Initial Upper Paleolithic Palaeolithic proved unsuccessful [5]. More studies in Paleolithic contexts are needed to check the utility of the ZooMS in the Zagros region. Recent strides in high-throughput protocols present renewed opportunities for large-scale ZooMS analyses. By integrating ZooMS taxonomic identifications with morphometric data, we can trace nuanced morphological changes and elucidate site-specific patterns of human-animal interaction and refine our understanding of faunal dynamics during the Late Pleistocene and early Holocene.

We thank the team of Tübingen-Iranian Stone Age Research Project (TISARP) and the Iranian colleagues, for their support during fieldwork.

References: [1] Starkovich, B.M., Riehl, S., Zeidi, M. and Conard, N.J., 2016. Subsistence strategies in the aceramic Neolithic at Chogha Golan, Iran. Bones and Identity Zooarchaeological Approaches to Reconstructing Social and Cultural Landscapes in Southwest Asia. 45-71. [2] Mata-González, M., Starkovich, B.M., Zeidi, M., Conard, N.J., 2022. New zooarchaeological perspectives on the early Upper Paleolithic Rostamian sequence of Ghar-e Boof (southern Zagros Mountains, Iran). Quaternary Science Reviews. 279, 107350. [3] Torres-Iglesias, L., Marín-Arroyo, A.B., Welker, F., de la Rasilla, M., 2024. Using ZooMS to assess archaeozoological insights and unravel human subsistence behaviour at La Viña rock shelter (northern Iberia). Journal of Archaeological Science. 161, 105904. [4] Seabrook, M., 2024. Balancing methods of Caprine identification: integrating morphological and zooms analyses. Available at SSRN: https://ssrn.com/abstract=4792693 [5] Shoaee, M.J., Vahdati Nasab, H., Storozum, M., Frenzel, P., Akhavan Kharazian, M., Fernandes, R., Hashemi, S.M., Jayez, M., Amano, N., Marzban Abbasabadi, B., Aalipoor, M., Lucas, M., Marzo, S., Ilgner, J., Patalano, R., Roberts, P., Boivin, N., Petraglia, M., 2024. Initial Upper Paleolithic in the Zagros Mountains. Frontiers in Earth Science. 12.

Pecha Kucha Presentation, Session 2, Thursday 11:20 – 12:50

Hip hip hooray! A complete virtual reconstruction of Sterkfontein's Sts 65 hipbone

Laura M. Watson[1,2], Nicole M. Webb[1,3], Martin Haeusler[3]

1 - Department of Palaeoanthropology, Senckenberg Gesellschaft für Naturforschung, Frankfurt am Main, Germany · 2 - Institute for Archaeological Sciences, University of Tübingen, Tübingen, Germany · 3 - Institute of Evolutionary Medicine, University of Zürich, Zürich, Switzerland

The adult Sts 65 hipbone from Member 4 of Sterkfontein, South Africa, presents a nearly undistorted right ilium and partial superior pubic ramus, as well as a fragment of the iliac crest. It has been dated to between ca. 2.6 – 2.1 million years and is attributed to *Australopithecus africanus*. Due to its fragmentary preservation, Sts 65 is among one of the most understudied hominin hipbones. In terms of size, it appears to be intermediate between the other pelvic remains recovered from Sterkfontein; specifically, the subadult Sts 14 and the StW 431 pelvis, a presumed female and male respectively. Based on the acetabulum size of Sts 65, a body mass 20-30% larger than that of Sts 14 has been estimated, whereas the inferred body mass of StW 431 is about 80% larger than Sts 14 [1]. Due to a possibly narrower greater sciatic notch and increased robusticity, Sts 65 was originally classified as male [2], although the true shape of the greater sciatic notch cannot be reliably inferred due to its preservation state. A faint depression in the preauricular region has also been interpreted as a preauricular sulcus, a characteristic usually found in females, which initiated a subsequent obstetric analysis of the Sts 65 birth canal [3]. However, this depression could alternatively represent a paraglenoid groove which would then be characteristic of males [4]. Contextualizing the enigmatic morphology of Sts 65 is therefore important given the aforementioned morphological inconsistencies and the recent claims of notable locomotor and taxonomic diversity at Sterkfontein [1,4-5].

Here we perform a novel virtual reconstruction of the right Sts 65 hipbone to assess the shape of the greater sciatic notch and the size disparity as well as to re-evaluate its taxonomic status. To approximate missing regions, a thin plate spline extrapolation method was performed utilizing different configurations of homologous landmarks using Sts 14 and StW 431 as reference warping templates. To optimize alignment between the target and various reference meshes, Sts 14 was scaled up by 8% to accommodate the size discrepancy between them, which is in accordance with previous suggestions of a significantly larger body size in Sts 65 [4].

In contrast to previous interpretations [3], our results demonstrate that the superior pubic ramus is incomplete, indicating a significant elongation of the pubis, which corresponds with aspects of the morphology observed in Sts 14. We also found that the greater sciatic notch forms a double arch with the outline of the sacro-iliac joint surface (the auriculum), supporting a male sex attribution. In addition, Sts 65 exhibits a distinct sigmoid curvature of the iliac crest that is unlike both Sts 14 and StW 431. In terms of general morphology, however, the partial hipbone Sts 65 seems to more closely resemble Sts 14. This unexpectedly high morphological heterogeneity revealed by our reconstruction adds to the ongoing discussion of the potential taxonomic heterogeneity observed at Sterkfontein.

LMW and NMW are supported by Leibniz Collaborative Excellence Grant no. K438/2022. MH is supported via the Swiss National Science Foundation grant nos. 31003A_176319 and 310030_212984.

References: [1] Fornai, C., Krenn, V.A., Mitteroecker, P., Webb, N.M., Haeusler, M., 2021. Sacrum morphology supports taxonomic heterogeneity of "*Australopithecus africanus*" at Sterkfontein Member 4. Communications Biology. 4, 347. [2] Robinson, J.T., 1972. Early hominid posture and locomotion. University of Chicago Press, Chicago. [3] Claxton, A.G., Hammond, A.S., Romano, J., Oleinik, E., DeSilva, J.M., 2016. Virtual reconstruction of the *Australopithecus africanus* pelvis Sts 65 with implications for obstetrics and locomotion. Journal of Human Evolution. 99, 10–24. [4] Haeusler, M, Ruff, CB, 2020. Pelves. In: Zipfel, B, Richmond, BG, Ward, CV (Eds.) Hominin Postcranial Remains from Sterkfontein, South Africa, 1936–1995. Oxford University Press, Oxford, pp. 181–201. [5] Georgiou, L., Dunmore, C.J., Bardo, A., Buck, L.T., Hublin, J.-J., Pahr, D.H., Stratford, D., Synek, A., Kivell, T.L., Skinner, M.M., 2020. Evidence for habitual climbing in a Pleistocene hominin in South Africa. Proceedings of the National Academy of Sciences. 117, 8416–8423.

Pecha Kucha Presentation, Session 7, Friday 13:30 – 15:00

It's a boy? A machine learning and deformation-based morphometric approach to evaluating pelvic sexual dimorphism in the Kebara 2 Neanderthal pelvis

Nicole M. Webb[1,2], Alessandro Urciuoli[3,1,4,5], Cinzia Fornai[2,6,7,8], Viktoria A. Krenn[2,7,9], Rebeka Rmoutilova[10], Martin Haeusler[1]

1 - Department of Palaeoanthropology, Senckenberg Gesellschaft für Naturforschung, Frankfurt am Main, Germany · 2 - Institute of Evolutionary Medicine, University of Zürich, Zürich, Switzerland · 3 - Universitat Autònoma de Barcelona, Campus de la UAB, Barcelona, Spain · 4 - Institut Català de Paleontologia Miquel Crusafont, Universitat Autònoma de Barcelona, Edifici ICTA-ICP, c/ Columnes s/n, Campus de la UAB, Barcelona, Spain · 5 - Universidad de Alcalá, Cátedra de Otoacústica Evolutiva y Paleoantropología (HM Hospitales-UAH), Departamento de Ciencias de la Vida, Madrid, Spain · 6 - Vienna School of Interdisciplinary Dentistry, Klosterneuburg, Austria · 7 - Department of Evolutionary Anthropology & Human Evolution and Archaeological Sciences, University of Vienna, Vienna, Austria · 8 - Center for Clinical Research, University Clinic of Dentistry, Medical University of Vienna, Vienna, Austria · 9 – Fraunhofer Austria Innovation Center for Digitalization and Artificial Intelligence - KI4LIFE, Klagenfurt, Austria · 10 - Department of Anthropology and Human Genetics, Faculty of Science, Charles University, Prague, Czech Republic

The Kebara 2 Neanderthal specimen from the Kebara limestone cave in Israel includes a remarkably well-preserved, albeit crushed, pelvis dated to 59–64 ka. With two relatively complete associated hipbones and an associated sacrum, Kebara 2 provides important information regarding the functional capacity of the Neanderthal pelvis; specifically, shedding light on locomotor biomechanics, sexual dimorphism, and by inference, the potentially unique birth pattern of these late archaic humans. Most notably, Kebara 2 has a distinctly elongated superior pubic ramus that could significantly influence the configuration of the bony birth canal in female Neanderthals. Nevertheless, Rak and Arensburg [1] demonstrated that the size of the inlet is still comparable to modern humans, thus obscuring the true functional relevance of this feature.

The current study introduces a new landmark-based digital reconstruction of the more complete right Kebara 2 hipbone, thus complementing previous attempts [2-3]. Our analyses utilize novel methodological approaches employed on a comparative sample of modern humans consisting of both juveniles and adults (n=147). Diffeomorphometrics, a landmark-free deformation-based approach, was performed using the Deformetrica software and in combination with both unsupervised and supervised machine learning classification algorithms (i.e., K-means clustering and support vector machines) to recover clusters representative of biological sex within the sample and to classify our Kebara 2 reconstruction. The advantage of a landmark-free approach is its ability to quantitatively consider the complete hipbone morphology without the need to establish individual homologous landmarks, a procedure susceptible to observer bias. The subsequent machine learning classification effectively partitioned the data into discrete clusters with and without a priori category assignment. Specifically, our supervised classification model achieved a high level of accuracy, correctly classifying over 90 % of the modern human sample. The within-cluster sum of squares (WCSS) was also lowest when two groups were defined, reiterating the presence of two morphological clusters. Kebara 2's classification as either male or female was highly dependent on the specific algorithm used. However, its elongated pubis places it at the extremes of human male variation, and the Deformetrica analysis places it along the periphery of the female cluster, which is a result that we have independently corroborated via traditional geometric morphometrics performed using a full pelvic landmark configuration (n=114) and similar comparative sample (n=167).

This work successfully demonstrates that our approach is a reliable and time efficient method that produces results comparable to the more intensive methodological alternatives commonly used to assess morphology. The notably long and slender pubis observed in Kebara 2, a feature shared among Neanderthals, could represent the primitive condition as inferred from australopithecines and the Gona pelvic material or relate to differences in locomotor biomechanics, thus representing a derived characteristic [1]. Such insights remain critical for directly testing whether Neanderthals had a more primitive birth pattern, given these unique features [4]. Our study suggests that the almost intermediate placement of Kebara 2 between males and females recovered in our shape analyses, driven by the unusual pubis, makes the consistent sexing of the specimen difficult, attesting to the importance of this feature for sex classification in anatomically modern human samples. However, it remains reasonable to assume a similar pattern overall of sexual dimorphism for Neanderthals as in modern humans and, by extension, a comparably difficult birth process given the fact it is namely one feature (the pubis) that is impeding reliable sex classification and that previous work [1] demonstrated that the elongated pubis does not contribute to a larger pelvic canal in Neanderthals. We thereby predict that female Neanderthals will similarly fall within the modern human range, albeit possibly at the extremes like Kebara 2, and this assumption should be used to guide future reconstructions and their interpretations.

NMW is funded by Leibniz Collaborative Excellence Grant no. K438/2022. MH is supported via the Swiss National Science Foundation grant nos. 31003A_176319 and 310030_212984. AU is supported via the R+D+I projects PID2020-116908GB-I00 and PID2021-122355NB-C31 (MCIN/AEI/10.13039/501100011033/FEDER, UE), the CERCA Programme/Generalitat de Catalunya, and European Union-NextGenerationEU funds, while RR was supported by Swiss National Science Foundation Scientific Exchange grant IZSEZ0_210923/1.

References: [1] Rak, Y., Arensburg, B., 1987. Kebara 2 Neanderthal pelvis: First look at a complete inlet. American Journal of Physical Anthropology. 73, 227-231 [2] Rmoutilová, R., Haeusler, M. 2023. The shape of the Neanderthal pelvis: implications of a new reconstruction of Kebara 2 for childbirth. American Journal of Biological Anthropology 180, 149–150. [3] h Adegboyega, M.T., Stamos, P.A., Hublin, J.-J., Weaver, T.D., 2021. Virtual reconstruction of the Kebara 2 Neanderthal pelvis. Journal of Human Evolution. 151,102922. [4] Weaver, T.D., Hublin, J.-J., 2009. Neandertal birth canal shape and the evolution of human childbirth. Proceedings of the National Academy of Sciences. 106, 8151-8156.

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

Zooarchaeological and palaeoproteomic analysis of the Baishiya Karst Cave faunal assemblage reveals Denisovan occupation history and subsistence strategies on the Tibetan Plateau

Huan Xia[1,2,3], Dongju Zhang[1,2], Jian Wang[1,4], Zandra Fagernäs[5], Ting Li[1], Yuanxin Li[1], Juanting Yao[1], Dongpeng Lin[1], Gaudry Troché[5], Geoff M. Smith[6,7], Xiaoshan Chen[1], Ting Cheng[1], Xuke Shen[1], Yuanyuan Han[1,2], Jesper V. Olsen[8], Zhongwei Shen[1], Zhiqi Pei1[9], Jean-Jacques Hublin[10,11], Fahu Chen[1,2,12], Frido Welker[5]

1 - Key Laboratory of Western China's Environmental Systems (Ministry of Education), College of Earth and Environmental Sciences, Lanzhou University, Lanzhou, China · 2 - Alpine Paleoecology and Human Adaptation Group (ALPHA), State Key Laboratory of Tibetan Plateau Earth System, Environment and Resources (TPESER), Institute of Tibetan Plateau Research (ITPCAS), Chinese Academy of Sciences (CAS), Beijing, China · 3 - College of Ecology, Lanzhou University, Lanzhou, China · 4 - School of Earth Sciences, Lanzhou University, Lanzhou, China · 5 - Globe Institute, University of Copenhagen, Copenhagen, Denmark · 6 - School of Anthropology and Conservation, University of Kent, Canterbury, United Kingdom · 7 – Department of Archaeology, University of Reading, Reading, United Kingdom · 8 - Novo Nordisk Foundation Center for Protein Research, Center for Protein Research, University of Copenhagen, Copenhagen, Denmark · 9 - Gansu Provincial Museum, Lanzhou, China · 10 - Collège de France, Paris, France · 11 - Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany · 12 - University of Chinese Academy of Sciences, Beijing, China

Genetic and fragmented palaeoanthropological data suggest that Denisovans were once widely distributed across eastern Eurasia [1-3]. From this limited archaeological data it has been suggested that Denisovans were capable of adapting to a highly diverse range of environments. To further address this question and better understand Denisovan subsistence strategies, we conducted an integrated proteomic and zooarchaeological analysis of the faunal assemblage recovered from Baishiya Karst Cave (China). Located on the lower ranges of the Tibetan Plateau, previous research identified a Denisovan mandible, Xiahe 1, as well as Denisovan sedimentary mtDNA throughout the stratigraphy [3-4]. We studied over 2,500 faunal specimens using traditional zooarchaeological methods. Of these, just under 2,000 specimens were analysed using ZooMS (Zooarchaeology by Mass Spectrometry) to assign taxonomic identities. In combination, this approach allowed taxonomic and bone surface modification analysis to be successfully conducted on the majority of the faunal assemblage.

ZooMS screening resulted in the identification of one new hominin specimen, Xiahe 2. Based on its stratigraphic position within layer 3 and previous radiocarbon dating of bone specimens from this layer [4], the Xiahe 2 specimen dates to approximately 48-32 thousand years ago. Shotgun proteomic analysis assigns this specimen to the Denisovan lineage, extending their fossil presence at Baishiya Karst Cave well into the Late Pleistocene. This result is in agreement with previous ancient mtDNA results obtained from sediments deposited within the cave [4].

Integrating ZooMS taxonomic identifications into a zooarchaeological analysis framework allows us to significanly improve taxonomic and behavioural insights obtained from the faunal assemblage. Throughout the stratigraphic sequence, the faunal assemblage is dominated by bovids, particularly Caprinae. In addition, we identify the presence of megaherbivores, carnivores, small mammals and birds. The high proportion of the bharal (*Pseudois nayaur*), the goa (*Procapra* cf. *picticaudata*), the wild yak (*Bos* cf. *mutus*) and equids (*Equus* sp.) indicates a grass-dominated landscape within Ganjia Basin. The presence of, for example, red deer (*Cervus elaphus*) and musk deer (*Moschus* sp.) suggests the presence of small-scale forest-shrub landscapes as well.

The high intensity of anthropogenic modifications on the bone surfaces suggests that Denisovans were the primary agent of faunal accumulation. The type and bone element location of these anthropogenic modifications suggests that the complete *chaîne opératoire* of carcass processing is represented at Baishiya Karst Cave, including meat, marrow and hide exploitation, but also the use of bone as tool-making materials. Anthropogenic modifications are also present on carnivore, small mammal, and avian remains. Our results therefore provide new and unique insights into Denisovan behaviours and their adaptations to the challenging environmental conditions of the Tibetan Plateau.

This study has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (grant agreement #948365) and the Marie Sklodowska-Curie scheme (#101027850). This work is supported by the National Natural Science Foundation of China (#41988101, #42325103, #42130502, #42001086, #42301171) and the China Postdoctoral Science Foundation (#2020M683605). We thank the Baishiya Temple for supporting the archaeological research at Baishiya Karst Cave.

References: [1] Reich, D., Green, R.E., Kircher, M., Krause, J., Patterson, N., Durand, E.Y., Viola, B., Briggs, A.W., Stenzel, U., Johnson, P.L.F., Maricic, T., Good, J.M., Marques-Bonet, T., Alkan, C., Fu, Q., Mallick, S., Li, H., Meyer, M., Eichler, E.E., Stoneking, M., Richards, M., Talamo, S., Shunkov, M.V., Derevianko, A.P., Hublin, J.-J., Kelso, J., Slatkin, M., Pääbo, S., 2010. Genetic history of an archaic hominin group from Denisova Cave in Siberia. Nature. 468, 1053-1060. [2] Demeter, F., Zanolli, C., Westaway, K.E., Joannes-Boyau, R., Duringer, P., Morley, M.W., Welker, F., Rüther, P.L., Skinner, M.M., McColl, H., Gaunitz, C., Vinner, L., Dunn, T.E., Olsen, J.V., Sikora, M., Ponche, J.-L., Suzzoni, E., Frangeul, S., Boesch, Q., Antoine, P.-O., Pan, L., Xing, S., Zhao, J.-X., Bailey, R.M., Boualaphane, S., Sichanthongtip, P., Sihanam, D., Patole-Edoumba, E., Aubaile, F., Crozier, F., Bourgon, N., Zachwieja, A., Luangkhoth, T., Souksavatdy, V., Sayavongkhamdy, T., Cappellini, E., Bacon, A.-M., Hublin, J.-J., Willerslev, E., Shackelford, L., 2022. A Middle Pleistocene Denisovan molar from the Annamite Chain of northern Laos. Nature Communications. 13, 2557. [3] Chen, F., Welker, F., Shen, C.-C., Bailey, S.E., Bergmann, I., Davis, S., Xia, H., Wang, H., Fischer, R., Freidline, S.E., Yu, T.-L., Skinner, M.M., Stelzer, S., Dong, Guangrong, Fu, Q., Dong, Guanghui, Wang, J., Zhang, D., Hublin, J.-J., 2019. A late Middle Pleistocene Denisovan mandible from the Tibetan Plateau. Nature. 569, 409-412. [4] Zhang, D., Xia, H., Chen, F., Li, B., Slon, V., Cheng, T., Yang, R., Jacobs, Z., Dai, Q., Massilani, D., Shen, X., Wang, J., Feng, X., Cao, P., Yang, M.A., Yao, J., Yang, J., Madsen, D.B., Han, Y., Ping, W., Liu, F., Perreault, C., Chen, X., Meyer, M., Kelso, J., Pääbo, S., Fu, Q., 2020. Denisovan DNA in Late Pleistocene sediments from Baishiya Karst Cave on the Tibetan Plateau. Science. 370, 584-587.

Poster Presentation Number 117, Session 2, Friday 17:00 – 18:30

Sexual dimorphism in the enamel-dentine junction of permanent canines of European modern humans

Cecilia Yacobi Izquierdo[1,2,3], Cecilia García-Campos[1,3], Mario Modesto-Mata[3,4], Laura Martín-Francés[3,5,6], Marina Martínez de Pinillos[3,7], María Martinón-Torres[3,8], Bernardo Perea Pérez[9], José María Bermúdez de Castro[3,8], Daniel García-Martínez[2,3,10]

1 - Universidad Autónoma de Madrid. Ciudad Universitaria de Cantoblanco, Madrid, Spain · 2 - Physical Anthropology Unit, Department of Biodiversity, Ecology, and Evolution, Faculty of Biological Sciences, Complutense University of Madrid, Madrid, Spain · 3 - Centro Nacional de Investigación sobre la Evolución Humana, Burgos, Spain · 4 - Universidad Internacional de La Rioja (UNIR), La Rioja, Spain · 5 - Institut Català de Paleoecologia Humana i Evolució Social (IPHES), Zona Educacional 4, Campus Sescelades URV (Edifici W3), Tarragona, Spain · 6 - Centro Mixto Universidad Complutense de Madrid - Instituto de Salud Carlos III de Evolución y Comportamiento Humanos, Madrid, Spain · 7 - Laboratorio de Evolución Humana (LEH), Universidad de Burgos, Burgos, Spain · 8 - Anthropology Department, University College London, London, UK · 9 - Laboratorio de Antropología Forense, Escuela de Medicina Legal y Forense, Universidad Complutense de Madrid, Spain · 10 - Laboratory of Forensic Anthropology, Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, Coimbra, Portugal

Determining the sex of an individual to create a biological profile is one of the main challenges that biological anthropology must face, especially with non-adult individuals, where determining sex with classical methods is near impossible [1]. Dental anthropological investigations into sexual dimorphism have conventionally concentrated on evaluating the dimensions and configuration of the enamel cap of canines. However, the morphology of the crown dentine surface can be closely linked to that of the enamel surface [2], which can make it easier to examine the morphology of the crowns even when the enamel surface is worn [3-4]. This work analyzes the surface of the enamel-dentine junction (EDJ) of permanent canines of males and females from a contemporary human population of Europe (Spain), assessing the differences that exist between males and females as well as between maxillary and mandibular canines. Micro-CT and 3D geometric morphometry techniques were used, gathering the morphological data of the EDJ with a template comprising a total of 96 landmarks and semilandmarks, followed by Procrustes registration [4], space principal component analysis (PCA) and comparison of centroid sizes. Significant differences in the morphology of the EDJ were observed between the sexes, particularly concerning the overall shape of the crown, the symmetry of the mesial and distal edges, and the development of the distal accessory ridge. Our results indicate a) that they could partially relate to retention of the canine-premolar honing complex in males thanks to the conservative properties of the dentine, which was presumed lost by this point of the human lineage, and b) that analyses of the permanent canine EDJ may potentially provide a novel method for estimating the sex of adult and non-adult skeletons, which would be especially useful in both the study of human evolution and concrete fossils as well as in forensic sciences.

This study has been supported by the Dirección General de Investigación of the Spanish Ministerio de Economía y Competitividad MINECO /FEDER) grant number: PID2021-122355NB-C33 and The Leakey Foundation through the personal support of G. Getty (2013) and D. Crook (2014-2020) to M. M.-T. MMM and MMP have received support from the European Research Council within the European Union's Horizon Europe (ERC-2021-ADG, Tied2Teeth, project number 101054659).

References: [1] Weiss, K.M., 1972. On the systematic bias in skeletal sexing. American Journal of Physical Anthropology. 37, 239–249. [2] Smitha, T., Sheethal, H., Hema, K., Franklin, R., 2019. Forensic odontology as a humanitarian tool. Journal of Oral and Maxillofacial Pathology. 23, 164. [3] García-Campos, C., Martinón-Torres, M., Martín-Francés, L., Martínez de Pinillos, M., Modesto-Mata, M., Perea-Pérez, B., Zanolli, C., Labajo González, E., Sánchez Sánchez, J.A., Ruiz Mediavilla, E., Tuniz, C., Bermúdez de Castro, J.M., 2018. Contribution of dental tissues to sex determination in modern human populations. American Journal of Physical Anthropology. 166, 459–472. [4] García-Campos, C., Martinón-Torres, M., Martínez de Pinillos, M., Modesto-Mata, M., Martín-Francés, L., Perea-Pérez, B., Zanolli, C., Bermúdez de Castro, J.M., 2018. Modern humans sex estimation through dental tissue patterns of maxillary canines. American Journal of Physical Anthropology. 167, 914–923. [5] Zelditch, M., Swiderski, D., Sheets, H. D., 2012. Geometric morphometrics for biologists: a primer. Academic press.

Poster Presentation Number 118, Session 2, Friday 17:00 – 18:30

A terminal Pleistocene demographic cycle at Natufian el-Wad Terrace, Israel

Reuven Yeshurun[1], Ma'ayan Lev[1], Mina Weinstein-Evron[1]

1 - Zinman Institute of Archaeology, School of Archaeology and Maritime Cultures, University of Haifa, Haifa, Israel

It is increasingly acknowledged that some intensive and prolonged human settlements at the end of the Pleistocene had strongly affected their environments in myriad ways before any reliance on food production. This included intensified subsistence practices that could have depressed game populations, niche-constructing activities that altered the abundances of animal and plant taxa (both intentionally and inadvertently), and synanthropic relations whereby certain taxa benefited from the refuse or shelter provided by the habitation. The intertwined nature of these effects and their equivocal archaeological signals require a detailed, high-resolution and multi-proxy record to tease out. Here, we present such a case-study from the earliest hunter-gatherer "built environment", the Natufian Culture of the terminal Pleistocene Levant. The deep Early Natufian sequence of el-Wad Terrace (Mount Carmel, Israel), provides a rich record (ca. 14.9–13.2 ka) that includes an initial phase with little architecture, followed by an intensive architectural phase with ten stratified construction levels, in turn capped by more ephemeral habitation levels. The sequence ends with an even more ephemeral-looking Late Natufian deposits (ca. 13.2–12 ka). Using the rich zooarchaeological samples from each stage, and controlling the environmental parameters by independent proxies (plant carbon isotopes and microvertebrate accumulations), we propose that the different modes of habitation had different effects on subsistence intensification and diversification, as well as proliferation of synanthropic taxa. We test how hunting patterns changed with the mode of occupation, revealing the human response to the impact a growing sedentary habitation had on the site's environment. Since our sequence's duration is comparable to ethnographically known demographic cycles, we further investigate the possibility that these developments correspond to a Malthusian cycle, whereby gradual demographic growth in this early sedentary hamlet eventually led to an overpopulation crisis, which was mediated first by adjusting the subsistence patterns, and later possibly entailed the partial abandonment of the site and reorganization elsewhere.

This research was supported by the Israel Science Foundation (Grant No. 511/22).

Podium Presentation, Session 1, Thursday 9:20 – 11:00

Could the Rising Star hominins represent relictual australopiths?

Clément Zanolli[1,2]

1 - Univ. Bordeaux, CNRS, MCC, PACEA, UMR 5199, France · 2 - Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, South Africa

Since 2013, the Dinaledi and Lesedi Chambers of the Rising Star cave system yielded hundreds of hominin remains attributed to *Homo naledi*, and dated to 335–236 ka [1-3]. This extraordinary assemblage represents a minimum of 15 individuals of various ontogenetic stages, all showing a surprisingly low degree inter-individual variation [4]. The estimated stature, body mass and endocranial volume of the Rising Star hominins are on par with those of *Australopithecus* and *Paranthropus* [1-2]. Most of the anatomy of this species is known, but counterintuitively, this led to an increasing number of questions regarding its evolution and phylogenetic relationships [1-4].

The rounded cranium of the Rising Star hominins was described as most similar to that of *H. erectus/ergaster* [1]. In addition, the absence of sagittal crest was described to be distinct from species of the genus *Paranthropus* [1], but some *Paranthropus robustus* specimens, like DNH 7 from Drimolen, display a rounded cranium without sagittal crest [5]. The maxilla and mandible of the Dinaledi and Lesedi hominins are prognathic and the teeth of the Rising Star hominins exhibit distinct australopith traits [1–3]. The postcranial remains of the Rising Star hominins show a mixture of australopith- and early *Homo*-like features, together with later *Homo*-like traits [1-2]. However, the scarcity of comparative material clearly attributed to *Paranthropus* and early *Homo* makes taxonomic interpretations of the postcranial elements challenging.

Morphological features of the cranium and teeth of the Rising Star hominins are revised here and new analyses of craniodental structures are conducted to re-evaluate their taxonomy and phylogenetic relationships. Several metric and non-metric traits were computed for the Rising Star hominins and compared with other hominin taxa (e.g., index of palate protrusion, mandibular corpus shape index, crown occlusal area of postcanine teeth). Using the surface models of the Rising Star hominins available on MorphoSource, bidimensional geometric morphometric analyses of the neurocranium lateral and posterior profile, maxilla lateral profile, and of the cross-sectional mandible symphysis shape were conducted in comparison with published and original data of specimens belonging to *Australopithecus*, *Paranthropus*, and Early to Middle Pleistocene *Homo*. The crowns of the mandibular M3s of DH1 (the least worn teeth) were virtually cropped and compared with the external surface files of original fossils and cast of unworn to slightly worn specimens attributed to *Australopithecus*, *Paranthropus*, and Early–Middle Pleistocene *Homo*.

The revision of craniodental metric and non-metric traits of the Rising Star hominins point toward an australopith-like condition (some traits being not diagnostic between genera, and a number of features being autapomorphic of *naledi*). This is supported by the geometric morphometric analyses of the neurocranium, maxilla, mandible symphysis and M3 crown shape that statistically attribute the Rising Star specimens to either *Australopithecus* or *Paranthropus*.

The Rising Star hominins lived toward the end of the Middle Pleistocene, at a time when it is commonly assumed that among hominin genera, only *Homo* existed, while the australopiths were long extinct. However, the African fossil record for this time period is extremely scarce, with only a few Middle Pleistocene fossils available for all of the continent. The present study of the Rising Star hominins suggest that they most likely represent the terminal stage of an australopith (possibly *Paranthropus*-related) evolutionary branch.

For access to three-dimensional surfaces of the Rising Star specimens and comparative data, I am grateful to the following colleagues, institutions and online databases: J. Braga, G. Chinamatira, A. S. Hammond, K. Jakata, S. Jirah, L. Kgasi, A. Mazurier, R. Macchiarelli, L. Pan, M. Tawane, R., A. Vecino Gazabón, S. Xing, B. Zipfel, Evolutionary Studies Institute, University of Witwatersrand, Ditsong National Museum of Natural History, American Museum of Natural History, https://africanfossils.org, https://www.morphosource.org. For scientific discussion, I sincerely thank J. K. Brophy, M. Cazenave, Z. Cofran, T. W. Davies, H. S. Groucutt, J. Hawks, S. D. Hurst, R. Joannes-Boyau, O. Kullmer, R. Macchiarelli, C. M. Orr, D. Reed, F. Schrenk, L. Schroeder, M. M. Skinner, A. Urciuoli, B. A. Wood, B. Zipfel. This study received financial support from the French government in the framework of the University of Bordeaux's IdEx "Investments for the Future" program / GPR "Human Past".

References: [1] Berger, L.R., Hawks, J., de Ruiter, D.J., Churchill, S.E., Schmid, P., Delezene, L.K., Kivell, T.L., Garvin, H.M., Williams, S.A., DeSilva, J.M., Skinner, M.M., Musiba, C.M., Cameron, N., Holliday, T.W., Harcourt-Smith, W., Ackermann, R.R., Bastir, M., Bogin, B., Bolter, D., Brophy, J., Cofran, Z.D., Congdon, K.A., Deane, A.S., Dembo, M., Drapeau, M., Elliott, M.C., Feuerriegel, E.M., Garcia-Martinez, D., Green, D.J., Gurtov, A., Irish, J.D., Kruger, A., Laird, M.F., Marchi, D., Meyer, M.R., Nalla, S., Negash, E.W., Orr, C.M., Radovcic, D., Schroeder, L., Scott, J.E., Throckmorton, Z., Tocheri, M.W., VanSickle, C., Walker, C.S., Wei, P., Zipfel, B., 2015. *Homo naledi*, a new species of the genus *Homo* from the Dinaledi Chamber, South Africa. eLife. 4. [2] Hawks, J., Elliott, M., Schmid, P., Churchill, S.E., Ruiter, D.J. de, Roberts, E.M., Hilbert-Wolf, H., Garvin, H.M., Williams, S.A., Delezene, L.K., Feuerriegel, E.M., Randolph-Quinney, P., Kivell, T.L., Laird, M.F., Tawane, G., DeSilva, J.M., Bailey, S.E., Brophy, J.K., Meyer, M.R., Skinner, M.M., Tocheri, M.W., VanSickle, C., Walker, C.S., Campbell, T.L., Kuhn, B., Kruger, A., Tucker, S., Gurtov, A., Hlophe, N., Hunter, R., Morris, H., Peixotto, B., Ramalepa, M., Rooyen, D. van, Tsikoane, M., Boshoff, P., Dirks, P.H., Berger, L.R., 2017. New fossil remains of *Homo naledi* from the Lesedi Chamber, South Africa. eLife. 6. [3] Delezene, L.K., Skinner, M.M., Bailey, S.E., Brophy, J.K., Elliott, M.C., Gurtov, A., Irish, J.D., Moggi-Cecchi, J., de Ruiter, D.J., Hawks, J., Berger, L.R., 2023. Descriptive catalog of *Homo naledi* dental remains from the 2013 to 2015 excavations of the Dinaledi Chamber, site U.W. 101, within the Rising Star cave system, South Africa. Journal of Human Evolution. 180, 103372. [4] Delezene, L.K., Scott, J.E., Irish, J.D., Villaseñor, A., Skinner, M.M., Hawks, J., Berger, L.R., 2024. Sex-biased sampling may influence *Homo naledi* tooth size variation. Journal of Human Evolution. 187, 103490. [5] Rak, Y., Kimbel, W.H., Moggi-Cecchi, J., Lockwood, C.A., Menter, C., 2021. The DNH 7 skull of *Australopithecus robustus* from Drimolen (Main Quarry), South Africa. Journal of Human Evolution. 151, 102913.

Poster Presentation Number 119, Session 2, Friday 17:00 – 18:30

Reconstructing Sandrone: digital investigation of *Oreopithecus bambolii*

Carlotta Zeppilli[1], Luca Bellucci[2], Giovanni Boschian[1], Marco Cherin[3], Andrea Faggi[4], Damiano Marchi[1], Jacopo Moggi Cecchi[5], Alessandro Riga[5], Lorenzo Rook[4], Antonio Profico[1]

1 - Department of Biology, University of Pisa, Italy · 2 - Geological and Paleontological Museum of Florence, University of Florence, Italy · 3 - Department of Physics and Geology, University of Perugia, Italy · 4 - Earth Science Department, Paleo[Fab]Lab, University of Florence, Italy · 5 - Department of Biology, University of Florence, Italy

It has been 150 years since *Oreopithecus bambolii* Gervais, 1872, a Miocene primate species, was discovered. This species inhabited the Tusco-Sardinian archipelago approximately 8.3 to 6.7 million years ago. The most complete specimen of *O. bambolii*, known as "Sandrone" (IGF 11778), was unearthed in a Late Miocene lignite mine in Baccinello (Grosseto, Italy). Despite its completeness and anatomical articulation, Sandrone exhibits significant fragmentation and deformation resulting from taphonomic processes.

Oreopithecus bambolii is a species that has sparked debate over more than a century with some researchers considering it as a potential milestone for investigating the origins of bipedalism. Previous analyses of the lumbar region, pelvis, foot, and inner ear of IGF 11778 have indeed suggested bipedal locomotion, although interpretations of pelvic morphology are not fully consistent with this hypothesis [1].

Here we introduce the project SANDRONE (Scientific investigation, virtual reconstruction AND musealization of ORe*Opithecus bambolii*: locomotor and manipulative adaptations before humaN Evolution). Our goal is to digitally restore the iconic fossil using cutting-edge techniques and protocols in virtual anthropology tailored to the status of preservation of each bone element. Then, we will focus on the morphological and functional analyses of its locomotion and manipulative capabilities in the frame of its (paleo)environment. The upper and lower limbs of IGF 11778 will be digitally studied through cross-sectional geometric and three-dimensional geometric morphometric analyses using the R package *morphomap* [2].

In the present work, we report the tomographic investigation of the fossil from Baccinello and the preliminary results of restoration protocols including retrodeformation [3], surface warping [4] and target deformation [5]. The methodological design of the virtual restoration will allow us to estimate the missing parts and the digital reconstruction based on multivariate analysis. Beyond the scientific aspect, the project aims to enhance the fossil, renewing the museum exhibition in the Geological and Paleontological Museum of Florence with a hyper-realistic body reconstruction of Sandrone, and several panels illustrating the paleoenvironmental features of the Baccinello area during the Miocene.

Additionally, the project aims at using only open-source software, to ensure that the methodologies employed can be replicated and further developed by other researchers in the field. The expertise gathered in this project will be utilised to organise training courses for students and early researchers about virtual anthropology.

This research was funded by the Italian Ministry of Education, University and Research (MIUR, PRIN projects 2022 PNRR): grant no. P20222SWYY (coordinated by A.P.)

References: [1] Hammond, A.S., Rook, L., Anaya, A.D., Cioppi, E., Costeur, L., Moyà-Solà, S., Almécija, S., 2019. Insights into the lower torso in late Miocene hominoid *Oreopithecus bambolii*. Proceedings of the National Academy of Sciences. 117:278–284. [2] Profico, A., Bondioli, L., Raia, P., O'Higgins, P., Marchi, D., 2020. Morphomap: An R package for long bone landmarking, cortical thickness, and cross-sectional geometry mapping. American Journal of Physical Anthropology. 174, 129–139. [3] Schlager, S., Profico, A., Di Vincenzo, F., Manzi, G., 2018. Retrodeformation of fossil specimens based on 3D bilateral semi-landmarks: Implementation in the R package "Morpho." PLOS ONE. 13, e0194073. [4] Gunz, P., Mitteroecker, P., Neubauer, S., Weber, G.W., Bookstein, F.L., 2009. Principles for the virtual reconstruction of hominin crania. Journal of Human Evolution. 57, 48–62. [5] Cirilli, O., Melchionna, M., Serio, C., Bernor, R.L., Bukhsianidze, M., Lordkipanidze, D., Rook, L., Profico, A., Raia, P., 2020. Target deformation of the *Equus stenonis* holotype skull: a virtual reconstruction. Frontiers in Earth Science. 8, 247