12TH ANNUAL MEETING OF THE EUROPEAN SOCIETY FOR THE STUDY OF HUMAN EVOLUTION ABSTRACTS TÜBINGEN, 22-24 SEPTEMBER 2022

Podium Presentation Session 3, Thursday 14:40-15:00

Investigating the co-occurrence of Neanderthals and modern humans in Belgium through direct radiocarbon dating of bone implements and Late Neanderthal remains

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The dynamics of the transition between Late Neanderthals and early anatomically modern humans (AMHs) is the subject of intense debate: the location and duration of the coexistence of the two human populations. As well as their relation and the cultural exchanges that could have occurred during this transitional period, referred to as the Middle Paleolithic to Upper Paleolithic Transition (MUPT), is still being discussed (d'Errico, 2003; Hublin, 2015). The precise chronological position of the different cultural facies, as well as the human remains associated with them, are therefore key elements that delineate the chronological framework within which Neanderthals and AMHs could have interacted. It bears upon the dynamics of colonization of Eurasia and the replacement of the last Neanderthals by AMHs. There is increasing evidence of admixture and co-existence of Neanderthals and AMHs in Central and Eastern Europe (Hajdinjak et al., 2021). Northern and Western Europe appears as a different scenario. Genetic analyses show the absence of genetic flow from early AMH to late Neanderthal populations as well as the absence of Neanderthal genes in Northern European Early Upper Paleolithic modern humans (Posth et al., 2016). However, this interpretation is based on a limited number of hominin specimens because of their scarcity in the archaeological record.

Mousterian and Aurignacian bone industries, associated with Neanderthals and AMHs respectively, are present in much larger quantities, and can also be used to define the timing of both occupations. Few radiocarbon dates, measured on ultrafiltered collagen, have been produced for these industries. These data showed a possible coexistence of Mousterian (42,300–39,900 cal BP) and Aurignacian (41,650–39,250 cal BP). We decided to reevaluate the chronology of the latest Mousterian and earliest Aurignacian cultural evidences using the compound specific radiocarbon dating approach (CSRA), which is the most robust pretreatment method. Our new data obtained on diagnostic bone implements (bone points and bone retouchers) show that the latest Mousterian occurrence possibly ended around 45,900–42,900 cal BP (95% probability) and that the earliest Aurignacian started around 42,100–40,300 cal BP (95% probability) - a date that is much older than the dates previously obtained on the same objects. Considering also the dates on Lincombian-Ranisian-Jerzmanowician industries, this new data tends to confirm that there may have been a hiatus implying that Neanderthals and AMHs did not co-exist in this region.

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Pecha Kucha Presentation Session 2, Thursday 12:20-12:45

Evidence of Neanderthal ochre production in Navalmaíllo Rock Shelter (Pinilla del Valle, Madrid, Spain)

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Ochre processing and use are considered proxies for detecting complexity and/or the emergence of symbolic behaviour due to the versatility of uses for this material. Apart from its colouring properties, actualistic studies show ochre can also be used, e.g., as an abrasive element for hide treatment, hafting, food preservation and skin photoprotector. The oldest evidence of ochre use can be found in South Africa, in MSA contexts associated with early Homo sapiens. It can also be found more frequently in the European Upper Palaeolithic contexts. However, some of the oldest evidence in Europe were recovered in Middle Palaeolithic sites and, except for Roebroeks et al., 2012 [1] with dates of 200-250 ka, the vast majority, are from MIS3. These dates partially overlap with known incursions of AMH into Neanderthal occupied territories (e.g., Mandrin Cave and Bacho Kiro) contributing to the debate on spontaneous invention vs contact or mimicking behaviour. Furthermore, the vast majority of Middle Palaeolithic sites with ochre evidence show traces of ochre or other materials with pigment stains and no clear evidence of ochre processing.

Navalmaíllo Rock Shelter is a Middle Palaeolithic site located in Calvero de la Higuera, a karstic hill located in Pinilla del Valle in the upper Lozoya river valley (Central System of the Iberian Peninsula at c. 1100 m a.s.l.). The valley is of tectonic origin and the Calvero de la Higuera Hill represents an Upper Cretaceous dolomite elevation, surrounded by granitic pop-up structures. The particularity of the orography and geology of the surroundings allows the study of Neanderthal behaviour regarding the exploitation of lithic resources available in the landscape. Level F (71 685 ± 5.082 and 77 230 ± 6.016 by TL [2]), has an occupation characterized by an abundance of lithic industry mainly in local raw materials (c. 95%) [3]. The presence of small traces of ochre in the Navalmaíllo Shelter has been recorded on an occasional basis since the 2006 campaigns. Considering there are no terra rossa-type clay soils in the Navalmaíllo Rock Shelter and the sediment that characterizes Level F originates mainly in the dissolution of the dolomitic karstic hill we concluded the ochre to be of autochthonous origin.

Analysing the lithic industry of Level F, we found macroscopically visible red residues on the surface of three lithic elements - two hammerstones and one pebble with mild wear. The raw materials were characterized, photogrammetric models were made on the two hammerstones, wear marks were studied by optical microscopy and mineral residues were analysed by SEM/EDS. Hammerstones are in aplite and quartzite pebbles. A ferruginous sandstone pebble was found close to the hammerstones, also with signs of percussion. The micro photogrammetry model and use-wear analysis demonstrate the presence of residues on the surface associated with the hammerstone's percussion marks. SEM imaging demonstrated that iron minerals are deposited on the surface of the hammerstones and these were interpreted as tools that had direct contact by percussion with coloured mineral material. The EDS results indicate that the colouring matter consists mainly of iron oxides, which coincides with the composition of the ferruginous sandstone that could be the raw material exploited for the production of ochre.

Considering the different physical properties of the raw materials used in the act of grinding the ferruginous material and the presence of a ferruginous sandstone pebble with signs of percussion, we interpret these materials as evidence of a chaîne operatoire of ochre production or transformation of the ferruginous material into powder with colouring properties. Parallels are found in recent chronologies and ethnographic contexts.

The data present the first evidence of possible ochre processing in a Neanderthal context on the Iberian Peninsula, at Navalmaíllo Rock shelter in early MIS 4.

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Poster Presentation Number 70, Session 2, Friday 18:15

With or without glue. Adhesive remains from Steenbokfontein Cave, South Africa

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Adhesives, used to haft tools to their handles, are one of the oldest complex technologies, and they are often used as a proxy to identify complex behaviours. Evidence of different organic-based adhesives in South Africa dates back to at least 65.000 years ago [1]. Among other sites, Steenbokfontein Cave (Western Cape, South Africa) yielded a rich sample of stone tools with adhesive remains. The assemblage includes a stone adze embedded in a large adhesive clump and a cigar-shaped adhesive object [2]. In addition, more than 30 stone tools with glue, from the complete stratigraphic sequence, were reported.

Here we present the preliminary results of the analysis of 13 tools with adhesives residues dated to the Holocene, between 5240 and 2170 ka cal BP [3]. The Steenbokfontein tools were studied with a holistic approach integrating optical microscopy, spectrographic methods and chemical analysis. Use-wear traces and residues on the stone tools were characterised and described with optical microscopy. This traceological approach allowed us to determine not only tools' functions, but also to study if they were hafted and with what adhesives. However, morphological identification of residues alone does not provide accurate identification of adhesives composition. Therefore, we analysed the glue residues on the artefact with spectrographic methods to reconstruct their inorganic and organic components.

Results from the XRD analysis pointed out the presence of iron oxide (Fe2O3) in the residues. As we know, red ochre is used in South Africa as an additive in hafting adhesives [4]. Micro-FTIR showed the preservation of the organic components in the adhesive mixtures. Then, the residues were sampled for gas chromatography-mass spectrometry analysis. GC-MS is a destructive technique, which offers the most reliable method to identify unknown archaeological mixtures through the identification of diagnostic biomarkers [5]. The GC-MS analysis is undergoing, and results will be provided soon. The combination of these results will tell us about the life history of these objects and their glues and allow us to reconstruct the technological and behavioural choices of the human groups who inhabited the cave. Taking a broader perspective, with our in-depth analysis of this sample of tools with adhesives from Steenbokfontein we lay the groundwork to illuminate regional and geographical trends of adhesive technology during the South African Stone Age.

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Podium Presentation Session 10, Saturday 12:00-12:20

Late Acheulean occupations of Montagu Cave and the pattern of Middle Pleistocene behavioral change in western Cape southern Africa

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Patterns of so-called modern human behavior are well documented in an abundance of Middle Stone Age (MSA) archaeological sites across southern Africa. Contextualized archives directly preceding the southern African MSA, however, remain scarce. Much of our understanding of the terminal Acheulean in southern Africa derives from a small number of localities that are predominantly in the central and northern interior. Many of these localities are surface and deflated contexts, others were excavated prior to the availability of modern field documentation techniques, and yet other relevant assemblages contain low numbers of characteristic artefacts relative to volume of excavated deposit. The site of Montagu Cave, situated in the diverse ecosystem of the Cape Floral Kingdom, contains the rare combination of archaeologically rich, laminated and stratified Acheulean layers overlain by a younger MSA occupation. Yet little is known about the site owing largely to a lack of contextual information associated with the early excavations. Here we present renewed excavation of Levels 21-22 at Montagu Cave, located in the basal Acheulean sequence, with data on site formation, ecological context, geochronology and technological variability, reflecting probable occupation of the cave at the onset of interglacial conditions in MIS 7. Study of the Acheulean occupations at Montagu Cave enables exploration of hominin behaviour in a time window just preceding the better-known period characterized by rapidly increasing complexity in the southern African archaeological record. While MSA technologies were practised by 300 ka in several regions of Africa, the classic Acheulean persisted later in the south western Cape. This regionalized persistence raises questions about the biogeography of African later Middle-Pleistocene hominin populations, about the geographic extents and ecological drivers of their technological systems, and about the pattern and pace of behavioural change just prior to the proliferation of the southern African later Middle Stone Age.

Poster Presentation Number 109, Session 2, Friday 18:15

Evolutionary selection and morphological integration in the hand of modern humans

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The modern human's hand has some unique characteristics compared to other hominoids. The most remarkable difference is the proportionally long thumb relative to the fingers, but also the short and strait metacarpals and phalanges [1]. This general hand morphology contributes to the well-developed and distinctive pinch grip in humans, which is enhanced by the hypertrophied and powerful thenar muscles. The fossil record suggests that the human-like hand proportions were already present in *A. afarensis*, which relatively concur with the first evidence of lithic technology dated around 3.3–3.5 Ma [2]. Thus, traditionally, the human-like hand proportions were seen as an evolutionary adaptation to stone tool-making. However, for some authors, the hypothesis that humans hand evolved as an adaptation to stone tool-making does not fully explain this process. Alternatively/additionally, they view it as an exaptation, highlighting the importance of bipedalism both by the relaxation of the selection pressures in the forelimbs, and the effect of pleiotropic factors in the coevolution of the foot and hand [2, 3].

In this work, we intend to shed some light on the evolution of the human hand by analyzing how traits are internally organized, and the role selection pressures have played in its morphology and proportions. To carry out this investigation, we quantified the degree of morphological integration and various index of selection in the five metacarpals and the 14 phalanges of 96 adult male and female Euro-American and Afro-American *Homo sapiens* individuals. The magnitude of integration represents the correlation between traits in a structure and depends on genetic, functional, and developmental factors [4]. Integration is important in evolutionary studies because it can limit evolution, either by selecting negatively to the fitness or by constraining the variation exposed to selection in a determined direction. Alternatively, integration can enhance evolution if the variation is concentrated in the line of least resistance [5]. Additionally, the indexes of selection (Evolvability, Flexibility, and Constraints) reflect the ability of the different hand bones to evolve under different scenarios, and thus, together with the analyses of integration, can help to reconstruct the evolutionary processes of this structure in modern humans.

The results revealed that the distal phalanges are the least integrated bones, followed by metacarpals, proximal, and middle phalanges. By rays, more lateral fingers (4th and 5th) are the most integrated, decreasing this pattern towards the medial rays. Also, they showed that distal phalanges are the most evolvable bones, followed by middle and proximal phalanges. Broadly, metacarpals also displayed high values of evolvability except for the 1st metacarpal, which is the least evolvable element of the entire human hand. By rays, lateral fingers are more evolvable, decreasing this ability toward medial position fingers. Overall, these results indicating a general pattern in which more distal and lateral elements are more evolvable are very similar to what we found in the modern human foot (under review). Indeed, in both studies, we found that the first metacarpal/tarsal is the least evolvable element from the autopods (excluding carpals and tarsals), and the distal 5th phalanges the most (except for the 4th metacarpal). These results support the hypothesis that the changes that occurred in the hand of hominins were, at least in part, produced by the coevolution of the morphological adaptations of the foot to bipedalism through genetic and developmental integration processes [2].

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Podium Presentation Session 7, Friday 14:30-14:50

The oldest ochre mine in the world. New ages for the Lion Cavern in Eswatini and implications for human behavioral evolution during the Middle Stone Age in southern Africa

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The African Middle Stone Age (MSA ~300,000 – 30,000 BP) is the period when anatomically modern humans appear for the first time at around 300.000 years ago. Numerous innovations in material culture are associated with the MSA, including personal ornaments, symbolic items, burials and the intensive use of pigments. This led to lively debates about the nature, timing and development of human cognitive capacities, complex language and social behavior amongst *Homo sapiens*. Furthermore, the MSA may provide the oldest evidence for humans actively changing their environment in the form of chert and ochre mining representing the beginning of human induced landscape alterations.

The archaeological site of Lion Cavern, located at the edge of the Ngwenya iron ore massive in Eswatini, was excavated in the late 1960s by Peter Beaumont and proposed to be the oldest ochre mine in the world dating back ~43,000 years BP. More than 50 tons of ochre were mined from this formation over the millennia. Unlike in neighboring South Africa, research on the MSA ended in Eswatini in the late 1980s and the promising results from Lion Cavern and other sites in the country have been overlooked since then. Due to the early stage of radiocarbon dating in the 1960s, the 14C dates of Lion Cavern were accepted only as a minimum age. Together with the poor publication record, the results could not be integrated in any clear archaeological context, leaving the site and its results loosely entangled in time. The sole existence of the Lion Cavern, however, induced future research generations to suggest that Lion Cavern, or more general Ngwenya, was the only source for ochre during the MSA and Later Stone Age (LSA) in the region, resulting in far reaching conclusions about human range of activity, transport distance and exchange networks amongst hunter gatherers.

In the current paper, we present the results of new excavations at Lion Cavern and a comprehensive re-dating of the archaeological deposits using optically stimulated luminescence (OSL) and 14C. We further provide preliminary results on a large-scale ochre provenance study from Lion Cavern and other mineral pigment outcrops in Eswatini related to archaeological sites in various distances and throughout different periods using neutron activation analysis (NAA).

Our results show the existence of two chambers with archaeological, intact deposits. Lion Cavern II (LCII) represents the lager chamber featuring a 4 m stratigraphic sequence dating to between 30,000 and 40,000 years based on OSL. The LCII deposits are associated with clear MSA artifacts, some of them having massive pick-like proportions, representing tools for ochre mining. Lion Cavern III (LCIII) is situated on top of LCII and was dated to between 3,600 on OSL at the top and 10.500 BP at the base on 14C, confirming a use of the mine during the Holocene LSA. Hence, Lion Cavern is now confirmed to be the oldest ochre mine in the world that was extensively exploited since ~40,000 years ago. These dates overlap well with results from other MSA sites in Eswatini under our investigation.

The results of our provenance study show that hunter gatherers living in the closer vicinity to Lion Cavern (~30 km) had a strong preference throughout the Stone Age for iron rich red pigments from this mine. On a broader geographic scale (~100 km), we identified different procurement strategies which imply other, local sources. However, to a limited degree, we found clear signs for long distance exchange networks, since ochre from Lion Cavern was found in sites at the eastern exposure of Eswatini and vice versa. Ultimately, we observed clear differences between the MSA and the LSA concerning the range of geological sources used. Our results have important implications for our understanding of human preference and selection of raw materials, changing behaviors through time and the onset of visible human exploitation of natural resources in the southern Hemisphere.

We express our gratitude to Hlobsile Sikhosana and the members of the Eswatini National Trust Commission for providing permission to excavate at Lion Cavern. We are especially grateful to Temahlubi Nkambule, Rosemary Andrade, Celiwe Dlamini and Nomsa Dlamini for their constant scientific and logistic support. Special thanks are due to Bob Forrester for his tireless effort to study and protect the rich cultural heritage of Eswatini and for introducing us to a multitude of sites in the country. This research was funded by the project BA 6479/2-1 of the Deutsche Forschungsgemeinschaft.

Pecha Kucha Presentation Session 2, Thursday 11:55-12:20

New Neanderthal Remains from Axlor Cave (Dima, Biscay, northern Iberian Peninsula)

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Axlor cave is located in a mountainous region in the north Atlantic range of the Iberian Peninsula. Several Middle Paleolithic layers (B to N) have been recorded ranging from 50 to 100 ky bp (Demuro et al., in prep.). We focus here on level F and N, accumulated during MIS5, dated 80.0 ± 5.3 and 99.6 ± 5.8 respectively, by OSL. This age is significant because there are few Neanderthal remains from Europe dating to this time period.

Previous publications have documented skeletal and dental remains recovered in excavations carried out in 1967-1973 (Basabe, 1973; Barandiaran, 1980; Gómez-Olivencia et al., 2019). These remains have been related in these publications to different levels (III, IV, V and VIII of the nomenclature of levels by Barandiarán). Due to questions of the methodology of the original excavation, with arbitrary horizontal levels, the direct equivalence with the current levels is not possible. Three new teeth have been collected at levels F (1) and N (2) of the modern stratigraphy. They include a deciduous lower second molar (m2), a deciduous lower canine (c1) and a permanent upper fourth premolar (P4). All three teeth are moderately worn. As a consequence, our results are primarily based on crown shape and morphology of the enamel-dentine junction (EDJ) and/or cervix. Our comparative sample included Neanderthals (n=11-13), fossil *Homo sapiens* (n=4-5) and recent *H. sapiens* (n=15-19). Sample sizes varied depending on the analysis and the tooth.

For the geometric morphometric analysis of the P4, landmarks were placed around the EDJ marginal ridge and the cervix of all specimens. Because of the moderate wear landmarks corresponding to the worn areas were not included. Due to their heavily worn condition, the geometric morphometric analysis of the c1 and m2 included the cervical outline only.

The c1, m2, and P4 are all significantly larger in Neanderthals than they are in *H. sapiens*. The Axlor c1 falls near the Neanderthal mean and outside the *H. sapiens* range, while the m2 falls above the Neanderthal mean and at the high end of the *H. sapiens* range. The P4, on the other hand, falls at the low end of the Neanderthal range and just above *H. sapiens* range. Details of the occlusal morphology of the c1 and m2 cannot be observed, while the P4 possesses a bifurcated paracone essential crest and accessory crests as well.

A Principal Component Analysis (PCA) in Procrustes shape space of c1 samples shows that *H. sapiens* and Neanderthals are separated along the first principal component (PC1). Neanderthal c1s are more asymmetrical than those of *H. sapiens*, and elongated along the distolingual and mesiobuccal plane. PC1 also separates Neanderthal and *H. sapiens* m2 shapes. The Axlor m2 also plots comfortably within the Neanderthal cluster. The cervix in Neanderthal m2s is round and symmetrical, with a slight buccolingual expansion of the talonid, whereas the shape of the cervix in *H. sapiens* m2 is more asymmetrical and oblong, with the trigonid being slightly more buccolingually expanded than the talonid. For the P4, Neanderthals and recent *H. sapiens* are likewise separated along PC1, while the fossil *H. sapiens* overlap both groups. The Axlor P4 occupies a negative position along PC1, closer to Neanderthals, although the specimen also plots relatively close to an Upper Palaeolithic specimen from Dolní Věstonice.

All three new teeth from the F and N levels can be confidently assigned to Neanderthals. The P4 is somewhat small compared to other Neanderthal P4s, but the shape and morphological complexity of the occlusal surface is consistent with Neanderthal assignment. Previous studies have shown that tooth size alone is a poor discriminator for permanent post canine teeth of Neanderthals and *H. sapiens*. This analysis corroborates this finding. We recommend that multiple analyses be undertaken for assignment of individual elements.

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Pecha Kucha Presentation Session 11, Saturday 14:15-14:40

Examining functional significances of masticatory changes during human evolution through multibody dynamics analysis

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During human evolution changes in technology and ecology have led to major dietary shifts. From the emergence of genus *Homo*, an increased reliance on extraoral food processing, cooking, and animal and plant domestication has likely led to a reduction in the mechanical requirements for feeding. *Homo sapiens* show more craniofacial gracilisation than early *Homo*, but whether they are functionally less capable, and if so, which morphological differences have impacted performance has not been fully investigated. This study applies multibody dynamics analysis (MDA) to predict the impact of anatomical changes during human evolution on functional performance (bite force and gape). Through selective alteration of modelled morphology (increased degree of prognathism, flared zygoma with increased height, and flatter articular eminences), hypothetical models are created, incorporating early *Homo* anatomical features; subsequent changes in functional performance are then assessed. It is predicted that when early *Homo* features are incorporated, the MDA model will predict higher bite forces and wider gapes.

A validated modern human MDA model was constructed by digitising a living modern human using two different imaging modalities (MRI, structured light scanning). Hard and soft tissue anatomy were virtually reconstructed, with cranium and mandible represented as rigid bodies articulating at the temporomandibular joint, allowing for both rotation and translation. Masticatory muscles were modelled as strands with passive and active components (Hill-type muscle model), and muscle activation data was collected from *in vivo* studies. The modern human MDA model was then modified in a step-wise manner to add early *Homo* like features; this included human models with an erectus-type zygoma, erectus-type degree of prognathism, and erectus-type articular eminence morphology (with predicted joint translational capabilities). To do this a CT scan of KNM-ER 3733 (*Homo erectus*) was used as a reference. Bite forces at different gapes and maximum gape were recorded for each model.

Results indicate that compared to the modern human model, erectus-type prognathism resulted in increased incisal gape but decreased bite force capability, while erectus-type zygoma increased bite force. The erectus-type articular eminence morphology was not advantageous for bite force but was for gape, the steep articular eminence in the modern human jaw allowed for greater inferiorly directed translation, increasing muscle stretch which limited gape but increased bite force.

These findings show that reduced facial prognathism in modern humans decreases gape, whilst increasing bite force. This removes the need for flared and heightened zygomas for enhanced bite force production, but the reduction in maximum gape is not offset by the development of a steep articular eminence. This may also explain why previous predictions of performance capability in *Homo sapiens* have suggested that they are not disadvantaged compared to other *Homo* species. It also highlights the importance of investigating features in isolation and combination; in doing so we can gain invaluable insight into functional integration, adaptation, and constraints within the masticatory apparatus.

Poster Presentation Number 45, Session 1, Thursday 18:15

Foxes as a proxy for human activities in the past: Isotopic evidence from Southwest Germany

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Remains of arctic and red foxes (*Vulpes lagopus* and *Vulpes vulpes*) are known from almost every European Late Pleistocene archaeological site (about 100,000 to 13,000 years ago). Cut marks on fox bones indicate the use of fur and meat in all archaeological horizons of the cave sites of the Swabian Jura (Baden-Württemberg, Germany). Of particular interest in archaeological studies are their canines, originating from Aurignacian (about 42 to 34,000 years ago) and Gravettian (about 34 to 30,000 years ago) layers. The canines were perforated by early modern humans and most likely worn as pendants or ornaments on clothes. Foxes became increasingly important to humans as a resource from the Aurignacian to the Magdalenian (about 16 to 14,000 years ago), while in the Middle Paleolithic (layers older than 42,000 years) almost no fox exploitation could be proven [1].

To investigate the possible connection between fox ecology and human presence and activities, we used the analysis of stable carbon and nitrogen isotopes from the collagen of archaeological fox bones to reconstruct both the diet composition and the trophic niches of the foxes associated to different cultures. We could detect a change in their trophic behavior over time that is related to human occupation and hunting activities [2, 3]. We could identify three main feeding behaviors of pre-LGM foxes (Middle Paleolithic, Aurignacian, and Gravettian), one of them being influenced by humans [2]. Some foxes from the Aurignacian onwards showed synanthropic behavior, i.e., an adaptation to humans and their food resources, meaning already about 30,000 years before people became sedentary. For the Magdalenian, only one fox could be considered synanthropic so far. It was found in Kesslerloch Cave (Canton Schaffhausen, Switzerland) together with dog and wolf remains. Both the dog and the fox shared the same trophic niche and fed similarly at that site [3, 4].

New results on the compound specific nitrogen isotopic analysis of individual amino acids from foxes' bone collagen revealed another aspect of trophic synanthropes. We analyzed the nitrogen isotopic values of phenylalanine (Phe) and glutamine (Glu) amino acids from the collagen of three foxes from the Swabian Jura and calculated their trophic position (TP). The TP of one of the analyzed foxes (TP = 2.7, site = Vogelherd) coincided with the TPs of the analyzed humans from the same time and region (TPs from 2.6 to 2.9). This suggests that this red fox also fed on similar food resources as the humans in similar proportions of plants and meat. Our new results thus support the hypothesis that foxes gained access only through humans to resources they could not obtain previously. Combining isotopic studies with archaeological information allowed us to establish a positive correlation between the abundance of foxes and the intensity of human settlement, as well as the occurrence of synanthropic foxes with the human population density and the hunting pressure on the megafauna in that region [5]. Foxes can thus be used as a proxy for human hunting activities and population density. The opportunistic foxes reacted to the environment influenced by modern human behavior by adapting their feeding strategies already 40,000 years ago.

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Poster Presentation Number 44, Session 1, Thursday 18:15

Avian fauna and the lifeways of Middle Palaeolithic Neanderthals at Hohle Fels Cave, Swabian Jura, Germany

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The role played by birds in the lifeways of Neanderthals in the Middle Palaeolithic has received increased attention in recent years, with studies suggesting that they may have been exploited for both dietary and symbolic purposes (Gómez-Olivencia et al., 2018; Laroulandie et al., 2020). Evidence of Neanderthal bird use is, however, still largely limited to sites in Iberia, France, and Italy. This taxonomic and taphonomic study of avian remains from the Hohle Fels Middle Palaeolithic expands upon this burgeoning area of study by establishing whether similar trends in Neanderthal bird use can also be observed in the German Swabian Jura. Hohle Fels avian fauna was previously analyzed by Conard et al. (2013), however, at the time the Middle Palaeolithic had not been extensively excavated and the density of Neanderthal occupation and of bird remains was quite low. This new study focuses on two horizons excavated in the years following this original analysis: archaeological horizon (AH) VI, the last Neanderthal occupation horizon before the onset of the Upper Palaeolithic, and the recently excavated AH X, which is dated to > 64 ka cal. BP (Conard et al., 2021). These horizons are characterized by their disparate find density, with AH VI being relatively poor in anthropogenic finds and AH X being relatively rich.

The results of this study present, for the first time in the Swabian Jura, evidence for anthropogenic cut marks on avian remains in Neanderthal contexts. Both horizons present small numbers of anthropogenically cut avian material, however, there is significantly more anthropogenic cut material in the AH X. Exploitation in both horizons occurred almost exclusively on ducks, ptarmigan/grouse, and medium corvids – taxonomic groups seen exploited at other European Neanderthal sites. Furthermore, the anthropogenically denser AH X assemblage consists of more nutritionally valuable species (ducks and ptarmigans/grouse) than AH VI, suggesting that beyond the direct evidence for cut marks on material, the structure of the avian assemblage also shifts in relation to the level of Neanderthal occupational intensity.

Collectively the results of this study indicate that though birds were not a major component to the overall subsistence of Neanderthals, likely contributing very few calories overall, they were nonetheless exploited from at least ~64 ka cal BP to the end of the Middle Palaeolithic and that this exploitation rather than being purely based on random opportunistic encounter was focused on key taxa.

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Poster Presentation Number 86, Session 2, Friday 18:15

Interpreting morphological variation within the *Australopithecus* assemblage from Sterkfontein Member 4 (South Africa): where do we stand?

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Interpreting morphological variation within the early hominin fossil record is particularly challenging. Apart from the fact that there is no absolute threshold for defining species boundaries in palaeontology, the degree of variation related to sexual dimorphism, temporal depth, geographic variation or ontogeny is difficult to appreciate in a fossil taxon mainly represented by fragmentary specimens, and such variation could easily be conflated with taxonomic diversity. One of the most emblematic examples in paleoanthropology is the *Australopithecus* assemblage from the Sterkfontein Caves in South Africa. Indeed, the study of craniodental and postcranial remains yields interesting conflicting signals. On the one hand studies of postcranial remains or inner cranial structures with functional implications for locomotion, as the inner ear, suggest variable locomotor behaviour consistent with the presence of two species [e.g., 1-2]. On the other hand, studies of craniodental material suggest a polymorphic single species [e.g., 3]. Evidence supporting the presence of multiple *Australopithecus* species at Sterkfontein would deeply affect our understanding of early hominin taxonomic diversity, ecology and speciation.

In this contribution, I briefly summarize the ongoing debates surrounding the interpretation of morphological variation at Sterkfontein Member 4 before exploring two promising avenues that would deserve specific attention in the future, i.e., temporal depth and nonhuman primate diversity. Indeed, if we consider the deposits of Sterkfontein Member 4 span about 600,000 years [4], temporal depth might be considered as a factor acting on morphological diversity within the Sterkfontein *Australopithecus* hypodigm. Moreover, the assemblage of fossil papionins found in stratigraphic association with *Australopithecus* remains has the potential to clarify the polarity of the morphological variation reported and the evolutionary context [5]. In particular, I suggest that the degree of polymorphism at Sterkfontein may be compatible with an anagenetically evolving lineage that could be similarly observed in the *Australopithecus anamensis-afarensis* sample in eastern Africa. As a whole, the primate assemblage from Sterkfontein might thus reflect diachronic changes in adaptable evolutionary species.

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Poster Presentation Number 30, Session 1, Thursday 18:15

Similar lithic technology and behavior of Neanderthals despite the different climatic conditions of MIS 6 and MIS 5e

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The ROCEEH team presents the results of a study to assess whether and how climatic changes in Europe had impact on Neanderthal behavior. For this purpose, sites from MIS 6 as a distinct cold phase were compared with sites from MIS 5e as a distinct warm phase. The raw data for this analysis are stored in the ROCEEH Out of Africa Database (ROAD), a relational database that contains geographic data as well as detailed information about stone artifacts and other cultural materials (e.g., organic tools, ochre), features (e.g., hearths), faunal and botanical remains as well as indications about the climate. Only sites that are clearly stratified and whose strata are reliably dated were selected. Following these criteria, 53 assemblages from 36 sites dating to MIS 6 and 55 assemblages from 34 sites dating to MIS 5e were included in the analyses. Each of the 108 archaeological assemblages compiled this way is described by its archaeological properties (lithic artifacts, raw material transport distance, other cultural materials, hints at the use of fire, modification of animal remains) alongside its environmental setting (time period, biome, vegetation type). We also considered prey diversity and site functions as indicators of mobility.

Since the focus of the data presented here lies on the analysis of lithic assemblages, we concentrate on the archaeological indicators which we applied to the lithic record. To augment information on Neanderthal behavior, we first calculated stone tool diversity, the specialization index, the tool-flake-core ratio, and artifact density. With this foundation we performed explorative data analysis to test whether climatic fluctuations resulted in a response visible in the Neanderthals' mobility patterns, preference for tool types, or assemblage composition. Using Multiple Correspondence Analysis, we reduced the dimensionality of our dataset by projecting the archaeological data onto a continuous feature space and tested for underlying patterns (e.g., clusters related to time period, site function, etc.). Furthermore, we evaluated the association between archaeological items (e.g., 'hand axes' and 'splintered pieces'), items and categories ('fire' and 'site function'), or items and temporal periods ('scrapers' and 'MIS 5e') with the Frequent Pattern Analysis. This approach is very sensitive and takes into account the trade-off between the frequency of finds and the magnitude of association.

So far, our results seem to indicate an overall stability in the archaeological record and only slight technological changes despite distinctly different climatic conditions of MIS 6 and MIS 5e. We therefore conclude that the versatile Neanderthal tool-kit allowed them to sustain themselves in variable environments without considerably altering their technology and behavior.

Poster Presentation Number 91, Session 2, Friday 18:15

Investigating methods of soft tissue nasal approximation of extinct hominins

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Visual approximations of our ancient ancestors in museums and text books play an important role in education, and have a duty to not spread erroneous concepts about human evolution. Variability between hominin approximations of the same individual, produced by different practitioners, has become a recognizable problem. Currently there are no clear guidelines or consistently reliable methods that practitioners can use to translate the morphological features of the hominin skull into a facial approximation. By and large this practice has been taken on by artists whose methods are based on forensic craniofacial approximation techniques, observed similarities between species, and best educated guess based on what has been proposed in scientific data. Anthropologists in this field are calling to revise current methods with the aim to bring about biologically accurate reconstructions built upon strong scientific foundations [1].

Recent publications have shown a renewed effort in tackling this problem with the production of regression equations for approximating facial soft tissue thicknesses (FSTT) and the position of the nasal tip in Plio-Pleistocene hominids [2-3]. To build upon this work, this research uses 3D landmark-based geometric morphometric (GM) methods to study subtle shape differences between a sample of extant *Homo*, *Pan* and extinct hominins to estimate soft-tissue nasal shapes (STNS) for hominins as fully rendered 3D shapes.

To conduct an interspecies comparison, CT scan data was collected of 17 fossil hominins, 20 *Pan* (*P. troglodytes* and *P. paniscus*) and 400 modern human skulls from a diverse range of populations which were processed for GM analysis. A database of bony nose shape data was created from the sample and analysed using General Procrustes Analysis (GPA) which was used to quantify the distribution of the bony nose shapes. Principal Component Analysis (PCA) was used to describe the diversity of the shapes, and were visualised as principal components (PCs) of shape variation in 3D graphs. A Two Block Partial Least Squares Analysis was employed to find the pattern of covariation between the skin and bony landmarks of the extant populations after GPA.

Significant correlations between the landmarks of the skin and skull for the extant groups were identified, confirming FSTT covary with craniometric dimensions. Using the PCs drawn from the original bony landmark dataset the nasal shapes of the fossil hominins were found to share the same morphspace as some of the extant populations. For example, classic *H. neanderthalensis* La Chapelle-aux-Saints, shared the same morphspace as a particular female African population, and a Middle Pleistocene African *H. heidelbergensis*, known as Kabwe, share the same morphspace as some of the Oceanic and Alaskan populations. For the fossil hominins that were found to share the same morphspace as that of either specific individuals or an extant population mean, an estimated STNS was created using the tools available in GM analysis. Using Thin Plate Spline (TPS) to account for allometry, the extant individual's or an averaged population's mean STNS was warped onto the hominin skull using TPS interpolation.

For the hominins found to be linearly distributed between the morphspace of two groups, firstly the two bony datasets were run through PCA, and based on the shape variation the PCs predicted a warped bony shape which was analysed against the fossil hominin to confirm similarity. Secondly, the mean skin surface of the two datasets was also run through PCA and the same PCs applied to it, which after accounting to allometry, was fitted to the fossil hominin using TPS interpolation. Thus creating a unique hypothetical STNS.

Finally using the hypothetical STNSs, a regression equation for approximating nasal morphology of the fossil hominins was created to ensure an estimation method was freely available and testable.

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Poster Presentation Number 108, Session 2, Friday 18:15

Aggression and identity: from coping with environmental changes to modern human wars

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Over the past few millions of years hominins have seen rapid evolutionary changes resulting in a number of species that emerged and mostly disappeared again. Hominin evolution was accompanied by various large replacement waves, of which the emergence of anatomically modern humans is for us the most conspicuous. However, a range of smaller waves have also been recognised in the anthropological and archaeological record.

Evolution, the progressive change of the genetic signature of populations, leading to the emergence and demise of species is a result of two fundamental processes. The first is genetic drift in which new mutations slowly spread through a population. In physics, this is regarded as a "diffusional" process, as the distance a mutation spreads tends to be proportional to the square root of time. The effective diffusion rate is inversely proportional to population density. The rate at which advantageous (complexes of) mutations spread therefore decreases with increasing population density. The second is the expansion of populations at the cost of other populations: replacement waves. These can be termed "ballistic", as the distance of expansion of a population is approximately linear with time and is less sensitive to population density. Using basic physics theory and numerical modelling, we investigate the competition between the two processes on evolutionary patterns that result, as well as the behavioural traits that would optimise evolutionary success, in terms of gaining dominance in a variable environment.

Because genetic drift is slow in a large population, only genetic drift makes a population poorly adapted to changing (environmental) conditions. Migration waves allow sub-populations that happen to be competitive in changed conditions to advance at the cost of less competitive populations to the advantage of the overall species. Migration waves are thus a highly effective mechanism to adapt to change. This, however, comes at a cost, as it involves displacing and wiping out members of the same species. It requires a tendency or trait for aggressive behaviour to occasionally take possession of other individuals' property, land or even lives.

Numerical modelling, based on that of Bons et al. [1], indicates that concerted migration waves, such as that of anatomically modern humans conquering the world, require the capacity to restrict the aggressive behaviour to those who are sufficiently different. Otherwise, the aggression would also damage one's own community too much. Initially the required trait to recognise differences would have been restricted to biological traits. However, with the advent of cultural identity, the same fundamental trait would have included cultural identity as well, which intensifies the impact of this trait, enhancing assortative mating, as well as invading and usurping the land of neighbouring 'different' populations. An originally successful biological strategy of apes to cope with environmental changes may thus have led to our war-prone modern human society where identity is dominated by culture.

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Podium Presentati on Session 4, Thursday 16:50-17:10

New Evidence for the Middle to Upper Palaeolithic Transition Interval in the Danube Gorges of the Balkans

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Over the past few years, new investigations in northern Bulgaria at the site of Bacho Kiro have revived the likelihood that the "Danube corridor" [1] route served as a primary axis for the dispersal of modern humans into Europe. The association of modern humans with material remains of Protoaurignacian and Aurignacian provenance and/or transitional industries, would push the start of the dispersal across this region to 47 ka [2]. Furthermore, fossil remains from the cave site of Peştera cu Oase in the Romanian hinterland of the Danube Gorges area of the north-central Balkans provide genetic evidence of admixtures between Neanderthal and modern human populations [3] that might have taken place precisely along this transitory corridor. Yet, there is still relatively little in the way of evidence about, on the one hand, the last Middle Palaeolithic, and by proxy Neanderthal, and, on the other hand, the Initial and Early Upper Palaeolithic, and by proxy modern human, settlement of the region. Our recent investigations in the Danube Gorges area have brought to light two new sites, Tabula Traiana Cave and Dubočka-Kozja Cave, with Middle to Upper Palaeolithic deposits [4-5]. The application of modern standards of recovery and recording have enabled us to apply a suite of cutting edge and state-of-the-art methodologies backed by extensive radiometric dating of these sites' deposits. In this paper, we will present most recently obtained radiocarbon accelerator mass spectrometry (AMS) measurements, which allow us to discuss the chronological attribution of different levels of the two sites with more certainty. We will also offer further details regarding the knapped stone assemblages, including the results of use-wear analyses on a select number of artefacts. Finally, this evidence is integrated with the results obtained through the analyses of the faunal assemblages and by characterizing taphonomic factors that impacted their formation. Complementary data come from a relatively large pool of unidentifiable bone samples analyzed through the application of proteomic fingerprinting known as the Zooarchaeology by Mass Spectrometry (ZooMS), which has allowed us to better characterize the animal taxa composition of the faunal assemblages from the two sites and identify agents of bone accumulation. The results indicate a late continuation of the Middle Palaeolithic presence characterized by a Levallois-derived lithic industry at one of the two sites and the broadly contemporaneous appearance of the Early Upper Palaeolithic tools in the lithic assemblage of the other site. We discuss how the locations of the two sites in this specific landscape zone along the Danube might have influenced their respective uses.

Research at TT and DK caves was supported by the High-Risk Research in Archaeology grant of the National Science Foundation (BCS-0442096) in 2004, British Academy Small Grant 40967 in 2005, the McDonald Institute for Archaeological Research in Cambridge grants in 2005, 2008, and 2009, Cardiff University in 2013 and 2017, the NOMIS Foundation in 2019–2020, Marie Sklodowska Curie-IF Global Fellowship for the project "CUSP" G.A. 846856 in 2021–2022 (all to DB), and the European Research Council Starting Grant Project HIDDEN FOODS grant agreement no. 639286 (to EC) in 2017.

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Pecha Kucha Presentation Session 2, Thursday 11:55-12:20

Resolving the relatedness of the Neandertals from the Troisième caverne of Goyet using ancient DNA

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The Troisième caverne of Goyet is one of the richest Neandertal archeological sites in Belgium. However, the analysis of the Neandertal remains from this assemblage is challenging in that most of the 97 recently identified bone specimens were fractured by anthropogenic activities [1]. While approximately half of these fragments could be refitted to each other, ancient DNA (aDNA) provides a complementary approach to identify bone fragments that belong to the same individual. Additionally, aDNA also enables us to study the relatedness between such individuals.

We have screened 14 skeletal remains for aDNA preservation. We extracted DNA from samples ranging from 1 to 57 mg of bone or tooth powder, pre-treated approximately half of them with 0.5 % hypochlorite solution, and created single-stranded DNA libraries [2]. Using hybridization capture [3-4], we enriched the constructed libraries for human mitochondrial DNA (mtDNA) and a set of ~700,000 single nucleotide polymorphisms across the nuclear genome. We were able to reconstruct mtDNA consensus sequences of the 14 specimens and obtained genome-wide low-coverage data from seven (all below 1-fold genomic coverage).

Using a newly developed method for genetic kinship analysis [5], we identified two groups of specimens that were genetically identical, i.e., they either belonged to the same individual or stemmed from monozygotic twins. The first group consists of Goyet Q57-1, Goyet Q57-2 and Goyet Q57-3 (a femur and two tibias), and the second group consists of Goyet Q56-1, Goyet Q305-7 and Goyet Q374a-1 (a femur and two tibia specimens). These two groups of genetically identical individuals show no evidence for direct familiar relationship to each other. Lastly, we identified a third individual, which is represented by a fragment of a left tibia (Goyet Q305-4) and is not related to the first two. All three represent adolescent/adult individuals.

Two of the genetically-identical specimens, Goyet Q305-7 and Goyet Q374a-1, had previously been attributed to two different right tibias (Tibia III and V, respectively) [1], suggesting that they belonged to monozygotic twins. Although possible, the discovery of identical twins in the Neandertal fossil record seemed unlikely. We therefore re-examined the refitting of the bones, and found that Goyet Q305-7 had been erroneously refitted to Tibia III. We confirmed this result by obtaining mtDNA sequences from another fragment from Tibia III (Goyet Q54-4), and verified that it did not match the mitochondrial genome of Goyet Q305-7. Thus, Tibia III and V belong to different, genetically distinct individuals, and the refit was updated accordingly. Moreover, genome-wide data from Goyet Q54-4 suggests that this tibia belongs to the same individual as Goyet Q57-1, Q57-2 and Q57-3, and does not represent an additional individual.

This case study highlights the potential of aDNA to resolve uncertainties in the refitting of fragmentary skeletal remains and to infer which fossil belonged to which individual. Further work is underway to characterize the genetic relationships between the Goyet Neandertal individuals and other Neandertals from Eurasia for whom genome-wide sequence data is available in order to improve our understanding of Neandertal population history.

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Podium Presentation Session 6, Friday 11:40-12:00

An unexpected opportunity for early human settlement in Southeast Arabia 170 ka ago

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Due to supposedly hyper-arid conditions, it is often assumed that Arabia was unpopulated during marine isotope stage 6 (c. 190-130 ka). Paleoclimatic research, however, has shown that brief spells of more favorable climatic conditions occurred at about 170 ka and 150 ka. Whether human occupation was possible during these short phases of increased precipitation remains speculative, given the lack of archaeological evidence for this period. In this paper we will provide new chronometric and archaeological evidence from layers AH VII to V of the deeply stratified site FAY-NE1 at Jebel Faya in the interior of Sharjah Emirate (United Arab Emirates). This data deepens the site's occupation history into the Middle Pleistocene and reveals an unexpected occupation opportunity during marine isotope stage 6 at about 170 ka. Our data further indicates that human occupation of Southeast Arabia occurred more often than previously thought and was not restricted to prolonged periods of increased rainfall. Instead, it provides evidence that brief wet spells have played an important role on shaping human presence in Southeast Arabia during the Pleistocene. Lithic typo-technological data from layers VII and VI of the site's Shelter sequence, dating to c. 170 ka and 125 ka respectively, shows the co-occurrence of bifacial and Levallois technology in both assemblages, which indicates shared lithic cultural traditions among those groups settling at Faya in the late Middle and early Late Pleistocene. The geographic source region of those groups settling at Jebel Faya remains unknown, but given indications of shared technological traits, we conclude that our results support the idea of a population refugia in Southeast Arabia at the end of the Middle Pleistocene and the beginning of the Late Pleistocene. With this evidence for human occupation of Southeast Arabia during brief wet spells, our results fill in important gaps in the archaeological record and contribute to the growing awareness of complex histories of Paleolithic hunter-gatherer societies in Arabia.

Poster Presentation Number 97, Session 2, Friday 18:15

Reference database of teeth from the Family Bovidae: a supplemental method for identifying the bovids used in reconstructing past hominin environments

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Researchers typically rely on fossil animals in the Family Bovidae (antelopes and buffaloes) to generate African paleoenvironmental reconstructions. Bovids reflect distinct ecological adaptations in terms of diet, habitat, water dependence, and seasonal migrations that vary according to their respective ecological niches. Bovids have dominated the southern African fauna for the past four million years and, therefore, dominate the fossil faunal assemblages, especially isolated teeth. In addition, several studies have demonstrated that changes in the relative abundance of bovid taxa reflected in fossil assemblages are indicative of fluctuations in environmental conditions. Thus, bovid teeth are important sources of information for reconstructing the paleoenvironments associated with the fossil hominins.

Unfortunately, the taxonomic identification of these specimens is often imprecise and subjective, a difficulty exacerbated by the fragmentary nature of the associated assemblages. The ubiquity of isolated teeth means an analyst cannot always depend upon helpful identification characteristics such as a tooth row or molar row. In addition, biasing factors such as a specimen's age-at-death and degree of occlusal attrition often result in considerable overlap in absolute and relative tooth size and may further complicate taxonomic identification. Traditionally, researchers reference modern and fossil comparative collections to identify teeth. However, researchers are limited by the specific type and number of bovids at each institution. B.O.V.I.D. (Bovidae Occlusal Visual IDentification) is a repository of occlusal surface images of bovid teeth. The dataset currently includes extant bovids from 7 tribes and 20 species (~3900). B.O.V.I.D. contains two scaled images per specimen: a color and a black and white (binarized) image. The large sample size allows one to visualize the natural variation that exists in each taxa. The current sample will help researchers taxonomically identify extant and fossil teeth with modern counterparts. The binarized images can also be used in statistical shape analyses.

One of the main goals that we envisage for this database is to provide a training data set to build classification models using statistical and machine learning techniques. As a preliminary test, the binarized images were used as training data to train different machine learning models and the performance of these methods in terms of classification accuracy was evaluated. The coordinates of the edges of the binarized images were obtained using matlab. These coordinates were then processed to obtain size-and-shape information. Several different predictive models (SVM linear kernel, SVM radial kernel, random forest, xgboost) were analyzed and the classification accuracy of both tribe and species was evaluated individually by tooth type. SVM with a radial kernel outperforms the other methods in nearly every case. For tribe level classification, for SVM with a radial kernel we observe accuracy levels between 80%-90% in cross validation. For species level classification, we observe the same best method (SVM with radial kernel), and we achieve classification levels of 65%-75% accuracy for species level.

This current data is available in the Open Science Framework at https://osf.io/r5hsw/. B.O.V.I.D. is a valuable supplement to other methods for taxonomically identifying bovid teeth. As the database continues to grow, more taxa, both extant and fossil, will be available at bovid.lsu.edu.

We would like to thank the following people and agencies for generously granting us access to their comparative collections: Stephany Potze, Theresa Kierney, and Francis Thackeray of the Ditsong Museum; James Brink of the National Museum, Bloemfontein; Buyiswa Mahala of the Amathole Museum, King Williamstown; Bill Stanley and Rebecca Banasiak, Field Museum, Chicago. Special thank you to the following Louisiana State University students for their help in preparing the data for publication: Jenifer Davis, Emery Doga, Riley Kloostra, Kinsey Van Dyke, Jude Sterkx, Brynne Costarella, and Anna Legrand. We also thank Chad Caswell for structuring the database. Funding was provided by the Texas Academy of Science, Texas A&M Dissertation Research Grant, the College of Liberal Arts at Texas A&M, the Louisiana State University Manship Research Grant and NSF #1812065.

Poster Presentation Number 56, Session 1, Thursday 18:15

How cold was it at the Marathousa 1 Lower Paleolithic site (Megalopolis basin, Greece) during the hominin presence?

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Marathousa 1 is a key South European Lower Paleolithic site in Peloponnese (Megalopolis, Greece) that has been chronologically assigned to the glacial period of Marine Isotope Stage 12 (MIS 12 [1]). Systematic archaeological research in the Megalopolis basin documented the site as the earliest currently known evidence of human occupation in the region [2-3], but the paleoclimatic conditions at the time of deposition are not properly constrained yet. The presence of hominins at Marathousa 1 during this period is of great importance, especially in the context of their occupancy and survival during glacial conditions. Here we use biomarker analysis (glycerol dialkyl glycerol tetraether lipids-GDGTs) to track changes in the environment, such as: mean air annual temperature (MAAT), paleo-soil pH and organic matter input. Additionally, we use stable isotopes on plant waxes (δ13C and δ2H) to 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, covering the stratigraphic units UB10-UB1. Lipids were further extracted from the rocks using a Soxhlet apparatus and separated into fractions based on increasing polarity. The polar fraction containing GDGTs was analyzed using a double column HPLC and quantification was performed using the Analyst software. Our results indicate a major cooling episode affecting Megalopolis and, by extent, southern Greece, during the time of hominin presence, with temperatures as low as 4.5°C. This interval is characterized also by changes in the vegetation towards open landscapes, a response to moisture decrease in the catchment. The lowest registered temperature coincides with the archaeological horizon, indicating a direct link between the environmental conditions and the hominin presence in Peloponnese and quantifying for the first time the glacial conditions in southern Greece during MIS 12. The new data supports the hypothesis that the local climatic conditions at Marathousa 1 allowed the survival of hominins and other animal species during glacial intervals, acting as both climatic and geographic refugium. This has further relevance for human migrations and human evolution in South-East Europe, opening new research paths regarding the possible hominin presence in similar contexts and continuous presence in the basin.

The Marathousa 1 fieldwork investigations were conducted with the support of the Ephorate of Paleoanthropology and Speleology, Greek Ministry of Culture and Sports and were funded by the ERC Projects PaGE (ERC StG 283503) and CROSSROADS (ERC-CoG-724703) awarded to K. Harvati. GAB research is supported with DFG funds from 2021 Gottfried Wilhelm Leibniz Prize awarded to K. Harvati.

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Poster Presentation Number 98, Session 2, Thursday 18:15

Icex and Icv: two new digital tools for the automatic extraction and calculation of intracranial volumes

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The human cranium is a complex structure featuring several cavities and pneumatizations. Notable structures include the neurocranial cavity, the paranasal sinuses and the nasal cavity, and spaces of major functional importance, like the orbits and the upper oral cavity. As is the case for the accompanying bony structures, the constraints and spatial relationships of these cavities may elucidate functional demands, developmental patterns, and evolutionary implications. The methodological advances in virtual anthropology occurred in the last decades permit more detailed and non-destructive investigations of hollow cranial structures. The most common approach for their study involves a virtual 'extraction' of the cavities as 3D volumes, via manual segmentation, namely by individual labelling of the areas of interest on each image of a series (e.g., from computed tomography or magnetic resonance tomography). Although effective and widely used, manual segmentation is time-consuming and error prone [1-2]. To overcome these limitations, a number semi- and/or automatic software or algorithms have been proposed, each with its pros and cons. We present the combination and implementation of three of these methods (endomaker, CA-LSE and AST-3D) developed in R and embedded within the package 'Arothron'[3]. This new open-source tool, called *Icex*, includes an algorithm (*Icv*) for the automatic calculation of the inner volume of the cavity. In contrast to existing methods, it provides an automatic extraction and volume calculation of any hollow space. The volume is calculated via the building of a polygon (α-shape [4]) enclosing the cavity of interest (COI), so incomplete structures are encompassed, conveniently permitting the inclusion of material with discontinuous surfaces or poorly preserved inner structures. *Icex* requires a 3D mesh and simple landmark configuration as input data, the latter can be either a single configuration to extract all COIs or a smaller, COI-specific one. *Icex* has been validated on a sample of modern humans of differing ages and on a fossil human individual with successful extraction of the orbits, the frontal sinuses, the maxillary sinuses, the nasal cavity, and the upper oral cavity. For each individual in the sample, we analysed the relative (% of the total volume of COIs) and absolute (cc) volumes, highlighting their variation with respect to each other. The possibility to extract and calculate the inner volume of different cavities through a fast, easily reproducible application permits the exploitation of large databases thereby allowing more extensive evaluation of the developmental and/or evolutionary significance of hollow cranial structures.

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Poster Presentation Number 104, Session 2, Friday 18:15

The role of the cerebro-cerebellar network in creativity, prosocial behavior, and expert stone knapping

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Several recent studies [1] have demonstrated the critical role of the cerebellum and the cerebro-cerebellar network not only in its traditionally recognized control of gross and fine motor movements, but also its exaptation for basic and higher level cognitive abstractive processes, including creativity, prosocial behavior, and increasingly more sophisticated stone knapping (ovates, s-twists, fossil inclusions, variegated materials, etc.). This exaptation of the cerebellum involves the continual and interactive refinement of thoughts, images, and ideas just as it refines and smooths sequences motor movements. The cerebro-cerebellar network accomplishes these refinements by creating internal and implicit models of the world, as opposed to the external and explicit models of the cortex, and the blending of these two types of models [2]. Thus, the cerebellum's older evolutionary function in creating internal models that refine motor movements in stone tool production may have been exapted to create models of cognitive and social reasoning, which resulted in the better anticipation of others' responses during social interactions (i.e., higher levels of intentionality) throughout older and more recent hominin history. The cerebellar-creativity hypothesis proposes that the cerebellum creates a hierarchy of models with varying levels of abstraction. The cerebellum, in these internal model simulations (learning and predicting), appears to perceive the actions and thoughts of others, thus creating social interactions more quickly, efficiently, and appropriately. The cerebellum's predominant role in developing automaticity in motor and cognitive sequencing allows processing below the level of consciousness, which may help to explain how insight and creativity arise. The automaticity provided by the cerebellum derived from extensive practice in stone knapping may have freed Baddeley's central executive (in his multicomponent working memory model) from its attentional demands and allowed the mind "to wander and wonder," [1] thus making novel discoveries and/or new associations. It has also been aptly demonstrated that the cerebellum has expanded laterally and posteriorly in recent *Homo sapiens'* history [3]. Further, a new method of measuring the cerebral and cerebellar fossae was proposed [4], which documents the progressive importance of the cerebellar fossae throughout recent evolution, particularly on the left side (accentuated petalias). Recently, Zwir et al. [5] obtained similar results in which they identified genes that cluster in association only with *H. sapiens* (and not in chimpanzees or Neandertals) that are over-expressed in brain regions involved in creativity, prosocial behavior, self-awareness, and healthy longevity. These regions included the cerebro-cerebellar network among other cortical and subcortical loops. In this regard, the left cerebellar fossae were one of the most activated fMRI parts in modern humans' brains [4]. There seems to be little question of an evolutionary trajectory, not only of an increase in the relative size of the cerebellum in the *H. sapiens* but also its progressively important role in higher levels of cognitive processing, such as abstractive thinking and creativity. This trajectory may also manifest itself archaeologically not only through more sophisticated stone knapping, but also through depictive parietal art, highly ritualized burials, and imaginative figurines in the more recent history of *H. sapiens*.

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Podium Presentation Session 7, Friday 15:30-15:50

Neoplastic diseases and human evolution: new insights into its evolutionary history through a palaeopathological assessment of a 1.6 Ma robust australopithecine form East Turkana, Kenya

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Current research has evidenced that the antiquity of neoplastic diseases among hominins dates as far as 1.9 million years ago [1-2]. In addition, anecdotic scattered case-studies, theoretical approaches, and side identifications have proven that oncological conditions were a reality throughout the evolution of our lineage [3]. Although there is robust evidence to support this, the role of neoplasia in the context of hominin adaptation remains relatively unexplored.

Here we present evidence of neoplastic lesions from the African Pleistocene hominin record and discuss the methodological and theoretical challenges of studying this complex genetic condition. Key case-studies are presented, including the analysis of KNM-ER-406, a 1.6 Ma robust australopithecine skull discovered by Richard Leakey in 1969 in East Turkana, Kenya (Africa) [4]. We have conducted a macro- and micro-scopic assessment of a lesion present in the frontal bone of this specimen, which we interpret as a tumour (possibly a dermoid/epidermoid cyst, Differential Diagnosis: Osteoid Osteoma, Osteoblastoma), representing one of the oldest evidence of neoplastic conditions in human evolution. Its malignancy or benignancy is discussed through a differential diagnosis, and we further explore how a hunter-gatherer lifestyle is linked to epidemiological causes of neoplastic diseases, including malignancy. The case of KNM-ER 406 is compared to others from South Africa (i.e., *Paranthropus robustus*, SK 7923 1.8-1.6 Ma and *Australopithecus sediba* U.W. 88-37 1.7 Ma), and its evolutionary significance is considered given the anatomical location of the lesion.

The incidence of neoplastic diseases in early prehistory is a debated issue among the field of palaeopathology, with cancer commonly considered as a rare condition. The present contribution suggests that neoplasia, including malignancy, may have been a much more common disease in the past, potentially playing an important role in our evolutionary history.

The research has been funded by Ng'ipalajem (ERC) and TRAUMOBITA (MSCA) projects.

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Poster Presentation Number 24, Session 1, Thursday 18:15

Late Middle Paleolithic stone tool technology at the Oscurusciuto rock-shelter and its implications for the Middle to Upper Palaeolithic transition in the south of the Italian peninsula

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The end of the Middle Palaeolithic in Europe is marked by the emergence of major cultural shifts that are concurrent to the replacement of local Neandertal populations by *Homo sapiens* between 50 and 40 thousand years ago (kya).

This diversification of cultural trajectories at the end of the Mousterian cycle affects different regions of Europe. The Italian peninsula is a key region because it attests to some of the latest evidence of Neanderthal occupation, but also the presence of the Uluzzian tecno-complex related to *Homo sapiens* - which partially anticipated a wider technological replacement process that is later concretised with the onset of the Aurignacian industries.

Factors that have played a role in driving changes in Late Mousterian industries are hotly debated, as is the question of relationships between Europe's so-called transitional industries and the earliest Aurignacian industries.

During the last years the Uluzzian has catalysed attention in discussions about the demise of Neanderthals and the arrival of *Homo sapiens* in Italy, overshadowing the lesser-known technological variability which composes the late Middle Paleolithic of the Italian Peninsula.

Here, we report the results of the analysis of lithic stone tool technology from the latest layers preserved at Riparo l'Oscurusciuto in southern Italy (research directed by the University of Siena, DSFTA). These layers have been previously published as Late Mousterian on the basis of a preliminary techno/typological analysis of a small number of artefacts [1]. Our analysis of the entire assemblage(s) shows the presence of original technological features that cannot be associated with the classical definition of Mousterian. In fact, several techno-typological aspects match with some slightly older lithic assemblages found in south-eastern France – namely, the Neronian techno-complex of Grotte Mandrin and surrounding sites [2]. For the time being, the question of the meaning and/or origin of these similarities remains unanswered, and they can lend themselves to different interpretations: technological convergences, population movement, or indirect contact.

However, regardless of the intrinsic value of these similarities, our analysis of the Oscurusciuto lithics demonstrates that the trajectory of technological changes at the end of the Middle Paleolithic is far from homogeneous. The debate about the meaning of the diversity within and between the Middle and Upper Palaeolithic assemblages in Europe is far from over.

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Podium Presentation Session 3, Thursday 15:00-15:20

Dual genetic ancestries of the Late Glacial Palaeolithic in Britain

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In the last years, a number of studies have examined the genetic history of some of the earliest human groups in west Eurasia, uncovering large shifts in their genetic ancestry long before the emergence of agriculture. One such large genetic shift occurred sometime during the Late Glacial, between the end of the Last Glacial Maximum (LGM, ~23,400 cal BP) and the beginning of the Holocene (~11,700 cal BP). With approximately two-thirds of its landmass covered in ice during the LGM, a rapid de-glaciation thereafter, and its position at the far northwestern corner of the post-LGM expansion of human groups, Britain provides a unique environmental context through which Late Upper Palaeolithic populations can be studied. However, to date, no genetic data has been obtained from Upper Palaeolithic individuals from Britain due to the scarcity of human skeletal material.

Gough's Cave and Kendrick's Cave represent two from a total of six archaeological sites in Britain from which human skeletal remains have been recovered. The two sites, although close in time, show stark differences in their mortuary practices. While Kendrick's Cave has been interpreted as a burial site, the human remains from Gough's Cave show extensive human modification which has been interpreted as evidence of cannibalism.

A human temporal bone from Gough's Cave, dating to 15,100-14,850 cal BP, and a mandibular first molar from Kendrick's Cave, dating to 13,800-13,350 cal BP, were targeted for downstream DNA analyses. Between 27 and 30 mg of bone or tooth powder was used for DNA extraction using a modified version of the protocol designed for the recovery of ultra-short DNA fragments. In total sixteen double stranded and double indexed DNA libraries were prepared and sequenced on a HiSeq 4000 Illumina platform (2x100bp).

We reconstructed full mitochondrial genomes of the two individuals to the 54 and 35-fold coverage. The mitochondrial genome of Gough's Cave individual belongs to the haplogroup U8a (0.97 posterior support), and the Kendrick's Cave individual to the haplogroup U5a2 (1.0 posterior support). The U8a haplogroup has not been detected in early prehistoric individuals in Britain previously, but has been identified in Magdalenian individuals elsewhere in Europe. Furthermore, we recovered in total ~67 and ~60 million nuclear DNA fragments from Gough's Cave and Kendrick's Cave individuals by a direct shotgun sequencing, amounting to an average genomic coverage of 0.53 and 0.48-fold, respectively. By comparing the number of DNA fragments that align to the X and Y chromosomes, we determined that the individual from Gough's Cave was female, and the individual from Kendrick's Cave was male. Furthermore, we compared nuclear DNA data from Gough's and Kendrick's Cave individuals to a broader set of ancient and present-day humans. Using f-statistics and admixture modelling with qpWave and qpAdm, we found that the individual from Gough's Cave traces all her genetic ancestry to largely Magdalenian-associated individuals closely related to those from sites such as El Mirón Cave, Spain, and Troisième Caverne of Goyet, Belgium. In contrast, the Kendrick's Cave individual traced his genetic

ancestry to groups who expanded across Europe during the Late Glacial, which replaced the ancestry of Magdalenian-associated individuals, and which were represented at sites such as Villabruna Cave, Italy. Taken together, these results indicate the presence of two genetically distinct human groups in Britain during the Late Glacial period, and which also differ in their mortuary practices, potentially as little as ~600 years apart. We thank Conwy County Borough Council and Llandudno Museum for permission to sample the Kendrick's Cave material, and the Longleat Estate, Natural History Museum London, and Heather Bonney for access and permissions to sample the Gough's Cave material. We also thank Catherine Rees for discussions on the excavation history of Kendrick's Cave, and Christopher Bronk-Ramsey for advice on OxCal modelling. R.E.S., S.C., H.R., J.T., S.B.G., I.B. and R.K. were supported by an ERC Consolidator Grant awarded to R.E.S. (Grant No. 617777). S.B.G. was supported by the German Research Foundation (DFG, German Research Foundation, Project Number 2901391021-SFB 1266). I.B., T.B. and S.B. were supported by a Wellcome Trust Investigator Award (Project No. 100713/Z/12/Z). C.S., I.B. and S.B. were supported by the Calleva Foundation. C.S was supported by the Human Origins Research Fund. M.H. was supported by Marie Sklodowska Curie Actions (grant no. 844014). P.S. was supported by the Vallee Foundation, the European Research Council (Grant No. 852558), the Wellcome Trust (217223/Z/19/Z), and Francis Crick Institute core funding (FC001595) from Cancer Research UK, the UK Medical Research Council and the Wellcome Trust.

Poster Presentation Number 22, Session 1, Thursday 18:15

What does a hybridized technocomplex look like? The Middle to Upper Paleolithic transition in Romania

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Since the proliferation of the single origin hypotheses, models of human migration into Europe have been built upon the notion that incoming modern humans effectively replaced indigenous hominins, potentially aided by allochthonous technological advances. During this period, approximately 50–40 thousand years ago, novel technologies that incorporate and synthesize elements of Middle and Upper Paleolithic technology are implicated in indigenous population replacement, the cultural intermingling of discrete hominin demes and/or the diffusion of developing technologies by modern humans. These technological packages, labeled either Transitional or Initial Upper Paleolithic, appear to be both chronologically and regionally bound and manifest in distinct spatiotemporal patchworks that reflect technologies potentially indicative of early incursions or discrete encounter events. In Central and Eastern Europe, a key intersection point of the continent, several industries such as the Szeletian, the Bohunician, among others, are known. The Late Pleistocene record of Romania forms an anomalous situation in these scenarios. On the one hand, the country has important Pleistocene fossil archives that preserve direct evidence of early modern humans with Neandertal genetic introgression. On the other hand, Romania shows no evidence of intermediary technology across the Middle-to-Early Upper Paleolithic transition. Here, we critically review the Middle-to-Early Upper Paleolithic archeological record of Romania with newly obtained radiocarbon ages from legacy sites and new excavation data to clarify the validity of the current archeological interpretations. We conclude that while Neandertals and modern humans were regionally in contact, raw material idiosyncrasies and incomplete empirical knowledge of past intergroup cultural transmission have obscured our ability to identify indicative material cultural signals implying that current methods of understanding hybridized material cultural material are incomplete.

Poster Presentation Number 19, Session 1, Thursday 18:15

Spatially distinct recycling behaviors among surface deposits at a Paleolithic site complex, Semizbugu, Kazakhstan

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Stone tool recycling, despite its many known cases in prehistory, often plays a relatively small role in the interpretation of the archaeological record. This is problematic because recycling can significantly alter the temporal span and appearance of archaeological assemblages because it combines behaviors across time at multiple scales. Consequently, we need to develop robust models for understanding the occurrence of stone tool recycling in the archaeological record. However, our current models rarely consider factors affecting recycling beyond raw material access. Furthermore, our development of new models is limited by the current focus on identifying chronological differences in recycling from stratified deposits.

A new analysis of material from Semizbugu, a Paleolithic surface site complex in Kazakhstan, was undertaken to study spatial distributions of recycled artifacts in order to determine what conditions promote or discourage the occurrence of recycling behaviors across a landscape. Analysis concentrated on identifying instances of double patina, where artifacts have been retouched after their surfaces have been weathered. Double patina reliably indicates that the artifacts have been recycled [1]. Length, width, thickness, weight, amount of cortex, morphological characteristics, and weathering stage of artifacts were also recorded.

We identified consistent recycling behaviors in the Semizbugu deposits, despite the abudance of local raw material [2]. We also found significant differences in the types and size of artifacts with recycling signatures between different locations within the site complex. These results are surprising because the distance between artifact deposits at Semizbugu fall within the range of measured and estimated daily ranges of hunter-gatherer populations. The patterns of recycling at Semizbugu, therefore, indicate the presence of local-scale factors unrelated to raw material access that cause areas of the landscape to be used differently in a recycling regime.

Despite the spatial differences in the morphologies of recycled objects, recycling signatures occurred consistently on mildly and strongly weathered artifacts. At surface sites characterized by geological stability like Semizbugu, weathering stage corresponds to how long artifacts have been exposed. This means that there is a positive relationship between the amount of time artifacts have been available for scavenging on the surface and the likelihood of them being recycled. This is consistent with the hypothesis posited by Camilli and Ebert that exposed deposits should be more subject to recycling because exposure facilitates the discovery of artifacts by making them visible [3].

Studying surface deposits like Semizbugu is essential for furthering our understanding of recycling behaviors. Surface sites allow archaeologists to investigate regional spatial patterning of behavior, a perspective that is inaccessible at sites with significant sediment accumulation and clear boundaries [4-5]. The results of this analysis of recycling at Semizbugu demonstrate the necessity of updating our model of stone tool recycling to included factors related to exposure of artifacts and the variable use of space by mobile human groups. For this reason, this project represents an important first step to properly investigating the full extent of variation in recycling behaviors in prehistory.

This material is based on work supported by the National Science Foundation under Grant No. 2133751. Funding for this work was also provided by the Leakey Foundation, the Fulbright U.S. Student program, and the Ranieri International Scholars Fund. Access to the collections and data collection in the field was made possible with the support of the A. Kh. Margulan Institute of Archaeology and the Museum of the Paleolithic of Kazakhstan at Al-Farabi Kazakhstan National University.

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Poster Presentation Number 87, Session 2, Friday 18:15

An overlooked *Australopithecus* brain endocast from Makapansgat, South Africa

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Makapansgat Limeworks Dump (MLD) yielded a startling amount of well-preserved Plio-Pleistocene hominin fossils from the Cradle of Humankind in South Africa in the 1940s–1950s. While many MLD hominins have been extensively studied, under-appreciated in this assemblage is MLD 3, a nearly complete right parietal bone and its complete natural endocast of an immature hominin. Importantly, MLD 3 preserves parietal lobe impressions that are not represented in the Taung child and other australopith endocasts. However, no analysis of the MLD 3 endocast has been published despite its discovery over 70 years ago. We therefore revisit this unique specimen, providing a detailed description and comparison of the endocast. We analysed the MLD 3 parietal bone and natural endocast using virtual imaging methods. We generated 3D maps to visualise surface topography, implemented an algorithm to automatically detect 3D surface features, and compared MLD 3 with other South African fossil hominins. Although MLD 3 suffered taphonomic flattening near bregma, endocranial surface topography is well preserved. The endocast presents a simple pattern of middle meningeal vessels, and clearly discernible cerebral impressions. The inferior precentral sulcus traverses the coronal suture, an ancestral morphology that is documented in other *Australopithecus* and Early *Homo*. In contrast, a well-defined lunate sulcus is located in a posterior position near the lambdoid suture, accompanied by an angular gyrus impression suggesting a derived morphology. The MLD 3 endocast confirms previous suggestions that the lunate sulcus is not fully preserved on the Taung natural endocast. However, the lunate sulcus of MLD 3 is in a similar position as that of SK 1585, the only other South African hominin endocast to preserve this feature. These two fossils suggest cerebral reorganization in small-brained hominins had begun over two million years ago. MLD 3 underscores the fact that fragmentary fossils discovered decades ago still have much to offer modern paleoanthropology.

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Poster Presentation Number 68, Session 2, Friday 18:15

CAVEWEST: A Database for Cave Research and Management in the Western Cordillera of North America

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In this poster, we outline a new interdisciplinary research project called CAVEWEST. The project is inspired by recent efforts to document caves in South Africa's Cradle of Humankind World Heritage Site, which have yielded spectacular results. It is our intention to apply a similar systematic approach to the Western Cordillera of North America.

The Western Cordillera is a system of mountain ranges that extends from the US state of Alaska to Mexico's southern border. There are three main belts of mountains in the Western Cordillera: the Pacific Coast belt in the west; the Nevadan belt, which is in the middle and includes the Sierra Nevada; and the Laramide belt, which is in the east and is dominated by the Rocky Mountains. All three belts generally run north to south.

Currently, the caves of the Western Cordillera are not well documented. Basic data relating to their characteristics, as well as the type and significance of the archaeological, palaeontological, and palaeoenvironmental evidence they contain, are highly variable and poorly integrated. Information is scattered across numerous formal and informal sources, which presents a major impediment to scientific research, the management of cave-related natural resources, and the protection of cultural heritage. Remarkably, we do not even have a rough estimate of how many caves and rockshelters have been discovered in the Western Cordillera.

With the foregoing in mind, CAVEWEST has two aims. One is to create a baseline database of information that is pertinent to research on, and management of, the known caves and rock shelters in the Western Cordillera from Alaska to the USA's southern border. The second aim is to develop a network of Institutional Partners. These will include archaeological research centers, Indigenous organisations, and recreational caving clubs. The Institutional Partners will participate in the selection of the variables for which data will be collected, and in the design of the protocols for how the database will be accessed and shared. In addition, they will be the database's primary users when it is complete.

Once finished, the database will help 1) clarify the nature and extent of caves and cave resources; 2) improve the broader-scale understanding of caves and cave-use; 3) facilitate new investigations of cave-sites and the materials recovered from them; 4) assist with cultural heritage and land-management decisions where caves are located; 5) improve cooperation and collaboration between cave-related stakeholders; and 6) shed light on a number of archaeological and palaeontological research topics. The most important of the latter is probably the colonisation of the Americas by humans during the Pleistocene. Currently, researchers disagree about whether the colonisation event occurred 15,000 years ago, 21,000 years ago, or 30,000 years ago. To resolve this debate new data are needed and the caves and rockshelters of the Western Cordillera are an obvious potential source for such data.

In the past 18 months, a part-time postdoctoral research assistant and an undergraduate volunteer have collected data on more than 850 cave sites in Alberta, British Columbia, The Northwest Territories, The Yukon, and Alaska. We have also been able to recruit several Institutional Partners, including the Alberta Speleological Society, the Center for the Study of the First Americans at Texas A&M University, the Royal Alberta Museum, Sealaska Heritage, and the Union Internationale de Spéléologie. Given the short time devoted to data collection and network-building so far, we believe this represents an excellent proof-of-concept. Accordingly, we are now in the process of applying for grants from government agencies and charitable organisations to support CAVEWEST.

We are actively recruiting Institutional Partners, so if you represent a relevant organisation and are interested in getting involved with the project, please contact Dr. Marina Elliott at mce4@sfu.ca.

Poster Presentation Number 102, Session 2, Friday 18:15

The role of the retrosplenial cortex in the emotional regulation of diplomatic speech

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The retrosplenial cortex (RSC), part of the inferior parietal lobule and located in the posterior region of the cingulate cortex, has been touted for its critical role in navigation, especially navigating de novo environments, and in spatial, episodic, and autobiographical memories. The purpose of the present paper is to hypothesize a heretofore unrecognized role the RSC might have played in the regulation of emotions, particularly those required for successful diplomatic negotiations, such as long-distance trading or mating with distant outgroups. The RSC is well-known for its translational functions between egocentric (relationships between the self and objects in the environment) and allocentric (viewpoint-independent relationships) frames of reference. Vann et al. [1] determined that place and grid cells of the hippocampus index locations contained within episodic or autobiographical memories while the RSC then translates these indexes into egocentric information such that a location in a memory may be then be viewed from alternative points of view. The RSC may also act as a short-term storage buffer as the information is being translated. It is little disputed that emotional states may bias decision-making [2]. The latter may be especially pertinent in diplomatic negotiations. Webb et al. [3] have empirically substantiated the relationship between emotional control goals (e.g., I will not get angry) and emotional outcomes (e.g., anger and aggression) and their subsequent regulation. In samples of purportedly normal adults, they found traditional techniques that helped regulate behavioral goals were highly successful in the regulation of emotional states. These techniques included forming future implementation intentions, i.e., creating "if-then" contingency plans for future actions. However, there are a number of mediating variables in if-then planning, and one of the most important of them resides in egocentric versus allocentric viewpoints. For example, King et al. [4] found empirical evidence that autobiographical (sense of self) memories contain both episodic and declarative/semantic specific information. More importantly, autobiographical memories can be recalled from an egocentric or allocentric perspective. They found that when autobiographical memories were recalled from an allocentric perspective there was a reduction in the emotional valence of the memory, which theoretically would reduce personal bias and distortions in simulations of the future. Importantly, they found no significant differences in the objective content in the recall of egocentric versus allocentric autobiographical memories. As has been previously noted [5], diplomatic or indirect speech requires adequate phonological storage and working memory capacity, recursive inner speech (if-then or what-if contingencies), and higher levels of Theory of Mind (reading the attitudes and intentions of others). Thus, the regulation of emotions in future-oriented diplomatic simulations would have been enhanced by the ability to engage in allocentric rather than simply egocentric perceptions of those negotiations. Thus, the RSC may have a played a broader role in human evolution than simply de novo navigation, as future-oriented simulations, i.e., thought experiments, more often avoid the dangers of trial-and- (and sometimes) fatal error or failed negotiations.

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Pecha Kucha Presentation Session 9, Saturday 9:40-10:05

Does the Energetics of Gestation and Growth (EGG) refute the obstetrical dilemma hypothesis?

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A hallmark of modern humans is our relatively large brain size. It not only consumes one fifth of our energy, but the head also forms the largest diameter of the body in newborns, thus contributing to the unique difficulty of human birth when compared to other mammals [1]. Nevertheless, newborn brain size makes up a significantly smaller percentage of adult brain size than in non-human primates. The "Energetics of Gestation and Growth" (EGG) hypothesis proposes that maternal metabolic limitations are responsible for the neurological immaturity and secondary altriciality of human neonates, thereby governing birth timing [2] rather than mechanistic pelvic constraints related to bipedalism as traditionally suggested by the obstetrical dilemma hypothesis [1]. Specifically, the EEG hypothesis suggests that the energetic demands of the fetal brain grow exponentially, and labour is initiated when fetal energy requirements exceed the maximum maternal metabolic capacity, which is presumed to be around 2.1 × basic metabolic rate (BMR). However, the assumptions of the EGG hypothesis only rely on metabolic data derived from one study that included 12 pregnant women in the UK. Moreover, recent findings in athletes suggest a higher maximum sustained metabolic scope of approximately 2.5 × BMR (extrapolated to a 180-day-long endurance event such as pregnancy) [3]. Here, we analyze the metabolic data of 12 additional studies in pregnant females with a diverse geographic and socioeconomic background (see review in [4]). These data show considerable variability of total energy expenditure and BMR with the maximum energetic requirement of the expectant mother ranging between 1.6 and 2.4 × BMR. The higher end of this range, however, is unlikely to be crossed around the time of birth by fetal energy demands [1]. Moreover, in the same studies the additional maternal energy requirement in the last weeks before birth compared to non-pregnant, non-lactating females ranges between 70 and 723 kcal/d. This high variability in both sustained maternal metabolic scope and additional maternal energy requirements is not similarly reflected in the variability observed for birth timing. Therefore, we conclude that pregnancy may not pose an energetic constraint in humans, nor does the placenta seem to constitute a significant energetic barrier. This is also supported by recent gestational weight gain and body composition data of human females [5]. Further, we suggest that pregnant women have developed different strategies to either lower their own energy requirements to offset the growing fetal energy requirements or to cope with the overall additional energy requirements. Additionally, the maximum metabolic scope in the women analyzed was observed four to five months after birth, when humans generally start to supplement the nutrition of neonates with other foods thus implicating lactation as the potential limiting factor. Conversely, the benefit of a presumed metabolic ceiling during pregnancy is unclear from an evolutionary perspective. Multifactorial explanations for the unique birth difficulties of modern humans are therefore required that simultaneously consider both obstetric selection and metabolic mechanisms as the two are likely not mutually exclusive.

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Pecha Kucha Presentation Session 9, Saturday 10: 05-10:30

The impact of cooperation under climate constraints: an agent-based model perspective from the Palaeolithic of Kazakhstan

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Human dispersal into northern latitudes during the last glacial cycle was an impressive feat of adaptation, which remains partly unexplained. Central Asia, with its cold and arid climates and harsh environments, all of which were exacerbated by Pleistocene climatic oscillations, presents an ideal laboratory for testing hypotheses about the role of human behaviour in dispersal under adverse conditions. Unfortunately, the archaeological data from this period are still very sparse. Therefore, computer models can provide an alternative for exploring different scenarios. We present here an evolutionary Agent-Based Model exploring the effect of behavioural adaptations in hominins under different climate scenarios in Central Asia (Kazakhstan).

Following Henrich et al. [1], our study uses an evolutionary model to test the cooperative dilemma (whether to cooperate or not) based on two social mechanisms: a) cost to maintain cooperation in hominins and punish non-cooperators, and b) cultural transmission where most hominins adopt common behaviour (conformist transmission). This evolutionary model will be exposed to different climate scenarios to understand how cooperation strategies can be affected by extreme conditions.

Our model uses new survey data from archaeological sites in two different regions (the Altai and Tian Shan (Kazakhstan)) gathered during fieldwork from 2013-2019. Here we propose four climate scenarios for each region based on the average temperature (BioClim variables) during glacial and interglacial periods [2]: a) a glacial scenario characterised by the annual mean temperature; b) a glacial scenario characterised by the mean temperature of the coldest quarter; c) an interglacial scenario characterised by the mean temperature of the coldest quarter; and finally, d) a glacial scenario characterised by the mean temperature of the warmest quarter.

The model simulates human-environment interactions, where groups try to find more resource-attractive places in the landscape while interacting to compete for resources. We compare how extreme climate scenarios affect human cooperation depending on the different regions and climates in which hominins are found.

Preliminarily, the model shows that: a) population size can significantly influence the pressure on the group to adopt cooperative or non-cooperative behaviour, such that a higher population could imply more pressure to cooperate, b) cooperative behaviours could be significantly affected by climate change, with a high probability of survival in the harshest conditions only when hominins are mostly cooperative, and c) if the initial probability of non-cooperation is higher, then human groups will tend to be no-cooperative even if a cooperative subgroup pushes them to cooperate.

In conclusion, we discuss the model's implications for the likelihood of finding Palaeolithic sites in different periods and provide a baseline for future work on dispersal and behavioural adaptations in the region.

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Poster Presentation Number 29, Session 1, Thursday 18:15

The RINO project: 'The use of Rhinoceros teeth for Industry among Neandertals: an Original behaviour?'

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Unlike for other megaherbivores, such as mammoths or elephants, the role of rhinoceroses in the subsistence and technology of past hominins has only been marginally explored. Osseous industries from the Lower Palaeolithic in Europe include large flaked tools made of Proboscidean bone and bone fragments of various large mammals used as hammers and retouchers [1-2]. Recently, we identified percussion marks on rhinoceros dental remains from the Middle Palaeolithic site of Payre, Ardèche, France, that could indicate their use as implements by Neandertals [3]. To our knowledge, the only two other cases of suspected use of rhinoceros teeth are from the sites of La Caune de l'Arago (MIS 12) in southwestern France [4] and Panxian Dadong (MIS 7-5) in southwestern China [5].

Although rhinoceros remains are relatively common at Western Europe Middle Palaeolithic sites, the exploitation of these species (*Coelodonta antiquitatis*, *Stephanorhinus hemitoechus*, *Stephanorhinus kirchbergensis*) by hominin groups has not been documented in detail. Rhino remains are often found in small quantities, in the form of fragmented bones and isolated teeth, which often makes it difficult to confidently establish the agent responsible for these accumulations. The identification of anthropogenic modifications on these remains can shed light on acquisition processes, either through hunting or scavenging, and the subsequent exploitation of animal resources. The frequent contrast between the high number of isolated teeth and the few post-cranial remains is puzzling and does not appear to result from differential preservation for this type of very large herbivores .

Payre is an archaeological site located on the right bank of the Rhône valley, dated to the end of the Middle Pleistocene. At this site, most of the rhinoceros remains result from intentional transport and exploitation by Neandertal groups. Isolated dental remains bear modifications that do not correspond to natural or post-depositional alterations. Their analysis rather suggests that these marks are of anthropogenic origin. The purpose of these modifications is however still unclear. The RINO project aims to document and understand the origin and purpose of these modification in order to reach a better understanding of rhino-Neandertal interactions. More specifically, we wish to address the following questions: Are rhino teeth with anthropogenic modifications found at other Palaeolithic sites? Are these practices widespread or limited to particular regions , periods or rhino species? Is this behaviour specific to Neandertals? With this goal in mind, we are in the process of examining large bone assemblages of the three Late Quaternary rhino species coming from twenty archaeological and palaeontological Pleistocene sites located in Western Europe (France, Spain, Luxemburg). These analyses have already provided data on the exploitation of rhinoceroses by Neandertals and may document the use of dental remains as tools. This project will also include an experimental component to identify the technical strategies for using these elements (gestures, purposes, etc.), as well as the type of raw material that produced the use-marks. The project results will have implications for our understanding of Neandertal cultural adaptations, innovations and symbolic behaviour. We expect that the project will also provide new data on the cognitive capacities of these hominins and their relationship with the environment, and megafauna in particular. The multidisciplinary and international nature of the project, which brings together zooarchaeologists, taphonomists, dental-wear experts, lithic specialists, palaeontologists and eco-ethologists is creating new links or reinforcing existing networks between institutions and individual researchers.

We thank the French Ministry of Culture and Communication (by the Regional Office of Archaeology Rhône-Alpes), and the Ardèche Department for financial support for fieldwork at Payre. We thank the Department "Homme & Environnement" of the Muséum national d'Histoire naturelle, and Sorbonne Université for financial supports of the RINO project. We would also like to thank the Cité de la Préhistoire of Orgnac, the Natural History Museum of Luxembourg, the Musée archéologique and the University of Strasbourg, the Institut de Paleoecologia Humana i Evolució Social (IPHES), the Centro Nacional de Evolución Humana (CENIEH), the Universitat de Barceolona (UB) and the Musée national de Préhistoire of Les Eyzies de Tayac, and especially S. Madelaine, for access to the material and study facilities. Finally, we thank the zoological parks of Peaugres and Montpellier in France for the supply of rhino dental remains for the experiments. The English manuscript was edited by L. Byrne.

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Poster Presentation Number 5, Session 1, Thursday 18:15

New insights on the Upper Paleolithic site of Lagar Velho rockshelter (Lapedo Valley, Portugal)

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The Lagar Velho rockshelter, located in the Lapedo Valley (Santa Eufémia, Leiria, Portugal), has preserved an extremely important archive on AMH (anatomically modern human) biology and culture, enhancing the knowledge of Early Upper Palaeolithic in SW Europe [1-2]. The burial of the Lagar Velho child (LV1; c. 29 ka cal BP), following the funerary practices recorded in several European contexts dating from the Gravettian technocomplex, and the excavation of the particularly well-preserved EE15 occupation surface (c. 27 ka cal BP), are major testimonies of the life and death of the Gravettian groups in this part of the continent. Recent investigations carried out at the site since 2018, 20 years after its discovery to Archaeology , have shown that the infant burial was not a single event (an isolated episode), as thought at the time on the basis of the available data, but most likely occurred during a Gravettian occupation of the site 29000 years ago. In fact, excavation of the sediments underlying EE15 revealed traces related to an earlier occupation of the shelter, contemporaneous with the child interment in radiocarbon terms (c. 29 ka cal BP). This data obviously has implications for the anthropological interpretation of the event.

These remains have been retrieved in a sector of the rockshelter located 10 meters to the west of the burial and define layer 143. Although our results are still very preliminary (several archaeological and geoarchaeological analyses are in progress, mostly related to the formation processes of layer 143) and further radiocarbon dates are needed (also in progress) we point to the presence of a palimpsest resulting from successive human activities. After the group's departure, the same area was then used (sequentially) by other biological agents, as shown by carnivore remains, coprolites and gnawing damage on bones. Most part of bones recovered in layer 143 present different degrees of thermoalteration, from slightly burnt to calcined. Abundant burned bones are well documented in other Palaeolithic sites mostly related to rigorous climatic episodes and scarce wood supply, suggesting the use of bone as fuel. However, the palynological record of layer 143 (based on pollen capsulated in coprolites) points to a semi-forested landscape [3] in agreement with the zooarchaeological record. Red deer is the dominant taxon, followed by taxa related to more dense forests, such as wild boar and roe deer. The open environmental taxa (e.g. equids and aurochs) are much less frequent.

From among the dataset recorded in layer 143, what can be used to make more substantive the hypothesis of its contemporaneity with the child burial is one of the challenges we want to address.

This study is part of the output of a research project entitled: "O Abrigo do Lagar Velho e os primeiros humanos modernos do extremo ocidental europeu" (PIPA 04/2017- Direção-Geral do Patrimonio Cultural, Portugal). The archaeological fieldwork at Abrigo de Lagar Velho had financial support from the Leiria Municipality and Museum. The development of this work was supported by the projects: i) Apoio financeiro extraordinário a projetos de investigação plurianual em arqueologia (2021); ii) the International Research Network (IRN 0871CNRS-INEE): Taphonomy European Network (TaphEN); iii) Las sociedades cazadoras-recolectoras del Paleolítico superior y los primeros humanos modernos en Portugal (T002020N0000045536). J. Daura count on the Ramon y Cajal (RYC-2015-17667) postdoctoral contract. We extend our thanks to Vânia Carvalho.

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Poster Presentation Number 84, Session 2, Friday 18:15

Enamel-dentine junction morphology in *Australopithecus sediba*

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The hypodigm of *Australopithecus sediba* includes two partial skeletons (MH1 and MH2) from Malapa, South Africa, dated to 1.977 Ma [1-2]. The relationship between *A. sediba* and other hominin taxa remains unresolved, although there are similarities across the skeleton with *Australopithecus africanus*, and some features suggested to resemble early *Homo*. Studies of dental morphology are useful in resolving issues of hominin systematics, and both MH1 and MH2 preserve large portions of the dentition. Previous analysis of the enamel surface morphology of these teeth suggest that they resemble those of *Australopithecus africanus*, but are distinguished from this taxon by the small size of the teeth [3-4]. Studying the internal morphology of hominin teeth can provide additional taxonomically relevant information, particularly in the case of worn teeth (as in MH2) [5]. Here we investigate the enamel-dentine junction (EDJ) morphology of *A. sediba*, examining the EDJ expression of a number of important discrete traits, as well as quantifying overall tooth morphology using geometric morphometrics and comparing to *Australopithecus africanus*, *Paranthropus robustus*, *Homo habilis* and *Homo erectus*.

We find that the shape of the postcanine teeth of *A. sediba* is most similar to *A. africanus* overall, including in the maxillary third molars which provide good distinction between *A. africanus* and early *Homo*. However, as previously noted, the *A. sediba* teeth are very small. In the MH1 maxilla, all teeth except the fourth premolar are smaller than those of *A. africanus*. In the mandibular teeth, MH2 is smaller still; all teeth are below the size range of *A. africanus*, while the I_2-P_3 of this specimen are also smaller than those of *H. habilis* and *H. erectus*.

Contrary to previous observations at the enamel surface [3], the mandibular molars of MH1 show no lingual accessory cusps (C7) at the enamel-dentine junction, while only the M_1 has a distal accessory cusp (C6). This arrangement in the M1 and M2 is typical of *Australopithecus*, although the absence of accessory cusps in the M_3 is unusual among specimens of *Australopithecus*, *Paranthropus* and *H. habilis* (but is seen in *H. erectus* specimen KNM-ER 992). Alternatively, the M_3 of MH2 has both lingual and distal accessory cusps, as is the case in a number of taxa. Other features that resemble *A. africanus* and differ from *P. robustus* and early *Homo* include the well-developed molar protostylids that extend mesially beyond the level of the protoconid, and marked buccal grooves on the P_4.

In conclusion, the overall tooth shape and discrete trait expression in *A. sediba* most closely resemble that of *A. africanus*, and are well distinguished from *P. robustus* and most early *Homo* specimens. In particular, the M^3 shape and lack of a M_1 lingual accessory cusp in MH1 distinguish the specimen from *H. habilis*. However, as previously noted, the teeth of *A. sediba* are notable by their small size, which for some tooth positions are within the range of *Homo*, and in others is even smaller than *H. habilis* or *H. erectus*.

For access to specimens and microCT scans, we would like to thank Bernhard Zipfel, Sifelani Jira (Evolutionary Studies Institute, University of the Witwatersrand), Miriam Tawane (Ditsong Museum), Emma Mbua and Job Kibii (National Museums of Kenya), Audax Mabulla and Agness Gidna (National Museum of Tanzania), and the Tanzania Commission for Science and Technology. For scanning and technical assistance, we thank Kudakwashe Jakata, David Plotzki and Heiko Temming. This project is funded by the European Research Council (grant agreement No. 819960).

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Poster Presentation Number 57, Session 1, Thursday 18:15

Lithic assemblages from Palaeolithic survey research in the Megalopolis Basin, Greece

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Target-oriented surveys conducted in the Megalopolis basin during 2012-2013 allowed the identification of multiple Palaeolithic sites with lithic material and faunal remains [1]. These include Marathousa 1, a Lower Palaeolithic elephant-butchering open-air site dated to ca. 400-500 ka BP [2-3]. Here we present results from the techno-typological analysis of the lithic artefacts found during these survey campaigns. The aim of this study is to evaluate the diachronic occupation of the area, in relation to the lithic technologies used, the typology of the artefacts and the raw materials exploited.

A total of 413 artefacts were collected from sites such as Kavia Cave, Isoma 1 and 2 and other survey sites and findspots both inside and outside the open-cast lignite mines; 4 sites (Marathousa 1, Choremi 3, Tripotamos 1 and Isoma) provided stratified lithic artefacts. Based on the techno-typological approach it was possible to provide a chrono-cultural attribution of 167 artefacts. These range from the Lower Palaeolithic to the Bronze Age, with an important percentage of artefacts belonging to the Middle Palaeolithic.

As far as the conservation of the specimens is concerned, they bear no major chemical or physical alterations, which allows us to assume a generally low-energy depositional context without significant taphonomic factors affecting the artefacts. The most frequently utilised raw material is radiolarite (80%) followed by flint (11%) and quartz (4%). The presence of several diagnostic retouched tools, that can be considered as 'index fossils', allows us to infer that the open-air sites were frequented comparatively more intensively during the Lower and the Middle Palaeolithic periods. A greater density of artefacts pertaining to the Upper Palaeolithic in Kavia Cave is in line with identified mobility patterns in the Peloponnese, where the occupation of caves becomes more intensive, although not exclusive, from the Upper Palaeolithic onward, as attested in the caves of Klissoura, Kephalari and Franchthi [4]. In sum, our results indicate a sustainable human presence, as well as a relatively continuous Palaeolithic settlement in a favourable ecosystem that, already since the Lower Palaeolithic, potentially acted as a refugium for hominins and other mammals due to its ability to preserve fresh-water bodies during both glacial and interglacial periods [5].

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Poster Presentation Number 72, Session 2, Friday 18:15

Geoarchaeology of the Leba Cave Deposits, Southwestern Angola

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Leba Cave is located in the dolomitic hills of the Humpata district, Huíla Province, Angola. This region of escarpments and inselbergs represents the westernmost highlands of the Great Escarpment of Southern Africa, connecting a mosaic of biomes between the coastal regimes, hyper-arid Namib and Kalahari deserts and the woodlands of Central Africa. For paleoanthropological studies, understanding the cultural and environmental dynamics of this sub-tropical area is particularly challenging due to its high rates of decay, bioturbation and erosion which often do not provide suitable context for preservation of organic material key for further cultural-environmental interpretation.

The area is known for a series of Plio-Pleistocene fossil-bearing infillings in caves and fissures of the highland region with abundant biostratigraphic evidence, exposed by mining activities and lime quarrying. Inside Leba Cave, a sequence of cultural remains suggested human presence at least since the Middle Stone Age (MSA), characterized by blade-point technologies and Acheulean tradition implements (cleavers and handaxes) using local cherts and quartzites.

This study aims at building a robust contextual framework for the Stone Age of Leba Cave by the stratigraphic reassessment of the cave infillings, identification of depositional agents, anthropogenic features, and post- and syndepositional phenomena with critical comparisons of geological and historical data. The results are based on the analysis of site formation processes using contextual data from artefacts and sediments approached with micromorphology and microanalytics.

Fieldwork in 2018 and 2019 focused on limited excavation, cleaning and re-evaluation of exposed sections in three different areas of the cave related to the MSA-LSA sequence previously published for the site. The targeted areas were named VOJ, JCF and DMT. Area VOJ (entrance trench) relates to unconsolidated sedimentary units with recent archaeological horizons ranging from the colonial period to historical foraging-herding populations, including hearths, groundstones, potsherds and dominant Levallois lithic technology. Areas JCF (middle trench) and DMT (back wall) are located further inside the cave, behind a large cone of roof spall boulders separating the cave channel in two different rooms. Lithic artefacts found in both areas suggest chrono-cultural affinities with the MSA layers described in past excavations, including handaxes, core-tools and flakes. Analysis of the surface exposed in area JCF showed this profile was particularly affected by post-depositional phenomena due to guano, groundwater and seasonal puddling since the excavation of 1950, altering the fossil breccia aggregates and anthropogenic features described and sampled by Camarate-França in 1964. Area DMT is a fossil breccia deposit that shows stratification at the micromorphological level including abundant mammal fauna, lithic implements, cave sediment and regolith aggregates.

Geoarchaeological investigation indicates a complex depositional history related to intense biogenic and anthropogenic activity, along with geogenic processes specific to the Leba karst and its hydrological regime. Our results propose a site formation model which poses further questions about the timing and expression of the MSA in Angola and its implications for our understanding of human evolution in southwestern Africa.

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Poster Presentation Number 107, Session 2, Friday 18:15

Exploring the impact of sexual dimorphism on cranial asymmetry in a worldwide modern human collection

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The human cranium exhibits a certain level of asymmetry. Previous studies in primates, fossil hominins and modern human have indicated a relationship between cranial asymmetry and environmental, genetic, and functional factors. In this communication, we applied a geometric morphometric protocol to the quantification and mapping of cranial asymmetry in a worldwide collection in relation to sexual dimorphism. Largest part of cranial morphological information is symmetric on the left and right side with respect to the midsagittal plane. A certain portion of cranial shape information is attributable to fluctuant asymmetry. Here, we used a large world-wide sample of modern humans (N=181; 89 females and 92 males) to measure the magnitude and pattern of asymmetry in the cranium. On each individual, we defined 50 fixed landmarks and a symmetric patch of 1000 surface semilandmarks. We have used Arothron R package [1-2] to quantify shape asymmetry. Our protocol splits each landmark and semilandmark configuration in a left (L) and a right (R) half. One side is mirrored, and the entire sets of landmarks and semilandmarks is superimposed via Generalized Procrustes Analysis followed Klingenberg [3]. Eventually, the configurations after generalised Procrustes analysis are processed by means of Principal Component Analysis (PCA). The variance associated to the asymmetric component is decomposed in two parts describing the percentage of asymmetric variation attributed respectively to Directional Asymmetry (DA, mean difference between sides) and Fluctuant Asymmetry (FA, average differences around mean of asymmetry). We found that the 18.00% of the total variance is associated to bilateral asymmetry. The asymmetric component is composed of 44.44% of directional asymmetry and 55.56% of fluctuant asymmetry. The pattern of cranial asymmetry (directional asymmetry) in females and males is largely overlapped. In both sexes the left posterior portion of the neurocranium is expanded and the left zygomatic region contracted. Neutral variations of cranial symmetry (fluctuant asymmetry) are found in the upper portion of the occipital bone and on the anterior part of the neurocranium. Our findings in contrast with previous literature demonstrate that the pattern of cranial asymmetry is not related to sex nor to cranial size. One of the novelty elements shown in this communication is the possibility to map the pattern of asymmetry based on geometric morphometric and virtual anthropology methods. Future investigations will focus on the study of cranial and brain asymmetry in living and fossil primates.

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Podium Presentation Session 4, Thursday 17:30-17:50

Phenotypic signatures of hominin hybridization: new insights from admixed modern human dental morphology

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During their dispersal across the globe, modern humans met and interbred with distinct archaic hominin lineages, including Neanderthals, Denisovans, and unknown hominin species [1]. This process is known as introgressive hybridization and is thought to play an important role in Middle/Late Pleistocene hominin evolution [2]. While these population interactions have been well documented at the genetic level the phenotypic signatures of hominin hybridization remain poorly understood [3-4]. Indeed, because aDNA can only be recovered from some Middle to Late Pleistocene specimens, skeletal and dental morphology remains the main source of information to assess the presence of hybridization in fossil hominins. Tooth structures hold reliable taxonomic and phylogenetic information and given their good preservation and high abundance in the fossil record, dental remains represent a suitable material to trace hybridization. Recent studies have used hybrids of distinct animals as models for identifying signatures of interbreeding in the fossil record, but few have investigated primate species and dental phenotypes commonly used in hominin evolutionary studies. Yet, the few existing ones are difficult to be applied to the hominin fossil record because the models used could be not adequate given their differences in tooth classes (e.g., murids) and morphology (e.g, pinnipeds, cercopithecoids) [3,5] than the hominin dentition.

Given the lack of studies investigating hybridization using valid analogous taxa to extinct hominins, here we propose to use the dental diversity of living admixed human populations as a model to infer admixture events based on tooth size and morphology. If it is possible to detect admixture at the intra-specific scale, we hypothesize that it is possible to identify the phenotypic signatures of interbreeding in extinct hominins. Accordingly, through the assessment of similarities and differences between parental and admixed modern human populations, we assess the degree of dental diversity in admixed and parental populations, the expected patterns of dental variation after a recent admixture process, the contribution of parental populations to dental diversity in admixed populations, and the reliability of dental morphology to identify hybridization in the fossil record. We obtained standard tooth dimensions and scored dental non-metric traits (with the ASUDAS method) from 3D scans of dental casts obtained from two admixed Latin American samples (Colombians and Chileans ~1200) for which genome-wide SNP data was recovered. We also included data from three putative parental populations (Central and South American Native Americans, western Europeans, and western Africans). To explore parental-admixed relationships, and in particular the pattern of association between ancestry and dental traits, we used partial correlations, PCA and biodistances.

The results suggest close biological affinities between admixed and parental population(s) that most contributed to their genetic makeup; several metric and nonmetric traits exhibited low to mean significant correlations with genomic ancestries and some dental phenotypes allow predictions or estimations of genetic ancestries successfully. In addition, these results show that the admixed populations are highly variable compared to their parental populations, and they exhibit a strong modification of the patterns of dental diversity compared to parental populations.

This study suggests that recent admixture events can be recognized in genetically distant groups of the same species (modern humans) using dental data. In agreement with previous studies, our results indicate that admixed groups have higher diversity than parental populations [3]. The significant discrimination of admixed samples with respect to the parental ones at the intra-specific scale is highly promising to investigate the fossil record and try to identify interbreeding events [3-4].

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Poster Presentation Number 50, Session 1, Thursday 18:15

The Los Pizorros archaeological site, a new Lower-Middle Paleolithic site in the Upper Guadiana Basin (Southern Iberian Plateau, Ciudad Real, Villanueva de Los Infantes)

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In 2021, a series of prospecting tasks were carried out in the region of the Cueva de Los Toriles [1], in the geomorphological unit of the Campo de Montiel and Upper Guadiana Basin, which belongs to the Southern Iberian Plateau (Ciudad Real, Spain). We prospected in an area close to an outcrop of quartzite, a rock that is known in the area for being the raw material for several archaeological sites belonging to the Middle or Lower Paleolithic, like Albalá and El Sotillo [2]. Five people prospected an area of 0.75 hectares for 2 hours on the southern slope of the outcrop and we just collected the material exposed on the surface. As a result, numerous simple flakes, retouched flakes, and other stone tools in this material were found. Specifically, 5 cortical flakes, 10 laminar-trend flakes, 50 simple flakes, and 30 cores (both Levallois and discoidal) were found. The raw material of all of them is quartzite. The prospection was carried out in a cultivated area that has produced alterations in the surface of the material, however, its state of conservation is fairly good since it allows differentiating various lithic categories corresponding to the Lower and Middle Palaeolithic. Even though the raw material found in Los Pizorros is like other archeological sites in the Upper Guadiana Basin (e.g., Albalá or El Sotillo), the difference between Los Pizorros and the rest of them is that here we do not find many final products such as handaxes or scrapers, but we find much more initial products such as simple flakes and cores. We hypothesize that this could be caused because we are prospecting close to the outcrop, which would act as a quarry, and probably hominins discarded initial products in the quarry area and carried with them the final products far from the quarry [3]. However, we do not rule out other possibilities for the lack of final products such as spoliation by local people. In this work, the results of this prospection and the future perspectives are exposed.

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Poster Presentation Number 23, Session 1, Thursday 18:15

The Neandertal-associated Châtelperronian industry is more 'Upper Palaeolithic' than the *Homo sapiens*-associated Initial Upper Palaeolithic

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The Initial Upper Palaeolithic (IUP) techno-complex is emerging as a key to understanding the replacement of Neandertals by anatomically modern humans (AMH) across Eurasia [1]. In Europe, IUP-type assemblages are increasingly being considered a proxy for the first AMH occupations in the region – a model which has been bolstered by fossil and genetic evidence from Bacho Kiro (Bulgaria) [2] and Grotte Mandrin (France) [3]. Similarities in bone tools and personal ornaments between the IUP at Bacho Kiro and the Neandertal-associated Châtelperronian assemblages at Grotte du Renne (France) has been proposed as supporting some form of behavioural influence by incoming AMHs onto late Neandertal populations in western Europe [2]. As an extension to this argument, the Châtelperronian has recently been referred to as a western European Initial Upper Palaeolithic technocomplex for the first time within scientific literature [4]. Yet, the question of whether the Châtelperronian industry in fact fulfills the technological definitions of the IUP has not been explicitly evaluated. If it is the case that late Neandertals produced archaeological assemblages consistent with Initial Upper Palaeolithic typo-technological characteristics: to what extent then can IUP-type assemblages be used as a proxy for the presence of AMHs in Europe? Here, we present a comparative, point-by-point analysis concerning the compatibility, or lack thereof, of Châtelperronian lithic technology with recent technological definitions/criteria for the IUP [5]. We show that not only is the Châtelperronian incompatible with the IUP (both sensu stricto and sensu lato), but that it in fact reflects a well-developed 'Upper Palaeolithic' package of lithic technological behaviours. It is also, despite some important debate, an archaeological industry currently associated exclusively with Neandertals. In other words: late Neandertals in France and northern Spain appear to have produced assemblages which are more 'Upper Palaeolithic' than those of their suspected 'influencers' – early populations of *Homo sapiens* in Europe. If we accept Neandertals as the producers of the Châtelperronian, models which propose a simple and unilateral diffusion of technological behaviours from AMH to late Neandertals during the Middle to Upper Palaeolithic transition are in need of critical re-evaluation.

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Poster Presentation Number 75, Session 2, Friday 18:15

Early *Homo sapiens* complex behavior in North Africa: Function of Middle Stone Age lithics in Morocco

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Recent discoveries have shown that *Homo sapiens* has a Pan-African origin, which highlights North Africa as an important scenario for the development and expansion of its biological and cultural traits [1]. Early manifestations reflecting a complex cognition of *Homo sapiens* in North Africa are tied to the emergence of the Aterian culture around 150 ka BP. These include bone and ivory tools [2], the exploitation of different animal, vegetal and marine resources [3], as well as the use of pigment and perforated shells for symbolic expressions [4]. Within this cultural repertoire, by focusing on aspects such as ecological adaptations and technological transmission, stone tools represent crucial evidence to infer the emergence and development of behaviors over time. The study of the Aterian stone tool industries from different regions in North Africa is argued to display significant variability and technological flexibility [5]. However, the significance of such variability and organization in the evolution of human behavioral traits is still unknown. Functional studies of stone tools will help to better understand the techno-economy of the Aterian. Any scope for discussing the Aterian industries is still limited by the paucity of detailed lithic studies related to use-wear analysis. This work aims to bridge this gap of knowledge by providing new functional studies on the MSA-Aterian context which can now be extended back well to MIS 5 or even earlier. In this project, an experimental approach is adjusted to the use-wear analysis of lithic tools from four key MSA sites in Morocco (Taforalt, Rhafas, Bizmoune, and Jorf El Hamam).

Our methodology includes (1) fieldwork in which the same lithic raw material present in the four sites was procured from different sources, (2) experiments including stone tools manufacture and use for different tasks, and (3) laboratory work that includes the microscopic study of both experimental and the archaeological stone tools to determine the function of the latter.

This work, presented and discussed in this poster, aims to shed light on how stone tools were designed and used, and how these reflect human behavioral decision-making processes, associated with different environments, including coastal adaptations and landscape resource use. It will also make a significant contribution to the debate on the *Homo sapiens'* origins and the emergence of the so-called Human complex behavior in Africa.

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Poster Presentation Number 1, Session 1, Thursday 18:15

Occupational intensity in the Paleolithic of the Balkan Peninsula

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The Balkan Peninsula is characterized by a rather sparse and patchy record of the Paleolithic occupations, compared to other regions of Europe. It has fewer stratified sites and a lower number of sites with high density of archeological material. This seems counterintuitive, given that the Balkans was a refugial region offering favorable conditions in the cold climatic phases, especially in its southern regions. It also acted as a migration corridor for movements east-west between Europe and the SE Asia, along the Danube river and the Mediterranean coast, but also to and out of its southern refugia. As such, it would have been suitable for a continuous human habitation.

Different factors can be responsible for the Balkans having a sparse evidence of human habitation compared to other regions of Europe: 1) lack of research, with this part of Europe having less intensive research history; 2) low population density and low human occupational intensity with frequent gaps in human presence, as it might be suggested by the higher number of ephemeral occupations in this region and high carnivore activity [1-2]; 3) preservation bias where the destruction or bury of the Pleistocene deposits could have resulted in a patchy Paleolithic record. Paleolithic research in the Balkans has intensified in the last decades which can hopefully reduce the factor of insufficient research. While addressing the preservation bias in such large territory would require extensive interdisciplinary work, the currently available archaeological record offers an opportunity to investigate whether and how the density of the record can be related to the intensity of human habitation.

In this study, we will use several parameters to evaluate occupational intensity in the late Pleistocene of the Balkans. Firstly, we review the site density and the changes through time in the number of occupied sites. Further, based on the published data, we collect the following variables: lithic volumetric density, retouched tool frequency, core, blank and chip frequency as well as tool diversity, and conduct two analysis: bivariate WABI (Whole assemblage behavioral indicator) [3] and multivariate PCA (Principal component analysis). The number of occupied sites and the density of finds are variables often used as indicators of average population density [4]. The lithic volumetric density and the assemblage composition, especially the frequency of retouched elements, are used to estimate how many people are using the sites and for how long. Therefore, they reflect site function and indirectly regional mobility and settlement patterns [3,5].

The goal of this study is to, based on selected variables, assess the length and the nature of each occupation, their association with the organization of technology (curated vs. expedient) and further infer the settlement and mobility patterns. This will help evaluate whether ephemeral occupations and low habitation intensity are the norm in the Balkans. We include both Middle and Upper Paleolithic sites, which allows us to detect changes through time, differences between hominin populations and in different microregions of the Balkan Peninsula.

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Podium Presentation Session 5, Friday 9:30-9:50

Early Denisovans - what we know and what we don't

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Denisova Cave is a unique Palaeolithic site that contains the physical remains and/or aDNA residues of Denisovans, Neanderthals, and the unique offspring of a Neanderthal mother and a Denisovan father, in the same (Middle Palaeolithic) archaeological layers, as well as of modern humans in the Upper Palaeolithic sequence. The first-ever identified Denisovan (Denisova 3) derives from a relatively high part of the stratigraphic sequence and it was indirectly dated to around 60 ka [1-2]. Yet, little is known of the first appearance of Denisovans at the cave and in the region more general.

Over the past 8 years we applied Zooarchaeology by Mass Spectrometry (ZooMS) on several thousand unidentifiable bone fragments from the East and South Chambers of Denisova. While we analysed material from throughout the sequence, we focused our most recent efforts to the lowermost layers of the site that lacked human evidence, hoping to identify the first occupants of the site.

Indeed, of the 11 ZooMS-identified human fossils, three hominin bones derive from these earliest archaeological layers in the East Chamber (layer 15 and 14), dating to 200 ka. Genetic analyses shown that they carry mitochondrial DNA of the Denisovan type [3], placing therefore Denisovans at the base of the sequence during MIS7, a very warm interstadial that would have favoured fauna and plant resources to thrive locally and would have render the Altai mountains a favourable spot for human occupation. The stratigraphic context of these early Denisovans contains a wealth of archaeological material in the form of lithics and faunal remains, allowing us to determine the material culture associated with these early hominins and explore their behavioural and environmental adaptations.

Finally, we will attempt to place Denisovans in their broader Eurasian context by discussing how the new hominin remains, their chronological position and associated archaeological evidence compare to those of other locations both in West and East Asia.

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Podium Presentation Session 1, Thursday 10:00-10:20

Mammoth, fish, and cannibalism: stable isotope insights into the diet of late Upper Palaeolithic hunter-gatherers in southwestern Germany

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Stable isotope ($\delta^{13}C$, $\delta^{15}N$) analysis of bone collagen has proven to be a useful tool in the reconstruction of human diet in a prehistoric context. However, the $\delta^{13}C$ and $\delta^{15}N$ values on bulk collagen of human remains provide potentially ambiguous results in regards to the contribution of terrestrial vs aquatic resources. This is due to some overlapping ranges in isotopic values, such as observed between megafauna, notably mammoth, and freshwater resources, namely fishes [1]. Since the seminal work of Richards et al. [2], the measurement of sulfur-34 ($\delta^{34}S$) can serve to better decipher the freshwater resources input in human diet, after a thorough verification that terrestrial prey contribution is indeed reflected by different δ34S values than those of aquatic food resources. More recently, the development of compound specific isotopic analysis, especially of phenylalanine and glutamine amino acids (δ15Nphe and δ15Nglu) opened a new avenue of investigation to detect aquatic resource consumption and estimate the trophic position of human individuals [3]. We have applied these recent means of isotopic investigation to reconstruct the diet of four Magdalenian human remains, from the sites of Brillenhöhle, Hohle Fels and Burkhardtshöhle (southwestern Germany). These remains are dated directly (Brillenhöhle and Burkhardtshöhle skulls) or indirectly (HohleFels10 femur and HohleFels49 femur) between 15,000 and 14,000 cal BP and have been previously subjected to ancient DNA investigation that revealed they belonged to mtDNA haplogroup U8a and were male individuals. The bulk collagen ^{13}C and ^{15}N abundances are very close from one human remain to another, indicating a similar protein composition of the diet. The human $\delta^{15}N$ values are substantially higher than those found in associated large carnivores (e.g. cave lion, wolf, wolverine), while the $\delta^{13}C$ values were comparable between human and animal predators. We first hypothesized a freshwater contribution to the diet since it could explain such a tendency as illustrated by the analysis of an otter from the Magdalenian site of Kesslerloch (northern Switzerland). However, the $\delta^{34}S$ value obtained on the same otter (+3.5‰) is significantly higher than those found on large herbivores in northern Switzerland and southern Germany during the same time period, that mostly delivered negative δ34S values ([4] and this work). The negative $\delta^{34}S$ value of the human from Brillenhöhle, the only one able to be measured, supports a terrestrial based diet for this individual. The $\delta^{15}N$phe and $\delta^{15}N$glu values of the human remains from Hohle Fels and Burkhardtshöhle aligned along a correlation expected for a terrestrial diet with high animal protein content and a trophic position (TP) of ca. 2.6 to 2.7 (where TP2=herbivory and TP3=carnivory), indicating the consumption of mammoth, the only prey that could explain their high bulk $\delta^{15}N$ values. The individual from Brillenhöhle shows the highest trophic position (ca. 3.0) generally expected for pure terrestrial carnivores that can be explained by the consumption of human flesh in addition to large herbivore meat. Cannibalism is indeed a practice attested to by teeth and cut marks on Magdalenian human remains of southwestern Germany [5]. These results provide first-time, direct evidence of mammoth consumption as well as a strong indication of cannibalism using a biomolecular approach in the late Upper Palaeolithic context of western Europe.

We would like to acknowledge Julia Becher for her technical support during laboratory work. KH is supported by the DFG FOR 2237.

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Podium Presentation Session 12, Saturday 17:40-18:00

Positional behaviour of chimpanzees living in the savannah-mosaic environment of Issa Valley, Tanzania: Insights to the origins of human bipedalism

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Habitual bipedal walking is unique to humans amongst primates and its associated morphological features are used to define the human clade (hominins) from other apes over the last 7 million years (Ma). Yet, the evolutionary origins of our bipedal gait remain unknown. The palaeontological record supports an adaptive hominin radiation from a closed (e.g., tropical forest) to a more open and seasonal heterogeneous environment (e.g., savannah-mosaic) as central to the emergence and evolution of terrestrial bipedalism in the human lineage [1]. However, morphological features that are advantageous for arboreal locomotion are present in the forelimbs of many hominins (early and late), generating long-standing debate around the functional significance of these features, and the link between bipedalism and terrestriality. In the absence of direct fossil evidence, extant chimpanzees that live across a habitat gradient provide ideal models to test the "savannah-landscape effect" on ape locomotor behaviour and substrate use [2-3]. Chimpanzee locomotor studies to date, however, have focused only on forest-dwelling communities [4-5], limiting our knowledge of the full range of chimpanzee locomotor behaviour and its application for modelling hominin evolution. Here, we characterize for the first time the positional behaviour and substrate-use of chimpanzees living in an open, dry habitat.

Chimpanzees (*P. t. schweinfurthii*) of the Issa Valley, western Tanzania, live in a savannah-mosaic habitat dominated by open miombo woodland with strips of closed evergreen (riparian) forest: a mosaic that resembles the reconstructed palaeoenvironments of Pliocene hominins. To investigate the influence of an open habitat on positional behaviour and terrestriality we, 1) quantified the frequency of terrestrial and arboreal positional behaviours between the forest and woodland at Issa, and 2) compared our findings to data published on forest-dwelling chimpanzees. Specifically, we tested the hypothesis that chimpanzees will increase time spent moving on the ground, and terrestrial bipedality, in more open vegetation. Data were collected on 13 adults over 15 consecutive months, including positional mode, contextual activity, vegetation type, and substrate-use of individuals every two minutes (N = 13260 focal observations, 2848 of which were locomotion).

Results showed that Issa chimpanzees spent more time terrestrially in the woodland compared to the forest, but overall, they were not less arboreal than forest-dwelling chimpanzees. Furthermore, bipedalism did not increase in frequency in open habitat, and instead remained an arboreal behaviour for terminal branch feeding. Our results demonstrate how early hominins could have remained dependent on trees in a more open habitat, with implications for hypotheses of the ecological pressures selecting for bipedalism (e.g., to efficiently and safely harvest more sparsely distributed, terminal branch, foods). These findings support the functional importance of morphological traits for arboreal locomotion in early hominins, and suggest bipedalism emerged in an arboreal context as an adaptation to moving on flexible terminal branches.

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Poster Presentation Number 110, Session 2, Friday 18:15

Cortical thickness and cross-sectional geometry in hominid metacarpals

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Unlike other living primates, the modern human hand is used primarily for object manipulation rather than for manipulation and locomotion. The evolution of this hand-use in fossil hominins, and its associated technological capabilities, has been the subject of much palaeoanthropological research. Fossil hand function has often been inferred via the shape and robusticity of hand bones. As diaphyseal cortical bone is thought to respond to mechanical loading over an individual's lifetime, via bone functional adaptation [1], its form can also provide information concerning living and fossil hand function. Several studies have analysed the diaphyseal cortical morphology of living hominid metacarpals using cross-sectional geometry [2-3]. Since this method measures cortical properties that are directly proportional to bending or torsional rigidity in bones [1], it allows researchers to associate observed hand function and biomechanical parameters in living primates, which in turn can be used to infer fossil hominin hand function. However, this method necessarily conflates diaphyseal shape and cortical bone thickness to calculate the biomechanical properties of metacarpals. To date, cross-sectional analyses of hominid metacarpals have tended to focus on comparisons with metatarsals [2-3] and cortical thickness has only been measured in the third metacarpal of some hominids [4].

Here we use the R package Morphomap [5] to report the 3D diaphyseal cortical thickness and cross-sectional geometry of all five metacarpals across a sample of all living hominids including: modern humans (*Homo sapiens*, n=13), bonobos (*Pan paniscus*, n=11), chimpanzees (*Pan troglodytes*, n=13), gorillas (*Gorilla gorilla*, n=12) and orangutans (*Pongo* sp., n=10). Each metacarpal was imaged using micro-CT scanning, binarized using the MIA-clustering segmentation and separated into cortical and trabecular bone sections using Medtool 4.5 (www.medtool.at). Meshes of the endosteal and periosteal surfaces of each metacarpal were generated using a custom python plug-in written for Paraview. These surfaces were then analysed with Morphomap [5] to measure cross-sectional geometry and cortical thickness in these metacarpal diaphyses. Specifically, the polar moment of inertia (J) and a ratio of the area moments of inertia in the radio-ulnar (IRU) and dorso-palmar (IDP) planes were calculated (IRU/IDP).

Inter-ray comparisons demonstrate that the first and fifth metacarpal maintain the highest bending rigidity in the radio-ulnar plane across all species. Interspecific results reveal that gorillas tend to have the most rigid and thickest diaphyseal metacarpus relative to other hominids in agreement with previous studies [2-3]. Interestingly, while humans have the thinnest cortical bone, they maintain bending rigidity comparable to all other species studied, except gorilla. More detailed inter-ray and interspecific differences in thickness and cross-sectional properties are discussed in terms of observed hand function in these species, with special reference to the first metacarpal and its role in manipulation. These results highlight the wealth of information in metacarpal cortical bone and will help us infer hand use in fossil hominins.

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Poster Presentation Number 92, Session 2, Friday 18:15

From footprint morphometrics to the stature of fossil hominins: experimental regressions and uncertainties

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Hominin footprints provide access not only to the locomotor behaviours of fossil taxa but also to their body characteristics such as their stature. Stature is usually estimated from the length of footprints by using the well-known foot length to stature ratio (15%). However, the morphology of the footprints is not only impacted by the dimensions of the foot but also by the biomechanical features of the individuals and the nature of the substrate in which they were left. Therefore, recent studies emphasize the need to better understand the relationships between individual stature and footprint morphometry and not just foot morphometry. Furthermore, while stature estimates have been based solely on linear measurements, methodological advances in 3D scanning and geometric morphometrics offer the possibility of investigating the correlation of stature with a wide range of under-exploited morphometric variables.

It is in this context that this study aims to quantify the relationships between different morphometric variables measured on footprints and individual stature by means of an experimental study and to discuss the application of these relationships to the fossil record.

In order to carry out this study, 22 individuals aged between 10 and 36 years and for which their stature was measured, were asked to make footprints on an experimental area. This area is composed of a dune sand of fine granulometry. This type of sediment is common in the fossil record and induces by its grain size, porosity and moisture a high intra-individual variability impacting the uncertainty of biological estimates from footprints. Each individual moved on the area in different ways (static position, habitual walking, slow running). A total of 221 experimental footprints, including 58 footprints digitized in 3D by photogrammetry, were thus studied by measuring 24 morphometric variables (16 linear, 5 surface and 3 volume measurements). The correlation between each variable and the stature of the individuals was then investigated.

The linear measurements of the footprints show on average higher correlations with stature than the surface and especially the volume measurements, the volume of the footprint being strongly impacted by the substrate moisture. The footprint lengths measured from the base of the heel to the tip of the hallux and second toe are the dimensions most correlated with stature, linear regressions giving the best predictions. It should be noted, however, that although these dimensions have one of the lowest intra-individual variability of the 24 morphometric variables, this variability remains significant. Indeed, the length of a footprint can differ by more than 10% from the average length of footprints made by a single individual. This uncertainty must be considered in particular for the study of isolated fossil footprints for which it is impossible to quantify intra-individual dispersion in the absence of trackways.

The estimation of stature from footprints is therefore confronted with two types of uncertainties, that of regressions between the average footprint length and the stature of the individuals and the more important uncertainty linked to the substrate deformation inducing intraindividual variability. In addition to these two uncertainties, there is a third uncertainty related to the variations in body proportions during hominin evolution. Indeed, the ratio between foot size and stature probably differ between modern populations and fossil taxa. However, direct quantification of this ratio is impossible for fossil species, including the most recent ones such as Neandertals, because of the fragmentary aspect of the fossil record.

I would particularly like to thank the volunteers who participated in the experiments. I am grateful to C. Biets, B. Albouy and M. Tudal for their help in entering the experimental data. The experimental study was validated by prefectoral decree #28-2017-339 (05/17/2017, Normandy, France). This work is part of a research project on the biological and biomechanical characteristics of hominins funded by the FYSSEN foundation. The experiments were funded by the CNRS - Institut Écologie et Environnement International Research Network IRN-GDRI0870. The metric analyses were conducted under the ANR-18-CE27-0010-01 HoBiS programme.

Poster Presentation Number 71, Session 2, Friday 18:15

A Holocene n-alkane stable isotope sequence from Wonderwerk Cave, South Africa, and its implications for the Later Stone Age record

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Sediment biomarkers, such as leaf wax n-alkanes, are routinely used in studies of marine and lake cores as a proxy for past vegetation change and rainfall regimes. Such records are an important source of regional to global climate signals particularly in regions which lack long-term terrestrial archives. Transects of modern terrestrial samples show a good correlation of hydrogen isotopic values with precipitation amount, for example in the summer rainfall zone of South Africa [1] but few studies have measured carbon and hydrogen stable isotopes from leaf wax n-alkanes deriving directly from archaeological sediments in the subcontinent [e.g. 2].

We tested the application of carbon and hydrogen stable isotope measurements from leaf wax n-alkanes derived from sediment samples taken during the excavations at Wonderwerk Cave. Situated in the semi-arid interior of South Africa, Wonderwerk Cave is remarkable for being the only cave site in the area with a ~2 million long archaeological record. Here, we present the results of the Holocene layers at Wonderwerk Cave, which hold a rich Later Stone Age (LSA) archaeological record. Recently, new micro-scale excavations have refined the stratigraphy and the chronological framework with modern methods and new radiocarbon dates [3]. Moreover, the Holocene of Wonderwerk Cave has been well studied and its environment has been reconstructed from diverse proxies including pollen, micromammal and macromammal abundances, charcoal and marcobotanical remains, geoarchaeology and a stable isotope study on the faunal material. This provides an excellent framework to compare the biomarker results.

Our biomarker results confirm a semi-arid to semi-humid early Holocene with a mix of woody C_3 plants and C_4 grasses in contrast to an increasingly arid, open and C_4 grass dominated later Holocene. A distinct humid period around 6000 cal. BP is evident between these two environmental regimes, which is associated with the highest density of LSA archaeological material in the Wonderwerk record. Through the integration of environmental proxy studies and archaeological analysis from both the 1980s excavations and the new ones we show a close connection between local environmental change and cultural change in lithic technology and worked ostrich eggshell at Wonderwerk Cave. Our study provides a first step in using biomarkers to create terrestrial environmental records of any age in this semi-arid region.

We are grateful to Silvia Koch, Stefan Lauterbach, Thomas Blanz and David Morris for their technical and logistical support. The research was funded by the European Union's Framework Programme for Research and Innovation Horizon 2020 (2014–2020) under the Marie Sklodowska-Curie Grant Agreement No. 837730 (MINERVA) to M. Ecker. Fieldwork at Wonderwerk Cave is funded by PAST and the Social Sciences and Humanities Research Council of Canada (SSHRC) grants held by M. Chazan. All fieldwork has taken place under permit from the South African Heritage Resources Agency (SAHRA).

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Podium Presentation Session 5, Friday 10:10-10:20

Reviving Paleolithic research in Lebanon

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Lebanon is a small country with a very rich Paleolithic record. Discoveries of Lebanon's prehistoric past were recorded as early as the 1800s by various diplomats and travelers, e.g., Paul-Émile Botta, Louis Lartet, the Duke of Luynes Charles Honoré d'Albert, during their journeys. By the end of the 19th century, the Jesuit priests established in Lebanon, and who were highly influenced by prehistoric archaeological findings in Europe, took over this field of research. Starting in 1889 with Father Godefroy Zumoffen, "the Father of Lebanese Prehistory", and continuing with his successors, notably Auguste Bergy, Henri Fleisch, and Francis Hours, Paleolithic research in Lebanon took off. By the 1930s, word about the importance of the Lebanese Paleolithic record had spread internationally. Scientists from different places around the world became interested in taking part in the action. Shortly before the beginning of World War II, but mostly soon after its end, teams from the United States (headed by Joseph G. Doherty and J. Franklin Ewing and also by Ralph Solecki), Switzerland (headed by Jean Haller), United Kingdom (headed separately by Dorothy Garrod, Diana Kirkbride, and Lorraine Copeland), France (headed by Jacques Tixier), and Japan (headed by Hishashi Suzuki), among others, conducted major Paleolithic field projects all over Lebanon. By the late 1960's and early 1970's, Lebanese Paleolithic research was booming with discoveries and future plans. However, the outbreak of the Lebanese civil war in 1975 put an abrupt end to all running and planned projects. Unlike other fields of archaeology, Paleolithic research in Lebanon never recovered. This almost 50 years of silence has resulted in the suspension of the flow of knowledge on 2 million years of our human ancestors' migrations and dispersals across Africa, Asia, and Europe from a unique geographic area, i.e., the heart of the Levant, the main land-bridge that has ever connected the Old-World continents.

The revival of Paleolithic research in Lebanon has been long overdue. In a place that has suffered so much political instability, and where the endless cycles of destruction and uncontrolled construction alike are continuously obliterating our ancestors' traces, the need for this revival is becoming even more imminent. "REVIVE", the multidisciplinary project funded through the European Research Council (Consolidator Grant to El Zaatari), has recently taken on the task to pick-up where Paleolithic research was left off in the 1970s and -for the first time in almost half a century- move this field forward. Previous research in Lebanon has identified an excess of 200 sites/find-spots scattered all over the country and spanning the entirety of the Paleolithic Period (see [1] for a recent review). Although not properly explored, these sites have yielded enough material (e.g., lithics, faunal assemblages, hominin remains) to show that Lebanon is an ideal study region, which may hold the key to answering many unresolved questions and to filling important gaps in the current Levantine Paleolithic record, including shedding light on earliest, and successive, migrations out of Africa, enhancing our knowledge of Neandertals and anatomically and also early modern humans interactions, linking specific industries and behavioral repertoires to respective hominin species, etc.

Through re-checking the status of old sites and material, (re-)analyzing old collections, and conducting new surveys to locate new sites and excavations following modern approaches, REVIVE has started to reinitiate the flow of knowledge on Paleolithic human occupations and migrations through the central Levant. This talk will go through the almost forgotten Lebanese Paleolithic record presenting its highlights and current state of affairs. It will also give an overview of REVIVE's activities and present the teams findings from this past first year's work on the ground.

This research is funded by the European Research Council under the European Union's Horizon 2020 research and innovation program, grant agreement number 101001889 (REVIVE).

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Poster Presentation Number 38, Session 1, Thursday 18:15

Neandertal dental caries: new evidence from El Sidrón site (Spain)

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Caries are defined as the demineralization of dental hard tissue (enamel, cementum and dentine) due to organic acids formed by bacteria in dental plaque, permanently damaging the teeth. The incidence of caries is often linked to an increase of carbohydrates consumption, and in paleoanthropological studies this has been used as a proxy to infer the type of diet of fossil hominins. However, the frequency of these lesions in fossil humans is scarce with just a few cases reported. In the case of *Homo neanderthalensis* just seven cases have been reported including three instances on deciduous teeth [1-3, among others].

Here we present the findings of an incipient caries lesion on a permanent upper left second molar (SD-2158) attributed to an adult male Neandertal individual from El Sidrón Cave (El Sidrón Adult 6). The El Sidrón Neandertal collection is housed at the Museo Nacional de Ciencias Naturales (MNCN-CSIC) in Madrid (Spain). The putative lesion was examined using an stereomicroscope and Environmental Scanning Electron Microscope (ESEM), and Micro-CT scans were used to confirm the lesion and to evaluate its extend. All the facilities are located at the Museo Nacional de Ciencias Naturales.

The lesion is found on the occlusal surface at the paracone cusp. Specifically, it is located inside the facet 6, which is developed during lateroprotusion movements during the mastication cycle. Micro-CT scans reveal a small furrow filled with sediment, with 2.6 mm in length and 0.78 in width. Regarding the etiology, it is possible that due to an intense use of the mouth in para-masticatory activities (presence of chipped enamel and "stuf-and-cut" features) [4], as well as evidence for a mixed diet with a high vegetal component [5], the molar tooth developed a crack lesion due to high masticatory forces and the abrasiveness of the vegetable component included. In fact, the occurrence of caries is often linked to an increase of carbohydrates consumption. This crack then should had been colonized by a bacterial biofilm, that deepened into the dentine and developed this small channel-shaped caries.

This study is not intended to be a conceptual advance, but it presents new data regarding the antiquity of human caries lesions, its development, and the possibility of the para-masticatory behavior component as an adjuvant in their origin, at least in *Homo neanderthalensis*.

We are grateful to Dr. Navajas (Universidad de Granada) for helpful discussions. This research is partially funded by Project PID2021-122356NB-100 (Ministerio de Ciencia e Innovación MICINN/FEDER) and Fundación Parlaq. A.E. is supported by H2020-MSCA-IF project No. 891529 (3DFOSSILDIET).

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Poster Presentation Number 100, Session 2, Friday 18:15

Advancing phyloproteomic analysis of Pleistocene hominins

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Genomic analyses of archaeological skeletal remains have allowed us to disentangle hominin evolutionary relationships over the past two decades. However, much of the hominin fossil record is beyond the reach of current genetic methods, due to DNA degradation. Proteins, on the other hand, can preserve far beyond the limits of DNA, and have recently been shown to preserve phylogenetically relevant information within skeletal tissues, even for hominin fossils [1-2].

This palaeoproteomic approach to studying ancient evolutionary relationships among hominin fossils does, however, come with a set of challenges. The recovered skeletal proteomes preserved in archaeological remains are generally small, the proteins are fragmented into short peptides over time, and the amino acids tend to be heavily modified. All three factors contribute to inherent challenges in applying palaeoproteomics to study hominin phylogenetics. Further method development and optimization, as well as a better understanding of the biology of skeletal proteomes, are therefore essential before the full potential of this approach can be realized.

To this end, the PROSPER project aims to expand our current knowledge of skeletal proteomes by studying variation in the proteome, both between and within skeletal elements, in order to guide sampling strategies and sample selection. Methods for sampling will be optimized for handling these very ancient tissues with minimal alterations. Finally, laboratory methods will be developed to maximize both proteome size and coverage of phylogenetically relevant proteins [3]. Through all these currently ongoing developments, a maximal amount of information can be extracted with minimal damage to irreplaceable hominin fossils.

PROSPER will use these optimized methods to study hominin evolution during the Pleistocene. Specifically, we will be addressing the phyloproteomic relationships among Middle Pleistocene hominin fossils, and their respective roles in the formation of the hominin populations that dominate the Late Pleistocene. The methods developed as part of PROSPER are not uniquely applicable to evolutionary research questions, but can also contribute to the flourishing of palaeoproteomics in palaeoanthropological and archaeological contexts.

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

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Pecha Kucha Presentation Session 2, Thursday 12:20-12:45

Cognitive strategies in Neanderthal tar production

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Advanced cognition is often recognized in the archaeological record through the presence of complex technologies such as adhesives and composite tools. However, definitions for what makes these complex generally focus on different aspects of production, and lack of standards. We overcome some of these shortcomings by using Petri nets models and metrics. Combined with observational data from birch tar manufacturing experiments, we assess the complexity of the technological processes. We analyse three possible Neanderthal tar production methods–Condensation , Raised Structure and Pit Roll [1-2]–as cognitive strategies to make optimal use of different cognitive resources [3]. We modelled the three methods as Petri nets and measured three dimensions of complexity that Palaeolithic or Stone Age makers were required to cope with to produce adhesives: 1) retain multiple pieces of information at the same time while executing the process; 2) avoid errors and correct problems throughout the process; 3) understand and abstract information about the materials, product templates, and the process itself before starting to make adhesives. Three metrics, formulated for process analytics, were used as a proxy for these dimensions of complexity, respectively: the Density metric [4], the Extended Cyclomatic metric, and the Structuredness metric [5]. The differences in the values of the metrics indicate that the condensation method requires the retention of more pieces of information at the same time than the other two methods. However, the condensation method showed the lowest values for likelihood of errors or problems during the process and for the amount of information required to understand the workings of the process. Conversely, the raised structure method scored higher for likelihood of errors and amount of previous knowledge concerning the process, and lower for simultaneous retention of information. Finally the Pit roll method scored the second highest in all three metrics, suggesting that this method does not provide any optimal solution to cope with one of the dimensions of complexity. The results show that no single tar production method can be considered consistently the optimal cognitive strategy to cope with complexity across all of these dimensions. It is therefore vital to consider what kind of solution each method provides to deal with the complexity of adhesive production.

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Poster Presentation Number 9, Session 1, Thursday 18:15

Linking blades: a systematic refitting analysis of blade fragments from the Protoaurignacian sequence of Fumane Cave

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High-resolution chronostratigraphic frameworks of the early Upper Paleolithic (eUP) are pivotal to the understanding of the dispersal and adaptation of early modern humans across the European subcontinent. Chrono-cultural models are commonly built through the analysis of the material culture, especially lithic artifacts, recovered from multi-stratified sites. However, despite playing a major role in the formation of lithic assemblages, site formation processes are seldom taken into proper consideration when analyzing cultural dynamics throughout a site's stratigraphic sequence [1]. Unraveling the taphonomic history of a site is rather critical in the study of the eUP – a period characterized by significant sedimentary and post-sedimentary processes correlated to major climatic events. Furthermore, disentangling the history of old, long-lasting site excavations is especially crucial in the analysis of archaeological assemblages. To this end, we conducted an extensive lithic refitting study that involved the systematic test for connections between blade fragments from the whole Protoaurignacian sequence of Fumane Cave [2], spanning from 41 ky cal BP to ca. 37 ky cal BP [3]. This approach is particularly effective for assessing the integrity of lithic assemblages because it allows to make the search for connections more systematic, objective, and statistically quantifiable [4]. Furthermore, the spatial analysis of the refitted fragments allowed us to better evaluate the reliability of the archaeological sequence and to refine our previous conclusions about the Protoaurignacian at the site [5].

Specifically, after devoting approximately 400 hours in the preparation of the assemblages, we isolated ca. 3,200 blade fragments to perform the break connections program. Blade fragments were laid on several tables and divided according to breakage, raw material type, and technological features. Thus, all possible connections were systematically tested by three independent lithic analysts until the relation between costs (i.e., time) and benefits (i.e., number of connections found) drastically decreased. Furthermore, we recorded several attributes on these fragments (e.g., thermal alteration, patina, edge damage) to conduct a lithic taphonomic study.

Overall, we were able to successfully connect ca. 500 blade fragments for a refitting rate of 16%. By statistically quantifying the distance and orientation of the refitting implements, and by assessing the spatial distribution of relevant taphonomic attributes, we were ultimately able to identify a relatively less disturbed area of the excavation, to be sampled for a more robust techno-typological study. Intra-layer conjoins are more frequent in the lowermost part of the sequence, which corresponds to the major occupation event at the site. Nevertheless, inter-layer conjoins are rather common throughout the sequence and would suggest significant post-depositional processes. Remarkably, the technological differences across the analyzed layers appear to be more marked than previously thought. We will therefore propose revised hypotheses and predictions that have a major significance in the study of eUP population dynamics.

Fieldwork and research at Fumane are coordinated by the Ferrara University in the framework of a project supported by the Ministry of Culture, public institutions and private associations and companies. This research is funded by the Deutsche Forschungsgemeinschaft (DFG) under grant agreement no. 431809858 – FA 1707/1-1.

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Poster Presentation Number 74, Session 2, Friday 18:15

The Geoarchaeology of the southern Kalahari: a case study from the Kgalagadi district

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The Kalahari is a semi-desert that stretches between three southern African countries, namely South Africa, Namibia and Botswana. Located in the south of this semi-arid sand plain is the Kgalagadi district of Botswana, which is the main focus area of our research. Our main goal is to examine to what extent periods of intense climate change affected groups of hominins during the southern African Middle Pleistocene. The Middle Pleistocene is seen as an integral period in human evolution in southern Africa, as behaviours considered to be indicative of increased complex cognition, such as pigment use [2] and hafted technologies [3] started to appear in the archaeological record. It is thus important to gain a deeper understanding of the environmental conditions that might have contributed to the rise of some of these behaviours. Although the Kalahari landscape is mostly flat, important geomorphological features, such as pans, are observed throughout. Pans are depressions in the earth's surface that are seasonally filled with water [1]. The distribution of pans could have influenced hominin site choices, as this would have reduced the distance to the nearest water sources. The pans can also assist in determining depositional histories and palaeoenvironmental conditions of the archaeological sites associated with them. However, very few studies have focused on conducting palaeoenvironmental analysis of the pans in the southern African interior. Our contribution presents several newly discovered Early and Middle Stone Age sites in the Tsabong area of the Kgalagadi district. These surface sites are mostly located on the ridges of the pans. The large accumulations of stone artefacts (several hundred to thousands per site) are located in close proximity to raw material outcrops. We will discuss in detail the geoarchaeological methodology used to investigate the associated pans and present the results of a sedimentological analysis from five localities. These results assist in testing hypotheses regarding both the depositional history and context of the Kalahari sediments, which will subsequently inform the prospected paleoenvironmental reconstructions of the landscapes utilised by groups of hominins.

Funding has been provided by the German Research Foundation (DFG) through the Emmy Noether Project "Kgalagadi Human Origins" Project Number 455851250.

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Poster Presentation Number 52, Session 1, Thursday 18:15

The relevance of blank predetermination in the Acheulean technocomplex of the Iberian Atlantic Margin (between Minho and Tagus rivers)

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Current data suggest the extensive presence of Large Flake Acheulean (LFA) assemblages in the Iberian Peninsula during the Middle Pleistocene [1-3]. In this sense, they display specific technological features within the European framework. These include the extensive use of large flakes, the presence of flake cleavers, the low degree of shaping of light-duty tools on flake, or the absence of predetermined flaking strategies (e.g., Levallois method) [1-3]. Furthermore, the development of sites seems to exhibit a significant chronological gap compared to that recorded in other European regions, with an extensive presence from Marine Isotopic Stage - MIS- 11, and especially between MIS 9-6 [1-3].

In the context of the previous discussion, we noted that there is a certain degree of asymmetry in the knowledge of this technocomplex between Spain and Portugal, which makes it necessary to deepen the research in the latter country [4]. Following this reasoning, here we present the study of more than 650 Large Cutting Tools (LCTs), mostly handaxes and flake cleavers, from sites linked to middle fluvial terraces of some of the main basins of the Atlantic side of western Iberia. Specifically, we have analysed the sites of Arbo (Minho River), Casal do Azemel and Capuchos (Lis River), Vale do Forno 1, Vale do Forno 3 and Cabeço da Mina (Tagus River). The LCTs were analyzed from 2D geometrical morphometric, techno-typological, and techno-functional approaches. The complementarity and inter-relation between the three procedures allow a holistic interpretation of these artefacts, from patterns of shape selection of the blanks to its transformation degree by shaping/retouching.

From this assessment, it is clear that the LCT group includes artefacts that are technologically distinct, but display a significant degree of support predetermination. This is particularly evident in flake cleavers. Indeed, besides the fact that their distal cutting edge is totally predetermined, we observed the existence of a pattern of blank selection by shape, which prevents extensive knapping transformation of the support. In this sense, we noted a recurrent behaviour, which is linked to the "shape determinism" of the blanks. In contrast, handaxes, that typically have pointed shapes (with specimens with distal chisel-edges being rare), usually display a greater degree of shaping, regardless of whether the support is a cobble or a flake. This pattern defines a strong difference in hominin technological behaviour between handaxes and flake cleavers, that can only be understood as a functional requirement. However, it is also important to point the existence of handaxes that testify a judicious use of the original volumetry of the supports, with a minimal transformation degree by shaping/retouching.

In sum, although there are shape/volumetric differences between the main artefacts included in the LCT group, they share important features: the management of large volumes of raw material; a well-defined mental template of the intended tool; and a strong standardisation, understood as the careful selection of the blanks, mainly for flake cleavers. Finally, this research contributes to deepen the understanding of the Acheulean technocomplex in Portugal and underlines the importance of "shape predetermination" in the choice of LCTs supports, highlighting a strong interrelationship between cognitive and motor skills.

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Virtual Pecha Kucha Presentation Session 8, Friday 17:05-17:30

The Neanderthal-like upper facial morphology of the Chinese late Middle Pleistocene fossil Maba 1

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The Asian Middle to Late Pleistocene fossil record has received recent attention for both the (re)discovery of the Xiahe Denisovan mandible from the Tibetan Plateau [1] and the Harbin skull [2-3]. To some this suggests that there may have been at least three hominin lineages (Denisovans - a sister-group of Neanderthals, *Homo sapiens*, and *H. longi*) living in East Asia in the late Middle Pleistocene [2-3]. Relevant to this discussion is the Maba 1 partial cranium discovered in the Guangdong Province in China and tentatively dated to between 300 and 130 ka. Following its original reconstruction by Wu and Rukang in 1959 [4], Maba 1 retains much of its upper face, including brow ridge, frontal processes of the zygomatic and maxilla, and right nasal bone. Like most African and Eurasian Middle Pleistocene hominins (i.e., *H. heidelbergensis/rhodesiensis*), Maba 1's estimated cranial capacity is within the range of modern humans and Neanderthals [5] and it has been described as having a combination of archaic (*H. erectus*-like) and derived (Neanderthal-like) features [4-5].

We performed a detailed three-dimensional shape analysis of the upper face and brow ridge of Maba 1, comparing it to Dali, African and European Middle Pleistocene hominins (n=8), Neanderthals (n=10), early and later *H. sapiens* (n=5, n=10, respectively), and early *Homo* (*H. erectus* s.l., n=5, and *H. habilis* KNM-ER 1813). Minor virtual reconstruction was performed on a 3D surface model generated from a cast of Maba 1 and landmarks and semilandmarks were applied. Following generalized Procrustes analysis, the shape coordinates were analyzed in a principal component analysis (PCA) in shape space, and individual and mean shapes were visualized in three-dimensions.

PCA in shape space reveals three distinct groups, Neanderthals, *H. sapiens*, and *H. erectus* s.l., along the first two dimensions which explains over 50% of shape variance. Maba 1, Dali, and all African and European Middle Pleistocene hominins partially overlap with the Neanderthal variation and are intermediate between them and early *Homo*. Maba 1's upper facial shape is Neanderthal-like, with its top nearest neighbors, according to inter-individual Procrustes distances, Neanderthals. Compared to the Neanderthal mean shape, Maba 1's brow ridge is more robust, but its upper face is more gracile, with a narrower interorbital breadth and less projecting nasal bones. Compared to Dali, it is smaller and more gracile.

Our results suggest that the upper facial morphology of Maba 1 and Dali is not distinct from most African and European Middle Pleistocene hominins, and that it is more like Neanderthals than *H. erectus*. These specimens are clearly distinct from Jebel Irhoud 1, an early *H. sapiens* fossil also dated to the Middle Pleistocene. Because of their alleged *H. sapiens*-like face yet archaic vault, the recently discovered Harbin skull, Dali, and several other Middle Pleistocene Chinese fossils (e.g., Jinniushan and Hualongdong) were allocated to a new species *H. longi* [3] to the exclusion of the more Neanderthal-like Maba 1 and Xuchang [2]. However, our study shows that many of the differences in upper facial morphology between Maba 1 and Dali are also noted as distinguishing the latter from Harbin [2]. For example, Maba 1 and Harbin have larger orbits and greater brow ridge curvature than Dali. Dali has a sagittal keel, whereas Maba 1 and Harbin do not. Based on the gracile features found on the Maba 1 facial bones it may have also possessed the more *H. sapiens*-like morphology of the lower face described in Harbin and others. A better understanding of the development, gracilization process, and polarity of these facial features is needed to disentangle the Chinese Middle Pleistocene human fossil record.

We would like to thank all curators who gave us access to fossil hominin specimens for computed tomography and analysis.

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Podium Presentation Session 6, Friday 12:40-13:00

Site formation processes and newly-identified Middle Palaeolithic guano-rich cave deposits: A revised stratigraphic examination of Tabun Cave Layer C

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The Middle Palaeolithic (MP) Layer C of Tabun Cave, Mount Carmel, Israel, holds a central role in paleoanthropological research due to its long cultural sequence and the incorporated skeletal remains [1], which uniquely represent two hominin populations [2-3]. Nonetheless, even though Tabun has been subjected to extensive Paleolithic research for over 90 years since D.A.E. Garrod's excavations and 50 years since A. Jelinek's excavations, many questions about its chronology, the identity of its hominin remains and the nature of its formation remain open. Tabun Cave MP sedimentary sequence measures over 13 m and within it, Layer C (~2.5 m thick) presents a complex sequence composed of multiple beds and thinner laminae within them (<5 cm thick), varying in colour, texture, and the amount of associated remains from human activity. Our study revisits exposed sediment profiles left after Jelinek's excavations at the site [4] in order to re-sample the sedimentary sequence in higher resolution than any previous study and identify possible variation through time. We were able to sample the full stratigraphic sequence of Layer C, with over 2.5 m thick sequence sampled for laboratory analysis, including the deposits immediately below and above Layer C (Layer D and B, respectively). The studied sequence largely conforms to the three Major Sedimentological Units (MSU I-III, themselves analogous to Garrod's layers B-D) previously defined by Jelinek et al. (1973). In order to provide a higher resolution and more refined interpretations into the evidently complex depositional and post-depositional processes characterizing this layer, we used mineralogical, elemental and micromorphological analyses of MSU II and the underlying and overlying sedimentological layers associated with the transitions between MSU III–II and between MSU II–I. Based on a reference and experimental sample collection, built especially for this study, we are able to demonstrate that the beds and laminae of MSU II (Garrod's Layer C) are primarily composed of bat and bird guano at various stages of preservation, occurring with varying amounts of allochthonous terra rossa soil and human activity remains, and generally not showing severe diagenetic changes. Above all, this study offers a new stratigraphic classification of Tabun Layer C being divided into four depositional sub-units (MSU IId-IIa), each composed of tens to hundreds of mm- to cm-thick laminae. An abrupt change from slow to rapid deposition of guano occurs between MSU III and MSU IId, followed by intensive use of fire in MSU IIc, then intermittent hominin use of the cave in MSU IIb. Lowered anthropogenic use of the cave characterizes the upper part of the section, where deposits become primarily biogenic (MSU IIa) and geogenic (MSU I). Using our reference collection and archaeological work at Tabun Cave, we demonstrate the ability to identify components within guano deposits that can allow distinguishing between different guano producers (e.g., bats and birds). Thus, in parallel to showing the complexity of Layer C, our study and methodology may also form a sounder basis for reconstructing changing environments at both regional and local scales and new venue to investigate human–environment relations in Palaeolithic cave sites.

We are indebted to the late Arthur Jelinek and his work at Tabun Cave. We wish to express our gratidude for his help and his permission to use his data base, as well as detailed stratigraphic sections. We also thank Paul Goldberg for his pioneering work in Palaeolithic cave geoarchaeology, starting at Tabun Cave, and for his help and support along the way. Thanks are also due to Steven L. Kuhn, for his continuous effort to re-analyse earlier results from Tabun Cave with us and bring them to publication. This research was funded by the Israel Science Foundation (ISF e No. 1955/16) to M.W-E, R.S. and L.W. and the Gerda Henkel Foundation (AZ/F/35) to M.W-E and R.S. Permission to sample the profiles at Tabun Cave was granted by the Israel Antiquities Authority (permit G/12e2017; G-15/2018; G-17/2019) and the Israel Nature and Parks Authority (17-A17, 18-A021, 19-A006). We thank Charles French for his support and Tonko Rajkovaca for helping with the preparation of the thin sections. Thanks to Dina Stiber and Olga Berlin of the Division of Geochemistry and Environmental Geology, Geological Survey of Israel, for the geochemical analyses of major and trace elements.

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Poster Presentation Number 52, Session 1, Thursday 18:15

Plasticity in orang-utan gestural communication and the evolution of productivity in human language

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Human language requires exceptional behavioural plasticity, given that effective communication in joint action contexts relies on highly flexible adjustments to social contexts, interaction partners and ecological settings. Thus, whether nonhuman species can adjust their communicative behaviour in response to the immediate ("behavioural flexibility") and developmental environment ("ontogenetic plasticity") has critical implications for communicative innovativeness prior to the emergence of human language, with its unparalleled productivity. Here, we used a comparative sample (N > 8000 communicative acts) of wild and zoo-housed orang-utans of two species (*Pongo abelii*, *P. pygmaeus*) to assess wild-captive contrasts in two parameters of communicative plasticity: (1) gestural repertoires (i.e. sets of gesture types) and (2) redoings (i.e. gestural repetition and elaboration after communicative failure).

First, we found that repertoires on both the individual and population level are larger in captive than wild settings, regardless of species, age class or sampling effort. In the more sociable Sumatran species, dominant use of signals towards single as opposed to multiple outcomes (i.e. functional specificity) was also higher in captive settings. Second, we examined gestural redoings and identified wild-captive contrasts in Borneans, but not in Sumatrans. Moreover, our results showed that the effectiveness of elaboration in eliciting responses was higher in Sumatrans, especially the captive ones, whereas effectiveness of mere repetition was influenced by neither species nor setting.

We conclude that orang-utans exposed to more sociable and terrestrial conditions evince remarkable behavioural plasticity, in that they produce additional innate or innovated signals, as well as more elaborate communicative repair strategies. Our findings also demonstrate that social tolerance, as a foundation for extended social interactions (both higher in Sumatrans and in captivity), plays a central role in the emergence of complex exchanges in great apes. Overall, these studies suggest a latent capacity for innovativeness in these apes' communicative systems, which is backed up by preliminary evidence for geographic variation in the use of vocalizations and gestures. A future large-scale project that systematically maps differences in repertoire and functional use across study sites may advance research on the precursors of productivity in unprecedented ways.

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

Direct cosmogenic nuclide isochron burial dating of early Acheulian stone tools at the T69 Complex (FLK West, Olduvai Bed II, Tanzania)

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Olduvai Gorge is one of the best-known paleoanthropological sites worldwide for the wealth of its Early Pleistocene paleontological and archeological record. This paper contributes to the ongoing effort to construct a solid geochronological framework for Olduvai archeological sequences by applying cosmogenic nuclide-isochron burial dating, for the first time, directly to stone artefacts. We apply the method to a new site named T69 Complex, located in the FLK West gully and positioned stratigraphically in Bed II.

The chronology of Olduvai Bed II is not well constrained compared to underlying Bed I, due to fewer tephra layers suitable for conventional K-Ar and Ar-Ar dating. Novelties of our contribution are twofold. First, this study applies a radiometric method that is still relatively new in archeology and has never been attempted before at Olduvai Gorge. Second, cosmogenic nuclide-isochron burial dating is significant because it can be applied directly to stone tools, rather than indirectly estimating ages from underlying or overlying sediments, or from surrounding sediments that are not always guaranteed to be the same age as the artefacts they contain. The stone tools selected for dating in this study were collected from the main archeological unit, T69L20. The dated artifacts are six quartzite cores and two quartzite hammerstones.

Cosmogenic nuclides are produced by cosmic rays interacting with elements on the Earth. The nuclide measurements in rocks and sediments allow us to study changes in landscapes at timescales of 1000 years to several million years. The isochron burial dating utilizes two cosmogenic isotopes (Be-10 and Al-26) measured in multiple samples collected from a stratigraphic horizon to determine a burial age. The approach is innovative by overcoming the uncertainty of conventional simple cosmogenic burial dating, which uses only one sample to calculate an age. The resulting isochron burial age in this study yields 1.48 ± 0.25 Ma age for this Olduvai Bed II sequence, which is consistent with previous dates from upper (~1.3 Ma) and lower bounding layers (~1.7 Ma).

To our knowledge this is the first attempt to aplly the cosmogenic nuclide-isochron burial dating directly to stone tools. The result is promising and opens up a new opportunity for future archeological studies. This Middle to Upper Bed II stratigraphic interval at Olduvai Gorge is a key period for our understanding of the disappearance of *Homo habilis* and the emergence of the Acheulian. This paper helps to more narrowly constrain the chronostratigraphic context to interpret assemblage variability during the onset of the Acheulian, at ~1.5 Ma in Olduvai Gorge.

Poster Presentation Number 4, Session 1, Thursday 18:15

New elements on the Gravettian-to-Solutrean transition in westernmost Europe: Calvaria 2 (Porto de Mós, Portugal)

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The Gravettian-to-Solutrean transition has been a central issue in the study of European Upper Palaeolithic [1]. During the early stages of the Last Glacial Maximum in Iberia and Southwest France, a pan-European technocomplex, using bone or wood projectile points armed with lithic barbs (Gravettian), was replaced by a regional technocomplex using stone points as hunting weaponry: the Solutrean.

In the mid-1990s a transition phase between the Gravettian and the Solutrean, characterized by the presence of Vale Comprido points [2], was identified in the littoral of Central Portugal: Estremadura [1,3].

Using radiometric data, the correlation between consistent stratigraphic sequences and the characteristics of the lithic reduction strategies, Zilhão, Aubry & Almeida [1,3] have presented a three-step model for the Gravettian-to-Solutrean transition (27 to 25 Ky cal BP) in Estremadura: 1) Late Gravettian: characterized by the presence of truncated and backed bladelets, microgravettes; 2) Terminal Gravettian: with marginally retouched bladelets and some backed bladelets produced from carinated cores (thick endscrappers); 3) Protosolutrean: with Vale Comprido points and marginally retouched bladelets.

Recently, two important open-air sites dating to the third phase of the transition process, Portela 2 and Calvaria 2, were discovered and excavated, on the scope of mitigation projects [4]. The chrono-cultural ascription was based on the abundant number of Vale Comprido points recovered at those two sites; their study is supporting a re-evaluation of the existing transition model.

The Calvaria site was excavated in 2009 due to the construction of a highway (A19). Although only the bottom layers were preserved (part of the sequence was disturbed by agriculture), about 4 000 lithic artefacts were recovered from a 100 m² excavated area. Faunal remains were not preserved but the recovery of *Pinus sylvestris* charcoal provides some information on paleobotany.

Portela 2 was re-excavated [5] in the scope of the PALEORESCUE project and the technological study of the Calvaria 2 lithic assemblage is currently ongoing. Special attention is being given to the identification of raw material sources. From a geological point of view, the site is situated in the Lusitanian Basin, close to Jurassic outcrops, though the excavation showed that the Pleistocene human occupations were preserved in colluvial sands. Flint represents 90% of the raw materials used and Cenomanian flint (locally available) is the best represented type. Formal tools are rare, and the lithic assemblage is characterized by one major reduction sequence: the production of elongated, naturally pointed blanks to be transformed into Vale Comprido points.

Radiometric dating of a *Pinus sylvestris* charcoal sample indicated an age of 25 159 – 24 376 cal BP (VERA7041).

So far, the gathered data indicate that human occupation at Calvaria 2 took place during the final stages of the Gravetian-Solutrean transition and this work aims at presenting a better characterization of the lithic industry and contributing to an understanding of human adaptations in reaction to environmental changes on a regional scale.

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Poster Presentation Number 63, Session 2, Friday 18:15

Lagomorphs in the Acheulean menu: taphonomic analysis of rabbit remains from the Valdocarros-II site (Jarama valley, Madrid, Spain)

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Although in the Iberian Peninsula the consumption of small mammals by humans, especially in Pleistocene sites, is mainly restricted to lagomorphs, in other areas such as Argentina, the easy capture by humans of fossorial micro- and mesomammals that live in colonies (caviomorphs, rodents and armadillos) is commonly observed in archaeological sites. A review of the palaeoenvironmental evolution of the Pampean region (Argentina) demonstrates that humans are an important taphonomic agent that could cause distortive effects in taphonomic patterns of non-human predators and palaeoecological interpretations [1]. Humans acted as selective predators, and when they are present, an increment in the number of small mammal prey with larger sizes is observed. However, the origin of small mammal remains in fossil sites is a key issue as they are also an important source of food for a large number of non-human predators. In the Iberian Peninsula, rabbits are usually predated by humans but also by other predators such as the European Eagle Owl, the Spanish Imperial Eagle, Fox, Iberian Lynx and Wild Cat. Therefore, the presence of rabbits in archaeological contexts could be the consequence of human and non-human predation.

Valdocarros-II is an open-air fossil site located in a fluvial environment associated to an abandoned meander in the Valdocarros unit from the Complex Terrace of Arganda in the Jarama valley (Madrid, central Spain). The site yielded ages of 254 ± 47 ka BP and 262 ± 0.7 ka BP, corresponding to the end of MIS8 and the beginning of MIS7. Several bone remains of large mammals have been recovered from the site and the zooarchaeological analysis suggested that hominids were the main accumulating agent of these bone remains. Apart from large mammal remains, small-vertebrate remains were also found, and rabbits (*Oryctolagus cuniculus*), are dominant in the assemblage [2].

Results obtained from the taphonomic analysis reveal the absence of possible transport events, and a high incidence of root marks, manganese staining and cracking associated to humid conditions. Weathering was not observed, supporting a probable fast burial of the bone remains or, at least, a dense vegetation cover which protected the remains from being weathered. Bone breakage was high (only the 1.39% of the elements were found complete) and most of the specimens analysed correspond to adult individuals. Digestion traces were also found in cranial and post-cranial remains, mainly concentrated in light degrees. Approximately, a 20% of the elements analysed show signs of digestion, which could be linked to the presence of a nocturnal bird of prey. Nonetheless, these percentages are lower than expected even for a European Eagle Owl (*Bubo bubo*).

The presence of human activity in the site has been reported and the possible acquisition and consumption of rabbits by humans is supported by the presence of anthropic traces (e.g., cut marks and burnt bones). Therefore, it could be considered the intervention of different predators in the accumulation of rabbit remains in Valdocarros-II. A possible mixture produced by eagle owls and lagomorph remains discarded by humans seems to be a plausible hypothesis to explain the low digestion percentages observed, which do not fit with any known taphonomic pattern of non-human predators. Anthropic and avian activities observed were probably not simultaneous and most likely humans and raptors alternate in time-periods. Comparisons with the results obtained from lagomorph assemblages from other Middle Pleistocene sites such as PRERESA in Manzanares valley, which is clearly related to the intervention of avian predators [3], support that the exploitation of lagomorphs was probably more intense in Valdocarros-II.

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Pecha Kucha Presentation Session 9, Saturday 9:15-9:40

The ontogeny of masticatory system mechanical performance and facial remodelling in modern humans and Neanderthals

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Morphological studies of the Neanderthal craniofacial system have shown that its post-natal ontogenetic trajectory diverges from that of modern humans [1]. Analyses of bone modelling of the developing craniofacial complex provide insights into the growth process that the craniofacial complex undergoes during development and inform us about ontogenetic processes that lead to differences in final adult form [2]. In modern humans, maxillary growth is characterised by bone resorption on the anterior subnasal surface, whereas in Neanderthals extensive bone deposition is found in this region [2].

Such differences in the pattern of bone remodelling between Neanderthals and modern humans have been hypothesized to be related to genetic signals that differ between these species, or to differences in force resistance arising from food processing during post-natal development. Additionally, within each species, the forces experienced by the cranium develop over time as diet and paramasticatory behaviour change [3-4]. While we cannot test the hypothesis that differences in growth remodeling are driven by differences in genetic regulation of craniofacial growth, we can test the hypothesis that remodeling differences arise from differences in how biting forces are generated and borne by the cranium. Thus, if changes in mechanical forces interact with changes in cranial form during development to drive differences in growth re-modelling, we expect differences in strain magnitudes and distributions to reflect the anatomical locations of differences in growth remodeling.

In the present study, we used CT scans of ontogenetic samples of 12 Neanderthal and 63 modern human skulls. Geometric morphometric and multivariate regression approaches were used to create a craniofacial growth model for each species. These models were used to extract a 3D virtual cranium representing the mean adult, juvenile and infant in each species. The 6 mean crania were then converted into finite element models and used to conduct two biting simulations; at the right fourth premolar or second deciduous molar (RP^2/RdM^2) and right central incisor (RI^1). Using Finite elements analysis and a series of multivariate analyses, we aim to highlight the differences in the strain distributions and magnitudes observed in the two species and to relate these to patterns of bone remodeling in each species.

In both RI^1 and RP^2/RdM^2 biting, the strain contour plots show that the highest strains are localised on the anterior maxilla, orbitals, and anterior subnasal surface in both species. These generally decrease between infancy and adulthood. In both RI1 and RP^2/RdM^2 biting, juvenile and infant models present higher strains than adults at the anterior maxilla with strains in Neanderthal infants exceeding those in modern humans on the working side. Over the anterior subnasal surface, the juveniles and infants present the highest strains. These are greatest in modern humans in RP^2/RdM2 biting while the opposite is found in the RI^1 biting simulations. Finally, for both biting simulations, modern humans and Neanderthals deform differently and show differences in the development of biting forces.

These findings confirm differences in masticatory system loading, strain distributions and magnitudes between modern humans and Neanderthals are found throughout life. Differences in modes of deformation and strain distributions are reminiscent of, but not perfectly coincident with, the known differences in remodelling maps. As such our findings do not falsify the hypothesis that facial remodelling differences arise because of differences in facial biomechanics. We cannot exclude the possibility that differences in growth remodeling patterns arise as a direct consequence of differences in cranial biomechanics. However, further work is needed to relate cumulative strain maps arising from a wider range of masticatory loads to facial growth remodeling features.

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Pecha Kucha Presentation Session 11, Saturday 15: 05-15:25

Improving classification accuracy in hominid subspecies using machine learning and high-density geometric morphometrics.

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Biological classification of hominin fossil remains is one of the most central and fiercely debated topics in paleoanthropology. Fossil remains are crucial for our modern understanding of human evolution. But the paleoanthropological record is sparse, fragmentary and often poorly preserved [1]. In addition, the classification of isolated fossils often entails assigning remains to one or more closely related species with overlapping anatomical variation. Therefore, fragmentary fossils are often assigned to species without explicit discussion of the classification accuracy of the relevant anatomical region, and without steps to maximise this classification accuracy. Due to small sample sizes associated with hominin species, we can approach hominin classification based on patterns of variation observed in great apes, as they are the closest living relatives of fossil hominins and the timescale of their diversification is similar [2].

To determine the classification accuracy of different craniofacial regions, we used dense configurations of surface semilandmarks [3] to describe the shape of the parietal, frontal, supraorbital, maxillary, nasal and zygomatic regions across 150 chimpanzee and 83 gorilla crania. Each of these regions included 144-363 semilandmarks to capture morphological diversity across chimpanzee and gorilla species (*Pan troglodytes* vs. *P. paniscus*; *Gorilla gorilla* vs. *G. beringei*) and subspecies (*P. t. schweinfurthii* vs. *P. t. troglodytes* vs. *P. t. verus*; *G. g. gorilla* vs. *G. g., dehli* vs. *G. b. beringei* vs. *G. b. graueri*).

Machine learning algorithms [4-5], as well as more classic classification approaches, such as linear discriminant analysis (LDA), were applied to these dense configurations of landmarks. The ability of these models to correctly classify chimpanzees and gorillas into species and subspecies by cranial region was assessed by measuring the accuracy of the model when applied to an unseen subset of the sample.

Some machine learning algorithms, such as support vector machines (SVM), generally performed better than LDA, although differences in classification accuracy were smaller than expected. Our empirical results also indicate that no anatomical region is universally better when classifying hominid species and subspecies. The nasal region showed the highest accuracy for classifying gorilla species, whereas the parietal region showed the highest accuracy to classify chimpanzee species (both >90%). The maxillary region showed the highest accuracy to classify gorilla subspecies (>70%), whereas the parietal region showed again the highest accuracy to classify chimpanzee subspecies (also >70%). The frontal and supraorbital regions performed relatively poorly compared to the parietal and the midfacial regions (nasal, zygomatic and maxilla). These differences in classification accuracy across different craniofacial regions are likely related to species- and subspecies-specific adaptations.

Our results indicate that classification accuracy can be improved by using high-density geometric morphometric approaches in combination with machine learning algorithms. However, these results also indicate that there is a limit on the maximum accuracy that can be attained when dealing with closely related subspecies, which will be exacerbated when classifying fossil hominins due to the limited and fragmentary nature of the fossil record. Our results also indicate that no anatomical region is universally more accurate, suggesting that fossil hominins may show different patterns of classification accuracy. These results indicate that classification accuracy for particular anatomical regions and configurations of landmarks should be properly quantified and discussed when classifying fragmentary fossil remains, which will help understand the uncertainty associated with those results.

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Poster Presentation Number 36, Session 1, Thursday 18:15

The Sima I of the Polvorín (Karrantza, Biscay): a new site with Neandertal lineage fossil remains in the Eastern Cantabrian Region (Northern Iberian Peninsula)

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The Iberian Peninsula is a key region to understand the evolution of Neandertals. It has yielded the largest European Middle Pleistocene fossil human assemblage (Sima de los Huesos-SH) [1] as well other known sites with Upper Pleistocene Neandertal remains, including purposeful burials, cannibalized remains and fossils with carnivore tooth-marks. With the exception of SH, well-preserved postcranial fossil remains are still scarce in Iberia. In this context, we present new fossil remains, comprising both cranial and postcranial remains, belonging to a single adult individual, with Neandertal morphological features, identified in the collections housed at the Arkeologi Museoa (Bilbao, Biscay).

The recent review of the paleontological collection recovered at the Sima I (cave pit) of the Polvorín cave (Karrantza, Biscay, Northern Iberian Peninsula) has allowed the identification of several human remains that show morphological features present in the Middle and Late Pleistocene Neandertal lineage. The Polvorín cave (180 m.a.s.l., Karrantza, Biscay) is located in the SW slope of the Peña de Ranero, 82 m above Karrantza river. The entrance of the cave is one of the classical archaeological sites from the Basque Country and was firstly excavated in 1931. This and more recent excavations have revealed a stratigraphic sequence with Middle and Upper Paleolithic occupations as well as a more recent (Holocene) prehistoric use of the cave [2]. The Sima I is located in a lower conduit of the cave system which is difficult to access. From the cave entrance, after c. 50 m, a lateral conduit has to be taken and then, using special caving equipment, descent a 7 m shaft and a 25 m sub-vertical ramp.

The human fossil remains identified at the museum comprise three virtually complete thoracic vertebrae, a partial thoracic vertebra, a partial right radius, an intermediate hand phalanx, and a partial hallucal metatarsal. The curvature of the shaft of the radius, the orientation of the transverse processes of the thoracic vertebrae, the relative width of the hand phalanx, and the shape of the metatarsal shaft are consistent with the morphology present in Neandertals, but also present in their Middle Pleistocene ancestors [3]. These human remains were found in a purely paleontological assemblage, mainly composed by cave bears and hyenas. These fossil remains were recovered in 1983 (n=255) [4] and 2000 (n=84) by speleologists from the surface of the cave in a disturbed context. The new excavations in 2021 have allowed to find three additional human fossil remains: a parietal fragment, a shaft fragment from a left radius, and a lateral cuneiform. Most of the bear remains from Polvorin-Sima I housed at the Arkeologi Museoa can be classified as *Ursus spelaeus* but a few remains show a morphology consistent with *U. deningeri*, which suggests a diachronic accumulation. *U. deningeri* is a taxon also present in the nearby (1.65 km as the crow flies) cave of Santa Isabel de Ranero, which has yielded one of the largest accumulations of this species in Iberia [5]. Additionally, the taphonomic analysis has revealed that the human remains do not show any sign of anthropic or carnivore mark and that the faunal remains show very low evidence (c. 7.5% of the remains) of carnivore activity. The preliminary geological study of the site shows different phases of infilling and erosion, with perched sediment remnants (with fossil remains) at different heights of the gallery. In fact, a minimum of three different fossil accumulation phases have been provisionally determined which would be consistent with the presence of two bear chrono-species in the recovered fossil assemblage.

In summary, the Sima I of El Polvorín has provided evidence of faunal remains from the Middle and the Late Pleistocene, and has also yielded 10 human remains belonging to single adult individual with morphological features present in the Neandertal lineage.

The excavations at Polvorín-Sima I are funded by the Diputación Foral de Bizkaia-Bizkaiko Foru Aldundia and the Ayuntamiento de Karrantza-Karrantzako Udala. Thanks also to Javi Moreno for all his support during the field work. AGO and NS are supported by a Ramón y Cajal fellowship RYC-2017-22558 and RYC2020-029656-I respectively. AP is financed by a research grant from Junta de Andalucía, Spain (EMERGIA20_00403). This project is also supported by the Basque Country Government (research group IT418-19), the Ministerio de Ciencia e Innovación-Agencia Estatal de Investigación, Grant Number: PGC2018-093925-B-C33 (MCI/AEI/FEDER, UE) and the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (Grant agreement No. 949330).

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Pecha Kucha Presentation Session 2, Thursday 11:55-12:20

Investigation of Neanderthal pyrotechnology through lipid biomarkers. An experimental case to understand molecular thermoalteration

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The study and interpretation of the evidence that demonstrates the controlled use of fire by Neanderthal groups in an archaeological context, i.e. pyroarchaeology, relies on various disciplines which, when put together, could reveal the existence of intentional combustion processes *in situ*. In the case of the Mousterian site of Cueva Des-Cubierta (Pinilla del Valle, Madrid), combustion processes are evident through the wide range of different archaeological remains recovered that seem affected by thermoalteration.

In addition, the human groups that inhabited the site have left their most visible mark in the form of an important collection of Mousterian lithic industry and abundant faunal remains, that include an unusual quantity of horned crania [1-2].

The Late Pleistocene stratigraphic succession of this site is made up by a clast-supported deposit. The circulation of water inside the cavity, as well as the complex sedimentary nature of the site, make it difficult to preserve the characteristic macroscopic elements of the combustion structures (ash or charred darkened sediment).

To confirm the evidence of *in situ* combustion in the interior of the cavity we applied a micro-contextual approach that includes micromorphology and organic geochemistry methodologies.

Analytical techniques in biomolecular archaeology allow us to obtain quantifiable data on the preserved lipid compounds. The separation and isolation of the different lipid fractions is carried out with extraction and derivatization processes that facilitates the detection of the chromatographic peaks of each compound through instrumental techniques. GC-MS (Gas Chromatography-Mass Spectrometry) allows detection of different molecular compounds contained in the sediment.

Here we present the results of the lipid compounds from an exhaustive experimental study. The experimental programme was performed to provide referential data at the microscopic and molecular scale in order to later approach the archaeological evidence collected at the site.

Four open-air hearths were built and were monitored in order to control the temperature reached, both on the surface and at depth. In addition, different materials (lithics, bones, speleothems and sediments) were included in these experiments and were recovered and thoroughly documented through their archaeological excavation.

The specific sampling of sediment from both the experimental hearths and the areas of the site presumably affected by combustion, allow the analysis and identification of various biomarkers related to the use of fire. Our first results show that the n-alkanes, one of the best preserved lipid biomarkers in the sedimentary record, experience certain degrees of biodegradation when exposed to different temperatures

This differential degradation of the n-alkane profiles obtained from the different experimental hearths sheds light on the degradation patterns of these biomarkers depending on the different variables related to combustion (temperature, fuel, sedimentary matrix). Obtaining data related to the other lipid fractions (aromatics, ketones and fatty acids) from both the experimental and archaeological samples will allow us to delve deeper into the characteristics of the combustion processes present in Cueva Des-Cubierta and their implications both for the formation of the hearth palimpsest and fire-related human behavior.

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Poster Presentation Number 112, Session 2, Friday 18:15

The human pubic symphysis: constraint or adaptation?

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The evolution of human childbirth and the pelvis has been intensively studied in recent years. Work has been heavily focused on pelvis shape and linear dimensions because shape and size are the main determinants of the space available in the birth canal and they thus predict the ease with which the fetus can pass through. But the degree of pelvic joint mobility also affects the space available inside the birth canal. The human pubic symphysis is a cartilaginous joint, capable of a limited amount of lateral expansion during birth. However, there are other primates and non-primate mammals that show much more flexible pubic joints, possessing not a symphysis proper but a syndesmosis, creating the appearance of a pubic "gap". In some taxa, this pubic gap is clearly an obstetric adaptation to birthing single, large fetuses, like in bats (Chiroptera). So why did humans not evolve a more flexible pubic symphysis, easing childbirth?

Taking a comparative approach, I documented the variation in adult pubic symphyseal morphology among ~100 placental mammal species across all major groups based on CT scans and dry skeletons. This revealed three potential states ranging from rigidity to high flexibility: a synostosis (a fused "symphysis"), a "true" symphysis (a cartilaginous symphysis), and a syndesmosis (a pubic gap spanned by a hyperflexible ligament). Next, I analyzed these pubic symphysis character states in relation to body size, locomotion, relative neonatal size, and phylogeny.

Marsupials and monotremes only possess synostoses. By contrast, both synostoses and true symphyses are frequent among placentals, with syndesmoses being less frequent but widespread phylogenetically. Nevertheless, there is strong phylogenetic signal in symphysis morphology, with many higher-order groups exhibiting a bias towards one character state. This can partly be explained by locomotion and habitat, which are also phylogenetically conserved: high-impact locomotion, such as running and digging, tend to favor a pubic synostosis (e.g. in large cats, canids, bovids, equids, aardvarks, pangolins). Among primates, partial synostoses were observed among some individuals of highly terrestrial Old World monkeys (*Chlorocebus aethiops* and *Erythrocebus patas*). Phylogenetic heritage can also be "overridden" by locomotor behavior and obstetric demands. For example, seals diverge from the typical carnivoran pattern (a synostosis) by possessing a true symphysis, which is required for giving birth to relatively large fetuses and enabled by their aquatic lifestyle.

The occurrence of a syndesmosis is evolutionarily labile, occurring in all major branches of placental mammals (Xenarthra, Afrotheria, Euarchontoglires, Laurasiatheria). It is also a strongly sexually dimorphic trait: when females possess a syndesmosis males of the same species nearly always do not. However, the occurrence of a syndesmosis is also strongly linked to small body size (< ~1 kg). It tends to occur in small-bodied placentals that either birth a single, large neonate (as in bats and bushbabies) or a large litter of small neonates (e.g. 15-30 offspring per litter as in some hedgehogs and tenrecs). This indicates that a syndesmosis can be obstetrically adaptive by enabling birth of a large offspring and by providing more space for the uterus to expand in the abdominopelvic cavity during pregnancy.

Humans' relatively large body size may thus have prevented them from evolving a more flexible pubic symphysis morphology, like a syndesmosis. Nonetheless, their strong terrestriality, obligatory bipedalism, and propensity for long-distance running, would predict a pubic *synostosis* despite an ancestral state of a true symphysis. Together with the low frequency of (partial) pubic synostoses in humans, even in old age, and the tight fetopelvic fit owing to large neonates, this implies that the true symphysis in humans is an obstetrical adaptation.

Poster Presentation Number 55, Session 1, Thursday 18:15

From the function to the structure of tools: going backwards in the lithic chaîne opératoire to investigate the diversity of lithic assemblages of the European Lower Palaeolithic

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European Lower Palaeolithic assemblages are characterized by a wide range of diversity (bifaces, flakes industries, pebbles, small tools…). This variability is accepted but still misunderstood, which constitutes an obstacle to identify the socio-economic behaviors of human groups in this period. Differences in assemblage composition are often explained only by cultural factors, without taking into account the influence of the raw material, tools function or the palaeoenvironmental context.

As tools are produced to meet a need, we choose to participate in their characterization by focusing on their function. In this perspective, through a combined functional and techno-morpho-functional analysis, we first identified the modes of use of the tools, then we went backwards in the chaîne opératoire to identify the structuring elements of the tools (active part, prehensile part and energy transmitting part; [1]). This approach gives the opportunity to comprehend the tool at different levels: at the individual scale and within its lithic assemblage. The structural and functional requirements conditioning the tools being then defined, the other factors influencing tool production, such as cultural trends or raw materials availability, could be perceived.

The study focuses on nine archaeological lithic assemblages, which are representative of the typo-technological diversity that characterizes the period and from varied occupation modalities and paleoclimatic contexts: Soucy (France; MIS 9), Marathousa 1 (Greece; MIS 12) and Valle Giumentina (Italy; MIS 15-12). These sites are well-dated, well-preserved and well-documented, to build a solid chronostratigraphic and contextual framework.

The results show that the tools are used in a brief and gentle way for a diverse range of activities. They are frequently structured around an active and a prehensile part (cortex, back, abrupt and/or irregular retouch) regardless of the blank. The adaptation to the local raw material and the desire to obtain a cutting edge and a non-cutting edge could be the reason for the diversity of the ancient artifacts. It suggests that the composition of the lithic assemblages reflects the flexibility of human groups and their adaptation to immediate needs, to diversified local raw materials and to varied paleoenvironmental contexts. Other elements such as weight or ergonomy should be considered now to continue this re-evaluation of the lithic assemblages from the Lower Palaeolithic.

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Pecha Kucha Presentation Session 9, Saturday 9:40-10:05

Multi-isotopic ($\delta^{44/42}$Ca, $\delta^{88/86}$Sr, $\delta^{66/64}$Zn) analysis from single bone and enamel aliquot of Upper Pleistocene mammals from Camiac, France

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Non-traditional stable isotopes have been increasingly studied in the past decades in the archaeological and anthropological fields for their potential as ecological and dietary tracer. Measurements of modern bone and tooth enamel show that calcium ($\delta^{44/42}$Ca) [1], strontium ($\delta^{88/86}$Sr) ([2] and zinc ($\delta^{66/64}$Zn) [3] isotopes are good indicators of diet and trophic position. These three elements can be recovered and analyzed from one single sample of less than 10mg. Despite this advantage, a multi-proxy study has not yet been attempted whereas it would allow less destructive analyses of precious Pleistocene samples. The present study consists in analyzing calcium, strontium and zinc isotopes in fossil bones and tooth enamel of carnivores and herbivores from the Camiac cave (Upper Pleistocene, Gironde, France) excavated by one of us [ML; 4]. Usually, non-traditional isotope studies focus on fossil tooth enamel rather than bone, as dental enamel is more resistant to alteration and natural taphonomic processes. However, bones are usually more abundant in archaeological sites and give access to late life information, which make them an interesting material to study. Our study aims at 1) developing a protocol of Ca, Sr and Zn stable isotope analyses from a single sample 2) testing the preservation of biological isotopic signatures of diet in bone and tooth enamel, and 3) comparing the variations of the three isotopic systems in a fossil ecosystem. Results obtained for the $\delta^{88/86}$Sr are very similar to $\delta^{44/42}$Ca results and they display differences between two groups of herbivores (ruminant and non-ruminant herbivores). It is the first time that $\delta^{66/64}$Zn results have been obtained in fossil bones and they are very encouraging as Zn isotope ratios in bone and teeth mirror one another and show a good separation between herbivores and carnivores. The concomitant analysis of these three isotopic systems on the two most abundant mineralized tissues of the fossil record allow to separate herbivores following their digestive system and allow a good separation between different trophic levels. Thus, it highlights the importance of analyzing several isotopic systems in a single sample and shows encouraging results for the preservation of biological isotopic signatures in fossil bone. This new methodology will surely be of use to study paleodiet in ancient human populations with limited sampling possibilities.

This work was supported by the European Research Council (ERC ARCHEIS 2019-2024), based at the GET, Toulouse. PJD and BM are funded by the CNRS and have benefited from the scientific framework of the University of Bordeaux's IdEx "Investments for the Future" program / GPR "Human Past". We would also like to thank the Musée d'Aquitaine (Bordeaux, France) for giving us access to the samples.

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Podium Presentation Session 12, Saturday 17:00-17:20

Scratching the surface: the genetic bases of brain globularity

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Endocranial imprints in fossil skulls document evolutionary changes within the *Homo sapiens* lineage toward a more globular endocranial shape [1]. It has been hypothesized that differences in the tempo and mode of brain growth and maturation, particularly myelination, contribute to the unique globular endocranial shape of modern humans [2]. However, it is not possible to uncover the underlying developmental processes based on endocasts alone, as they represent only the brain's outer surface. Prior work on magnetic resonance imaging (MRI) brain scans of around 4500 healthy adults suggested a link between globularity and the expression of two genes involved in neurogenesis and myelination, respectively [3]. Here we broaden the search in a genome-wide association study (GWAS) based on a substantially larger dataset of MRI brain scans and genetic data from individuals of European ancestry in the UK Biobank (N=33,951) [4]. In addition to Neanderthal introgressed alleles [3] we examine contributions of "archaic deserts" in the genome, i.e., large regions depleted of introgressed fragments from Denisovans and Neanderthals, and ancient selective sweep sites.

We quantified the endocranial shape of the UK Biobank brain scans in a framework of shape differences between a sample of modern human (N=102) and Neanderthal (N=10) computed tomographic (CT) scans using geometric morphometrics. As a summary metric for overall brain shape, we calculated a *globularity score* for each individual by projecting the Procrustes shape coordinates onto the vector between the mean shapes of modern humans and Neanderthals following [3].

GWAS identified 27 genome-wide significant loci, containing a total of 154 independent genome-wide significant single nucleotide polymorphisms (SNPs) associated with interindividual differences in the globularity score. These SNPs were linked to 215 genes, based on location and functional genomics data. Gene property analysis using MAGMA software revealed that genes associated with interindividual variation of the globularity score were significantly enriched in late-prenatal and early childhood brain tissues from the BrainSpan database. Notably, we found significant enrichment in tissues of the cardiovascular and reproductive systems, both based on gene property analysis using GTEx gene expression data, and partitioning heritability (linkage disequilibrium score regression) in regulatory regions identified with chromatin data. The ventricular system, and several distinct white matter tracts were most strongly related to the globularity score among 565 neuroanatomical features analyzed with genetic correlations and a phenome-wide association scan. Partitioned heritability analysis of genomic annotations showed significant enrichment of identified variants in archaic deserts.

As expected, our data show that endocranial globularity is a complex trait influenced by multiple factors. Our findings go beyond confirming prior hypotheses linking endocranial globularity to the brain's white matter, to reveal which distinct white matter tracts may contribute. Based on the association between the globularity score and the ventricular system we hypothesize that rounder endocrania may be caused in part by an increased hydrostatic pressure of cerebrospinal fluid. Our finding that genes and regulatory regions associated with endocranial globularity show significantly enriched activity in tissues of the reproductive system suggests that genetic effects on brain shape and function may have co-evolved with the reproductive system. In such a scenario, evolutionary selection acting on either system would also affect the other. Thus, perhaps the greatest advantage of our approach is that it can uncover unexpected signals, generating novel testable hypotheses for future work.

We thank all curators of fossil and modern crania for access to the material in their care. We are grateful to the participants of the UK Biobank. This research was funded by the Max Planck Society.

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Poster Presentation Number 103, Session 2, Friday 18:15

Room for communication: affordances for language evolution in the ESA

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(Spoken) Language is a human phenomenon, the evolution of which is difficult to be traced. The study of the origins of language has so far paid little attention to the question of concrete conditions of bodily-spatial co-presence, based on which linguistic communication has evolved. What are relevant places, social situations and states of co-presence that accompanied or even promoted the emergence of language? Although on a basic level also evident in great apes, hominins developed specific performances and structured spaces that fostered communication. We identified three configurations within the archaeological record that could have created room for intensified co-presence and joint attention.

1. Modularization (example: Lokalalei 2C, Kenya, 2.34 Ma): The decoupling of basic needs and their immediate satisfaction facilitated the partition of behavioral sequences into smaller independent units (modules). These could be conducted separately of each other at different times and locations with intermediate goals. As side-effect, several individuals could act in different modules and thus co-operate in reaching the final goal.

2. Use of specific locations as central place for congregation (example: David's site, Tanzania, 1.84 Ma): The repeated visit of a site for specific purposes is another hint for intensified co-presence. This is especially due when both the raw material for tools as well as the things to be worked or consumed were transported to the site, and these transports were beyond the capacity of one individual.

3. Maintenance of fireplaces (example: Gesher Benot Ya'aqov, Israel, 780 ka): Keeping fire alive is a sort of caretaking that – with its different elements like gathering fuel and adding it at intervals – affords the participation of several group members that are all rewarded by warmth, light, and protection. The fire structures the place where to gather (central place), the mode how to gather (offering a prolonged face-to-face situation), and the time when to gather and to do something.

All these practices create a common focus and an interactional space. Extended coordination and cooperation would therefore have supported the interactive alignment between group members. On different levels, the modularization of social practices and tasks went in hand with a re-organisation of the chrono-spatial environment that was conducive for extended and, possibly, more focused forms of communication.

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Podium Presentation Session 4, Thursday 17:50-18:10

Hybridization in the Late Pleistocene: Merging morphological and genetic data

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Recent research has shown that the process underlying modern human origins was considerably more complex than previously appreciated. We now know that gene flow between distinct lineages (e.g., Neanderthals, Denisovans, early *H. sapiens*) occurred repeatedly in the Late Pleistocene, and this has resulted in a shift in the prevailing human origins model: from one of near-complete replacement to a more nuanced view of partial replacement with reticulation. Here we explore the degree to which cranial variation seen in the fossil record of Late Pleistocene hominins from Western Eurasia corresponds with current genetic and other comparative data, aiming to help understand the degree to which skeletal morphology can reflect admixture. We interpret results in the context of predictions derived from model taxa, including primate and mouse hybrids.

Three anatomical regions of the skull were considered: the mandible, the face and the posterior cranial midsagittal profile. Our sample comprises late Middle and Late Pleistocene (roughly corresponding to MIS 7-2) fossil human specimens from Europe, Africa and the Middle East assigned to Neanderthals and *H. sapiens*, including, but not limited to, individuals that are genetically known and morphologically proposed hybrids. In order to frame our study consistently with studies of model organisms, the Neanderthal sample is considered as representing one of the "parental" populations. Because of the poor representation of penecontemporaneous African early *H. sapiens* in the fossil record, we consider a pooled sample of ancient and recent sub-Saharan Africans (from eastern and southern Africa), expected to have no or minimal Neanderthal ancestry, as a proxy for early *H. sapiens* anatomy and the second "parental" population (African *H. sapiens*). Our datasets consist of 3-D coordinate data of landmarks and semilandmarks designed to capture salient morphological features considered Neanderthal or *H. sapiens* derived traits routinely used for taxonomic identification. The data were processed with Procrustes superimposition and semilandmark sliding and analysed using Principal Components Analysis. A shape index was developed by calculating an axis between the mean Neanderthal and mean African *H. sapiens* shapes and projecting Eurasian *H. sapiens* onto it. Data indicating the presence of non-metric skeletal abnormalities, and genetic information on percentages of Neanderthal ancestry, where available, were compiled from the literature.

Our findings [1] indicate some correspondence between these different lines of evidence, flag individual fossils as possibly admixed, and suggest that different cranial regions may preserve hybridisation signals differentially. We discuss our results in the context of equifinality (similar results produced through different evolutionary mechanisms). We urge further studies of the cranial and skeletal phenotype, in order to expand our ability to detect the ways in which migration, interaction and genetic exchange have shaped the human past, beyond what is currently visible with the lens of ancient DNA.

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Poster Presentation Number 37, Session 1, Thursday 18:15

The Grotte de l'Hyène (Arcy-sur-Cure, North-East of France) Neandertal maxilla III: new study of its dental macrowear, oral paleo-pathologies and behaviors

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Some Neanderthals present heavily worn teeth, especially anterior teeth relatively to the posterior ones. With the teeth as tools and dental loading hypotheses [1-2], Neandertal dental macro-wear has also been investigated together with oral pathologies. Moreover, there are numerous case studies regarding peculiar dental wear on isolated Neandertal teeth.

Whereas biotriboligical and biomechanic works are developed in exploratory studies on larger extant human samples and/or on complete dental arches; the whole Neanderthal masticatory apparatus cannot be extensively reviewed, due to the fossil record, methodological and interpretative bias. Nonetheless, studies on fossil maxillae and mandibles have the potential to help us understand isolated tooth wear and potentially associated patterns, such as hypercementosis.

In this presentation, we will focus on the analysis of dental macrowear of the sub-complete Neandertal maxilla III, discovered at the Grotte de l'Hyène or GH (Arcy-sur-Cure, France) during A. Leroi-Gourhan excavations in 1951 [3-4]. We will also present the same analysis conducted on four isolated teeth from the Grotte du Bison or GB (Arcy-sur-Cure). We must point out that, these two caves (GH and GB) are related to the same limestone cliff and are few hundred meters apart.

GH maxilla III is renowned for showing evidence of an intense activity together with alveolar bone pathological manifestations. However, it was never further investigated. In this study, we will describe this specimen creating a three-dimensional digital model, and compare its tooth wear patterns along with those of the GB isolated teeth.

We will analyse the occlusal surface topography of the teeth, using occlusal fingerprint analysis (OFA). OFA is a method used to understand how wear facets are formed, through mechanical constraints. Molar macrowear accumulates during the lifespan of an individual and thus reflects masticatory activities over long periods. Our aim is to adapt the OFA protocol to identify non diet related wear and identify para-masticatory stigmata, created by some repetitive activities. Furthermore, CT scans analysis also provide further evidence for the extensive GH maxilla III alveolar pathologies and tooth modifications.

Our main results will underline peculiar wear patterns on several teeth of the dental arch of GH maxilla III, especially large occluso-distal faceting on almost all the teeth, in addition to heavily chipped anterior teeth (labialy). Two deciduous canines, one canine and one premolar from the GB showcase similar occluso-distal wear patterns. For these specimens, we will highlight different stages of occluso-distal wear patterns, comparable to the GH maxilla III ones in shape and orientations. Interestingly, those similarities are shown on both deciduous and permanent teeth. This could allow us to discuss potential peculiar Neandertal behaviors.

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Podium Presentation Session 12, Saturday 16:20-16:40

The HARVEST project: insights into roles of plant foods throughout human evolution

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Modern day human diets are characterized by a high degree of flexibility and a reliance on processing, but a reduced variability compared to those of our closest living relatives. The development of this dietary repertoire is highly debated, and the first appearance of these traits as well as the relative importance of specific food items throughout our evolutionary trajectory remains a contentious subject. Our understanding is somewhat limited by methods and theoretical frameworks that emphasize the consumption of animal-derived resources, while the potential role of plant foods remains undervalued.

For the past five years, the ERC-funded HARVEST project has asked: What types of plants did hominins eat, and why did they choose the ones they did? We have employed a variety of methods, and explored the relative influences of energetic, environmental, and behavioral constraints. Analyses of plant microremains and residues preserved in dental calculus has provided a snapshot of the kinds of foods consumed by various fossil taxa (e.g., [1]). We have furthermore developed a model dental calculus system that allows us to explore new analytical methods and address hidden biases associated with the extraction and analysis of microremains [2]. Our studies of food preferences and energetic costs of various subsistence-related behaviors among the Baka forager-horticulturalists in Cameroon have highlighted the interactions between cultural mores, individual preferences, and energetic constraints [3]. Our analysis of variation in plant properties among microhabitats in southern and eastern African environments similar to those used by hominins has allowed us better model what nutritional qualities drive their food choices. A novel approach using methods and frameworks from environmental science and modern ecology has offered new insights into the habitats and plant types early hominins potentially exploited, and the surprising variation within and across foods thought to be typical, and atypical, of early hominin diet [4]. Finally, we have assessed how the energetic costs of food processing, including both internal processing such as chewing and external processing such as cooking over a fire, might influence food choices and dietary behaviors [5]. Results from these studies have indicated that plants were an essential part of the hominin dietary repertoire throughout our evolutionary history, and that the consumption of plants is determined by environmental, caloric, cultural, and personal influences.

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Poster Presentation Number 39, Session 1, Thursday 18:15

Dental macrowear analysis of the Neanderthal mandible Bourgeois-Delaunay 1 (Charente, Southwestern France)

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Neanderthals are characterized by large anterior teeth relative to the posterior dentition, with a distinctive morphology marked by robust crowns, strong shovelling, labial convexity, presence of a lingual tubercle and by a high level of wear [1]. The latter is often cited as one of the main pieces of evidence indicating the use of teeth as tools for daily task activities. Such interpretation is based on ethnographic studies from Inuit and Australian Aboriginal populations. The repetitive use of the anterior dentition could have led to a change of the cranio-mandibular morphology, as proposed by the anterior dental loading hypothesis [1], resulting in the unique Neanderthal cranio-facial anatomy.

The aim of this study is to examine tooth macrowear patterns of the Neanderthal mandible of Bourgeois-Delaunay 1 (BD1) to obtain information about its chewing behaviour and its diet, in combination with dental tissue proportions and cortical bone distribution. The remains of BD1 were recovered in 1967 from layer 12 of Bourgeois-Delaunay cave shelter located in the final Middle to initial Late Pleistocene site complex of La Chaise-de-Vouthon (Southwestern France). The mandible, with complete and well-preserved dental crowns, has been dated between 127 and 116 ka (Marine Isotope Stage 5e) and it has been associated with temperate fauna [2].

To shed light on BD1 masticatory behaviour, we employ the occlusal fingerprint analysis method [3], a digital approach based on the identification and measurement of occlusal wear facets, enabling to decode information about diet and cultural habits of the individual. We combined the macrowear results with published enamel and cortical bone thickness data of BD1 [4].

BD1 is characterized by a greater level of wear in the anterior teeth relative to its posterior dentition, which follows the typical Neanderthal pattern [1]. Moreover, a detailed examination of premolars and molars reveals the presence of larger dentine exposures and larger enamel wear facets on the left side, suggesting that the left part of the mandible was the preferred chewing side of BD1. The dental tissue proportions are equally distributed between the left and the right antimeres, without a clear asymmetric pattern. However, a slight right dominance in cortical bone thickness is found at M1/M2 and M2/M3 levels [4]. The discrepancy between asymmetric wear and cortical bone distribution could be partially due to the balancing movements that occur in the non-working side of the mandible during mastication.

Furthermore, a comparative analysis of the relative wear areas of the right second molar places BD1 in the deciduous woodland ecogeographic distribution, which is compatible with a diet consisting of meat and plant foods [5]. This agrees with the temperate fauna associated with BD1 [2].

Future studies are needed to better understand if the unique Neanderthal cranio-dental morphology represents an adaptation to resist high mechanical loadings due to tooth-tool uses.

The fossil specimen BD 1 is curated at the Musée d'Angoulême and access was kindly provided by the curator J.F. Tournepiche. Scanning of the mandible BD 1 was performed by R. Macchiarelli and A. Mazurier within the framework of the European «TNT Project» at the ESRF beamline ID 17 (Grenoble) thanks to the local collaboration provided by A. Bravin, C. Nemoz and P. Tafforeau. This study was supported by the Australian Research Council (grant number: DP190100465), and by the Monash Biomedicine Discovery Institute PhD scholarship.

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Podium Presentation Session 3, Thursday 14:20-14:40

Biological profile and early life history of the Upper Palaeolithic infant of Grotta delle Mura (Puglia, Italy): integrating dental histology, aDNA, and time-resolved geochemical signals

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Grotta delle Mura (Puglia, southern Italy) is a karstic cavity located at the bottom of a small bay in central Puglia (Monopoli, BA, Italy), with an Early Neolithic to Middle Palaeolithic stratigraphic sequence. Here, in 1998, the University of Siena excavated an infant's grave with no grave goods, which was enclosed and covered by rocks with the side facing the cave's entrance left open [1]. The remains were initially attributed to the Final Epigravettian, though recent direct AMS radiocarbon dating provided a calibrated age range of 17,079-16,990 cal BP (68.3% probability).

In this study we apply a multidisciplinary integrated approach that combines, for the first time, dental histology, spatially-resolved elemental and isotopic analyses through LA-(MC)-ICPMS, and ancient DNA analyses to reconstruct the biological profile and early life history of the Upper Palaeolithic infant from Grotta delle Mura.

The histological analysis of the enamel of the upper left first deciduous incisor (ULdi1) and upper right first permanent molar (URM1) provided high temporal-resolution insight into the child's development and health during both the pre- and post-natal stages. The ULdi1 shows an early crown initiation (~30 weeks before birth) and a fast crown formation time (~41 weeks) compared to modern standards, as well as several physiological stress events (3 prenatal and 1 postnatal, two of which developed hypoplastic defects on the enamel surface). Chronological age at death was estimated through histology on the still forming URM1 at ~13 months after birth. The reconstruction of the individual-specific odontochronology guided the spatially-resolved trace element (Sr, Ba, U, Mn) and isotope (87Sr/86Sr) analyses which identified and possibly timed – despite a complex-to-resolve diagenetic imprint due to incomplete mineralization of the URM1 – breastfeeding, the onset of weaning at ~4 months, and the likely absence of mobility during enamel deposition.

In concert, the paleogenetic analysis, through genome-wide sequencing on the left petrous bone, enhanced the information on the child's biological profile. The infant was male and belonged to Y chromosome haplogroup I2a. The uniparental markers belong to lineages already detected in post-LGM and Mesolithic hunter-gatherers of western and southern Europe. Single-nucleotide polymorphisms predict some phenotypic traits of the infant (i.e., blue eyes, dark skin, and curly brown hair) and his inability to digest milk in adulthood (due to the presence of the ancestral alleles on rs4988235 and rs182549 of the MCM6 gene). The identification of two pathogenic variants (rs397516457 on the TNNT2 gene and rs193922385 on the MYBPC3 gene) associated with congenital hypertrophic cardiomyopathy suggests a potential correlation with prenatal stress events identified in the enamel, but higher nuclear coverage is necessary to confirm the proposed genotype. Moreover, the reconstruction of 75% of the nuclear genome with an average depth of 2.5X places him at the extreme end of the Western Hunter-Gatherer group, whereas the long runs of homozygosity suggest the existence of a close familial relationship between the parents.

This study sheds light onto the growth and health of an Upper Palaeolithic infant, who did not survive beyond 13 months of life, and describes the early stages of the child's nursing. The possible close parental relationship between his parents suggests an unprecedently reported high level of endogamy in this society. Overall, the infant from Grotta delle Mura contributes to our better understanding of the Italian peninsula genetic puzzle following the Last Glacial Maximum.

We thank the Superintendence of Archaeology, Fine Arts and Landscape for the metropolitan city of Bari - Ministry of Culture, Italy. This work was supported by the European Research Council under the European Union's Horizon 2020 research and innovation program (grant number 724046, SUCCESS; www.erc-success.eu) awarded to S.B. and (MSCA-IF-2018-842812-WEAN-IT) awarded to A.N., as well as by the Italian Ministry of Education, Universities and Research (MIUR) through the PRIN 2017 action (20177PJ9XF – AGED) awarded to D.C

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Podium Presentation Session 3, Thursday 15:20-15:40

Exploring spatio-temporal variation in the disappearance of Neanderthals in the Italian Peninsula using high precision radiocarbon dating and Bayesian modelling

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The last decade has seen significant improvement in the ability of chronometric scientists to reliably date Palaeolithic archaeological sites. Developments in instrumentation and pretreatment chemistry have improved precision and decontamination, leading to increased reliability. The process of the biocultural shift from a Neanderthal-dominated Europe and western Eurasia to one exclusively occupied by *Homo sapiens* has proven difficult to diagnose on the basis of material cultural remains alone. It appears on the basis of radiocarbon dating and genetics that there was a long overlap between the two groups, during which there was interbreeding and hybridisation [1-2].

Chronology is crucial to determine the extent to which overlap occurred and for how long. Italy is a key region because we can discern the presence of early Upper Palaeolithic industries which appear to be linked and related to the presence of early *Homo sapiens*. One of the key industries related to this has been suggested to be the Uluzzian technocomplex [3], found stratigraphically after the Mousterian and prior to the Proto-Aurignacian. Questions remain regarding the relationship between the Uluzzian and the preceding Mousterian in the context of the Italian Peninsula and Greece.

In this paper we present new chronometric evidence based on robust new radiocarbon AMS determinations and OSL dates, obtained from the four key sites in the south of Italy; Cavallo, Castelcivita, Cala and Oscurusciuto (where research is directed by the University of Siena). We used the most optimised methods to obtain reliable radiocarbon and OSL date estimates, and built Bayesian models using the latest calibration curves and the OxCal calibration programme. The results more reliably document the initial presence of some of these earliest lithic industries. We find that the Uluzzian starts later than originally thought [2]. By building a larger Bayesian model and integrating the results from other sites in Italy we test whether there is a cline in the beginning and ending of these industries from the south to the north of the Italian peninsula. We will explore the implications for the process of the transition to the Early Upper Palaeolithic and the disappearance of Neanderthals in the region.

The research leading to these results has received funding from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013 grant 324139 "PalaeoChron") awarded to TH, and the European Union's Horizon 2020 Research and Innovation Programme, grant agreement no. 715069 (FINDER) to KD; and ERC grant "SUCCESS" (724046) awarded to SB - which supported excavations at La Cala and Castelcivita. We thank all members of the project as well as the staff of the Oxford Radiocarbon Accelerator Unit and Oxford Luminescence Laboratory, University of Oxford. Research at sites has been carried out under permission of local heritage offices.

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Poster Presentation Number 32, Session 1, Thursday 18:15

Using technological, taphonomical and spatial analysis to understand multi-occupational Palaeolithic surface sites: the case of Zahrani River Mouth lithic scatter in Southern Lebanon

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Surface lithic scatters are the most common type of sites from the Palaeolithic Period found in any landscape on Earth. These may range from single isolated finds to extensive multi-component workshop sites located on primary or secondary raw material outcrops; each site or locality contributes different amounts of information aiding the reconstruction of human prehistoric landscape use. Despite their numerous nature and potential, lithic surface scatters have often been neglected compared to cave sites and other types of stratified occurrences. To some extent, this dichotomy is warranted by the overwhelming potential of cave sites due to the chronological control provided; however, in this study, we show how technological, taphonomical and spatial analysis of surface finds from the Zahrani River Mouth site (Lebanon) may be used to construct a relative chronology and, thereafter, assess site occupation throughout the Palaeolithic.

The site is located on the coastal plain of Southern Lebanon, approximately 8 km south of Sidon on a raised terrace five meters above the current sea level. The vicinity of the site has been severely altered by construction activities; however, a high quantity of lithic artefacts was collected during a systematic survey of 55 m² of the site. Over 500 stone tools were recorded using a handheld GPS device. Lithic artefacts were subjected to technological, typological and taphonomic analyses. The lithic analysis included attribute analysis of the technological features on the blanks, cores and tools. Different quantitative and qualitative methods were used to classify and categorize the lithic assemblage and reconstruct diachronic site function and changes in lithic production patterns across the Middle Palaeolithic. Based on the analysis of the surface alterations on the lithic artefacts and comparison of these patterns with a reference collection, different processes could be discerned: a) incorporation of the artefacts within a pebbled beach environment associated with various sea high stand events during interglacial conditions, b) incorporation of artefacts to a predominantly aeolian sandy environment likely associated with sea low level stands during glacial phases, and c) an organic-rich soil environment during phases of increased vegetation cover of the coastal environments.

Our study shows how site use patterns had changed through the ever-shifting tides of marine transgression and regression, and climate-induced landscape oscillations, and possibly reflecting different lithic traditions. Overall, our analysis of the Zahrani River Mouth site suggests a Middle Palaeolithic occupation preceding the MIS 5 sea-level high stand characterized by large flakes with prominent striking platforms and semi-prepared unidirectional parallel cores. We also identified a post-high stand occupation characterized by preferential Levallois flake and point production using various modalities of the Levallois method, including Nubian Levallois technologies.

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Podium Presentation Session 12, Saturday 16:40-17:00

So much more than teeth: how knowledge of the genetic architecture of the dentition improves and broadens our understanding of human evolution

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Teeth dominate the fossil and bioarchaeological records because they consist mostly of inorganic material. Consequently, dental anthropology has long been essential in our investigation of the human past. Variation in the anatomy of teeth is instrumental for differentiating species, identifying biological affinities between populations, making inferences about dietary adaptations, and timing key developmental life stages. However, recent advances in genetics, genomics, and developmental biology undermine many assumptions built into anthropologists' study of the size and shape of teeth by revealing extensive pleiotropy–when one gene influences more than one anatomical structure simultaneously. These pleiotropic effects offer a new set of opportunities for the study of human evolution. Here, we provide an overview of our investigations into dental pleiotropy over the last two decades. Our research uses two distinct approaches: one based on quantitative genetics and another on insights from genome-wide-association-studies (GWAS) and developmental genetics. We will demonstrate how knowledge of pleiotropic effects broadens and improves research into human evolution.

For example, with the concept of pleiotropy at the core, Hlusko and colleagues used quantitative genetics to construct matrices of genetic correlations by analyzing dental variation in a pedigree of captive baboons housed at the Southwest National Primate Research Center in Texas. These genetic correlation matrices provide the base for comparative phenotypic correlation studies assessing the similarity of these matrices (the genetic architecture) across cercopithecid monkeys, anthropoid primates, mammals more broadly, and ultimately, the fossil record [1]. The results demonstrate that our genetically-defined traits are better proxies for phylogeny than traditional size measurements [2], and when explored through time via the fossil record, reveal two major categories roughly corresponding to species within the genus *Homo* and those that are not [3].

More recently, we demonstrated that dental variation can be exploited for insight to the evolution of some soft-tissue anatomies thanks to the pleiotropic effects of the ectodysplasin and WNT developmental pathways on teeth, hair, mammary glands, and other ectodermally-derived epithelial structures [4]. Using morphological variation in maxillary incisors (incisor shoveling), we identified selection during the last ice age on the ectodysplasin pathway in the Arctic, hypothesizing that the target of that selection was mammary glands and not the dentition. Consequently, this research reveals that dental variation can provide a window into human variation that extends far beyond teeth (e.g., [1, 5]).

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Poster Presentation Number 93, Session 2, Friday 18:15

Hominins Making a Splash

Chris Hopton[1], Sally Reynolds[1], Marc Vander Linden[1], Jason Heaton[2]

1 - Bournemouth University · 2 - Birmingham-Southern College

Faunal proxies have long been employed to reconstruct the palaeoenvironment of significant hominin sites. Typically, this method relies on the presence or absence of indicator bovid species, or similar herbivores such as equids, to deduce vegetation types around the site catchment area. Broadly, changes in abundance in various mammal indicator species can indicate climate or ecological changes, which provides context for understanding contemporary hominins developments. Despite being a key component in any hominin environment, the importance of water is often overlooked in preference of concepts noting vegetation aridification as a primary evolutionary driver. More recent work has highlighted the potential significance of natural springs and palaeolakes in reconceptualising how we view some of our more arid hominin-bearing deposits. In this study, I evaluate the role of aquatic faunal records as a means to understand the hominin site characteristics better. I will use existing faunal records pertaining to a varied taxonomic sample in combination with modern wildlife indices detailing physical characteristics, to create a correspondence analysis to identify similarities between physical characteristics – such as body mass or size – and apparent absence from faunal rich sites to highlight any potential underrepresentation that may be evident in groups such as microfauna. Implications will be discussed, including the likelihood of preservational or previous researcher bias within the broader area of study. This research forms the basis of a wider study that will seek to re-evaluate how we view evolutionary drivers, in particular aridity and the presence of 'hydrorefugia' within continental Africa.

Poster Presentation Number 43, Session 1, Thursday 18:15

The environmental niche of *Homo neanderthalensis*: its significance and changes through time

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Modelling the ecological niche was developed for conservation studies and has been in use for more than a century [1]; however, its application to the extinct hominin species is relatively new. Models allow us to gain a different perspective on key influences on evolutionary processes. The genus Homo has occupied virtually every habitat on earth and survived, lived, and often thrived through massive climatic shifts. Most published literature around Homo focuses on the taxonomic and morphological variability in the members of the genus, but this ignores a more fundamental question; did the different species of the genus occupy the same ecological niche? How did these species deal with climate change? Did they adapt, migrate or become extinct? Were the extinctions brought about by climate change or only speeded up by it? Here we attempt to explain the niche of Neanderthals and how it changed over millennia. Our own species remains loosely defined as occupying a 'generalist specialist' niche [2], but does this hold true for others?

The Neanderthals Homo neanderthalensis one of the few European species in the hominin ancestry, are the closest to us in a temporal sense and present many similarities to our own species. This has made them a subject of continuing interest. As a species, Neanderthals were distinctly different from modern humans, with stocky and muscular bodies, large, barrel-shaped chests, receding chins and broad noses. However, they shared many of our behaviours, and their development seemed to match ours in some significant areas, such as the capacity for symbolic expression [3]. Their world was unfamiliar to ours as we know it now. The open, steppe-like landscapes that dominated Europe in their prime had good exposure to sunlight and rich vegetation that sustained considerable populations of mammoth, bison, deer, horse and reindeer – species fundamental to the Neanderthal diet. Neanderthal landscapes were nothing like the barren steppes of present-day Eurasia or any landscapes anywhere in today's world.

Here, we present the results of analyses to model the Neanderthal niche using Maxent [4] which uses presence data of sites with a high certainty attribution to the species and reconstructed environmental data [5]. The resulting models show the climatic optimum for Neanderthals, which helps us understand them as people, their climatic requirements, and ecological preferences from the first appearance of this species (circa 300kyr) to the last appearance (circa 40kyr). Coupled with geological data, the results can open new prospects for finding additional sites, as well as help us understand how they differed from our own species.

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Poster Presentation Number 6, Session 1, Thursday 18:15

First evidence for corvid synanthropism in the Mid Upper Palaeolithic of East-Central Europe

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Synanthropism refers to forms of animal behaviour benefitting from, and promoted by, human neighborhood, and in turn typically involves adaptation to human-shaped environments [1]. Establishing the time-depth, contexts and patterns of synanthropism is important not only for understanding how human-animal relationships evolved through time, but also to identify and trace low-threshold processes of anthropogenic ecosystem-shaping and the often subtle ways in which Pleistocene hunter-gatherers impacted and "co-engineered" the webs of life in which they participated. We here provide the first direct evidence for synanthropic behaviour among raven (*Corvus corax*) in the Gravettian of the Pavlovian Hill region (Czech Republic). We sampled 15 previously published raven specimen from the classic Gravettian localities of Pavlov, Dolni Vestonice I and Predmosti I to assess the birds' diet and mobility through isotope analysis and to situate the raven in the wider food-web of the regional Mid Upper Palaeolithic. Twelve of the sampled ravens yielded enough collagen to determine $\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$ values. We use a Bayesian mixed model approach to 1) reconstruct dietary compositions of the raven individuals and 2) to examine trophic niche overlap between Gravettian ravens, other scavengers and humans, the latter of which have largely focused their subsistence efforts on mammoth [2]. Our results reveal two separate groups of ravens: specimens of the first group showed the same $\delta^{34}S$ isotopic signature as the local fauna and fed primarily on mammoth, while specimens of the second group showed higher $\delta^{34}S$ values and primarily consumed other herbivores, such as horse and reindeer. Independent ^{14}C age determinations on a subsample of the raven individuals indicate that both groups are penecontemporaneous but that the dated birds are mainly associated with the final stages of Pavlovian site biographies in the area. We interpret this data as evidence for "local" ravens adapting to human settlement and foraging fingerprints (mammoth preference), with the possibility of "non-local" birds from adjacent areas drawn in by human-mediated foodgetting opportunities. These findings confirm earlier hypotheses on corvid facilitation through human behaviour [3-5] and add to the growing evidence for human impacts on Late Pleistocene ecosystems before the LGM. These impacts, as implicated by our data, have the capacity to steer localized human-environment feedbacks centered on carrion landscapes and food leftovers, thereby disclosing unique subsistence opportunities also for the involved human foragers.

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Poster Presentation Number 81, Session 2, Friday 18:15

Morphometric analysis of the mandibular and maxillary molar sample from Lomekwi, Kenya

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The discovery of *Kenyanthropus platyops* at Lomekwi, Kenya [1] expanded hominin taxonomic diversity during the Pliocene in Africa, placing it alongside recognized taxa such as *Ardipithecus ramidus*, *Australopithecus afarensis*, *A. anamensis*, *A. bahrelghazali*, and *A. deyiremeda*. An analysis of the maxilla of the *K. platyops* holotype KNW-WT 40000 has shown that it is different from other *Australopithecus* [2]. Additionally, the crown size of the M2 and the estimated size of the M1 of the paratype KNM-WT 38350 were observed to fall below (or at the lowest end of) the ranges seen of contemporaneous hominin species [1]. In this study we analyze the isolated molar sample from Lomekwi to 1) quantitatively assess their tooth positions, and 2) undertake a comparative morphological analysis of the enamel crown shape through 2D GM by capturing both the shape of the occlusal outline and fissure pattern. The comparative sample included specimens from *A. afarensis* (n=43), *A. africanus* (n=68), *A. anamensis* (n=18), *H. habilis* (n=11), and early *Homo* (n=13). Since the taxonomic affinities of the Lomekwi sample are unclear (and in principle they could sample more than one taxon), a determination of tooth position of the isolated molars was based on comparison to combined maxillary and mandibular molar sample of the three *Australopithecus* taxa. Evaluation of tooth types was carried out with canonical variate analyses using principal components (PCs) in shape and form space.

The majority of the Lomekwi molars classified consistently as one molar type using shape (68.4-100%) and form (73.3-100%) data, with three exceptions: KNM-WT 38339 which classified 52.6% of the time as an M2 with shape data, but 100% as an M1 with form data; KNM-WT 38349 classified as an M3 78.9% of the time with shape data, but 100% of the time as an M1 with form data; and KNM-WT 38359b which classified as an M2 94.7% and 57.9% of the time with shape and form data, respectively. Two of the upper molars (KNM-WT 16003 and KNM-WT 38362A) consistently classified as one tooth type across the analyses using shape (71.4%) and form (77.7-100%) data. KNM-WT 38337 classified 50% and 44% of the time as deciduous maxillary second molar with shape and form data, respectively. However, the molar plots within the cluster of permanent maxillary first molars, suggesting that it is morphological information present in later PCs that drive the molar to classify as deciduous.

In the PCAs where there is a reasonable distinction between *A. afarensis* and *A. africanus*, the Lomekwi maxillary and mandibular molars tend plot closer to the *A. afarensis* cluster. However, the M1 Lomekwi specimens are distributed across the two groups, with some plotting outside those clusters. Lomekwi M2s form their own group and do not overlap with other *Australopithecus* groups. Additionally, some Lomekwi lower molars exhibit an unusual morphology. For example, KNM-WT 38333 has a significantly reduced hypoconulid, KNM-WT 38339 which is buccolingually very broad and possess a very large hypoconulid and small entoconid, and KNM-WT 38347 which displays a typical M3 morphology yet in size falls well below the range of M3s of the comparative sample. In conclusion, most Lomekwi molars can be assigned a molar position with high confidence. While the molar morphology is similar to *A. afarensis*, there are certain specimens which possess morphological traits that separate them from *Australopithecus*. Further analysis of 3D crown/EDJ shape and enamel thickness may help to clarify the taxonomic status of the Lomekwi sample.

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Poster Presentation Number 120, Session 2, Friday 18:15

Preliminary 3D mandibular dental analysis of *Ouranopithecus macedoniensis*

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Ravin de la Pluie (RPl) in Axios valley is one of the three localities where material from the late Miocene ape *Ouranopithecus macedoniensis* has been found. Material from RPl includes, among others, mandibular fragments and multiple isolated teeth (e.g., [1] and references therein). Although the dental remnants of this hominoid have been studied extensively, its internal dental structure is poorly known.

This preliminary analysis investigates and characterizes the root length and morphology in the lower postcanine dentition of *O. macedoniensis* and compares it to extant and extinct taxa using 3D techniques. Recent methodological advances allow the in-depth quantitative investigation of complex features, such as internal tooth morphology, traits previously difficult to assess. We measure the root length and characterize the root morphology in the premolars and molars of two original mandibular fragments (RPl-54 and RPl-75) and an isolated tooth (RPl-237) from *O. macedoniensis*. We compare our results with published data on extant great apes, humans, and a few extinct hominoid taxa (e.g., [2]), including the much-discussed *Graecopithecus freybergi* [3].

The results show that the *O. macedoniensis* specimens investigated here resemble the internal tooth morphology of the African apes and *Pongo*. Furthermore, they are homogeneous in their mandibular root morphology, suggesting that the configuration shown was not uncommon in this species. Unlike our previous work on facial and mandibular morphology, which found affinities between *O. macedoniensis* and *Gorilla* and *Gorilla* and *Pongo*, respectively [4-5], no clear relationship between *O. macedoniensis* and any of the great apes in postcanine mandibular root morphology was observed. Furthermore, the *O. macedoniensis* specimens so far examined differ from the described morphology of *G. freybergi* in the root and pulp canal configuration. Given the small number of individuals examined here, further research on the lower dentition is needed to clarify this issue.

This preliminary study contributes new data about the internal postcanine mandibular tooth morphology of *O. macedoniensis* obtained from three previously not investigated specimens from the RPl fossiliferous locality. Our results so far do not reject the hypothesis that *O. macedoniensis* is taxonomically distinct from *G. freybergi*. However, additional research on an expanded lower dentition *O. macedoniensis* sample is needed.

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Podium Presentation Session 5, Friday 9:50-10:10

Crumbs along the earliest Silk Road: new data from the Palaeolithic of Kazakhstan

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The foothills of the Pamir, Tian Shan, and Dzhungarian mountains trace a biogeographic corridor that connects two important areas for human evolution: the Fergana valley and the Siberian Altai. This so-called Inner Asian Mountain Corridor (IAMC), located mostly within Kazakhstan, may have provided an area of connected refugia from harsh climates during the Pleistocene and should provide a good record of hominin dispersal throughout the region. To date, this region contains very few secure, dated Pleistocene sites. To remedy this gap in knowledge, since 2017, the PALAEOSILKROAD project has been systematically searching for new Palaeolithic sites in the region [1-2], as well as re-evaluating known sites in order to improve the density of dated archaeological sequences.

Here, we present a general outlook on the distribution and chronology of known Late Pleistocene sites in Kazakhstan, followed by a report on our new field discoveries. This includes the ongoing excavations at four new cave sites in the Qaratau Range (Tuttybulaq 1, Aqtogai, Jetiotau, Hasan-Ungir) and three new open-air, loess sites (Tikenekti (Dzhungarian Alatau), Uzynagash (Almaty region) and Terektysai (Ugam region)).

Additionally, we report on the 14C dating and characteristics of the only previously known cave site situated in the Kazakh (southern) Altai, Bukhtarma Cave. The site was excavated during the 1950s [3] and was subsequently inundated during the 1950s by the construction of the Bukhtarma hydroelectric dam. We present here a summary of the zooarchaeological collection and new dating of cut-marked bones, demonstrating that the cave originally contained materials of multiple human and carnivore occupations after 50ka BP and up until the Holocene.

In conclusion, it appears that cave sequences in this region do deliver systematically older occupations than open-air sites, as suggested in one of our earlier papers [4]. Although significantly older sites have so far eluded our search, we have extended the chronological range of stratified Palaeolithic occupations to nearly 50 thousand years, which will enable us to draw conclusions about human occupation during the crucial time of the Middle to Upper Palaeolithic transition in the region, as well as to draw parallels with the two better-studied regions (Siberian Altai and the Fergana Valley).

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Poster Presentation Number 21, Session 1, Thursday 18:15

An assessment of the cultural connections between Aghitu-3 Cave in Armenia and the surrounding regions

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This paper synthesizes the study of lithic artifacts from Aghitu-3 Cave in southern Armenia, an Upper Paleolithic site located along the Vorotan River. We attempt to answer the question of the relationship of each of the find layers in the cave to the technical and cultural aspects of the surrounding regions.

Excavations at the cave revealed five archaeological horizons (AHs) providing evidence of Paleolithic occupation between 39,000 and 24,000 years ago. Notable finds include shell beads, an eyed bone needle, and other bone tools, plus a large assemblage of lithic artifacts and faunal remains. Based on typological and technological studies, as well as the chronostratigraphy of the Upper Paleolithic (UP) horizons, we divided Aghitu-3 into three main phases of occupation: early (EUP), middle (MUP) and late (LUP).

We call the oldest occupations in the cave EUP (AH VII-VI). They share some notable features with the southern Levantine Early Ahmarian culture, including core preparation and reduction techniques. People focused on narrow-faced uni/bidirectional cores [1]. We also find comparisons with the Early Ahmarian and Baradostian cultures with regards to tools, such as fine laterally retouched bladelets, points, and truncated burins [2]. However, we notice the absence of characteristic tools like El-Wad points (Early Ahmarian), Dufour bladelets and Arjeneh points (Baradostian) [3].

As for the MUP (AH IIID-B), we continue to see parallels with Early Ahmarian, Baradostian, and also Late Ahmarian. Baradostian cores show the same methods of core preparation as at Aghitu-3, wherewide-faced prismatic or bipolar cores predominate [4]. The tools are comparable to Early Ahmarian bladelets, points, backed pieces, and end scrapers [1], and also to Baradostian tools, such as laterally retouched bladelets and points [4]. Tools similar to the Baradostian are presentat Aghitu-3, but these are not as common, and include Arjeneh points (13%) and Dufour bladelets (6%). There is also some similarity with Late Ahmarian tools (Masraqan), for example, fine retouched bladelets, Dufour bladelets (6%), and multifaced burins [3]. However, some key components of Early and Late Ahmarian assemblages are lacking, such as El-Wad points and microliths.

The LUP settlement at Aghitu-3 (AH IIIA) shows an affinity with the Epipaleolithic Zarzian and, to a lesser degree, Late Ahmarian. As for the preparation of cores, Aghitu-3 is closer to the Zarzian, with wide-faced single and opposed platforms. As for the tools, we see Zarzian-like tools such as microliths, geometrics, and backed and extreme backed bladelets [5], but Zarzian points are not present. There are also similarities to Late Ahmarian tools such as bladelet tools, microliths, and multifaced burins, in addition to a scarcity of points.

These comparisons show a progression of artifacts that fit within the regional development of technology and tools. The features of the surrounding cultures seem to have left their mark on the tools of Aghitu-3: 1) the occupations of the EUP are similar to the Early Ahmarian and Baradostian; 2) the occupations of the MUP compare with Early and Late Ahmarian but, more often, Baradostian; and 3) the occupations of the LUP parallel Epipaleolithic Zarzian and Late Ahmarian. However, these comparisons should not be definitive evidence of the cave's affiliation with any of them, especially since the cave is located far away from these other regions. We stress the absence of typical artifacts, as well as the importance of the local character and technological requirements to satisfy specific needs of the inhabitants of Aghitu-3.

Gerda Henkel Stiftung, DAAD, The Role of Culture in Early Expansions of Humans (ROCEEH), Heidelberg Academy of Sciences and Humanities

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Poster Presentation Number 28, Session 1, Thursday 18:15

A palaeoecological study of the Pleistocene hyena population from Cueva del Camino site (Pinilla del Valle, Spain)

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The Late Pleistocene Cueva del Camino site (Pinilla del Valle, Madrid) represents one of the most complete MIS5 records from the Iberian Peninsula. It forms part of the collection of the Calvero de la Higuera-Pinilla del Valle archaeological sites. The site includes a high number of large and small mammals remains and two human teeth [1]. F. Alférez (Complutense University of Madrid) conducted the site excavations between 1980 and 1989 [2]. From 2002 to 2009 a new multidisciplinary research team resumed the excavations [1]. This work represents the first palaeoecological study where the entire hyena remains recovered from Cueva del Camino, are analysed.

The site is in the upper valley of the Lozoya river in the Sierra de Guadarrama, a mountainous alignment with a NE-SW direction and general pop-up structures that form part of the Sistema Central range formed by Proterozoic to Carboniferous rocks. It is part of a Karst developed in Upper Cretaceous carbonate rocks forming rock shelters and caves. Cueva del Camino is constituted by 4 sectors: the North, Central, Diaclasa Roja and South. The North and Central comprised the most abundant macrofaunal remains. The fossil assemblage studied come mostly from these sectors [1].

The assemblage comprises 237 *Crocuta crocuta* (Erxleben, 1777) remains. We carried out a dental ontogeny analysis employing X-ray imaging techniques on juvenile, subadult and adult cranial remains and isolated teeth. The ontogenetic analysis was performed following Demirjian et al., [3] and Cameriere et al., [4] methodology, originally applied on forensic science. The former consists in a description of the developmental processes of the tooth crown and roots. The latter is based on numerical values obtained by dividing the sum of the widths of the intern margin of the two open apices by the length of the tooth. Individuals were classified into five juvenile/subadult age categories. A minimal number of individuals (MNI) and a mortality profile was proposed, which was analysed through a ternary diagram and compared with other Pleistocene hyena sites. Although these analyses are commonly used in accumulations composed of preys hunted by humans, we adapted the three classical zones of a triangular graph to a mathematical zoning following the model proposed by Discamp and Costamagno [5]. The new specific age class boundaries were based on ethological and ontological data.

Previous studies suggested that Cueva del Camino mostly served as a hyena den [1]. According to extant *C. crocuta* studies, they used dens for a long period of time to rear their cubs. Juveniles stayed in their shelter from the age of 3 to the age of 8 months old, at the beginning of dental replacement. In Cueva del Camino, this time period is the most common in the mortality profile (Stages III and IV). In addition, the triangular graph indicates that the assemblage corresponds to a highly intensive communal denning activity. From an ethological perspective, the age structure from Cueva del Camino together with other hyenas Pleistocene sites, point to a common pattern in the use of dens, where the presence of neonates and subadults is rare. Previous authors have pointed out that the two human teeth recovered may have been incorporated into the assemblage by hyenas [1] discarding an anthropic origin. This is supported by the scarce evidence of human activity and taphonomic analysis and it is consistent with the large-term den occupation reported here.

This research was supported by the PhD scholarship "Training of researchers UCM Program" of the Univesidad Complutense de Madrid. This research was also supported by UCM research group Ecosistemas Cuaternarios (931098) and the research project 'Estudio del Valle de los Neandertales: hacia el establecimiento de un nuevo paradigma conductual en *Homo neanderthalensis*' (H2019/HUM-5840). We would also like to thank all the technical staff of the Diagnostic Imaging Service of of the Complutense Veterinary Teaching Hospital for their work and help in taking the X-rays.

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Poster Presentation Number 60, Session 1, Thursday 18:15

The ROAD Database: open access to information on human evolution

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The ROCEEH Out of Africa Database (ROAD; https://www.roceeh.uni-tuebingen.de/roadweb/) is a data source for the study of the deep history of human evolution. The database provides information about sites in Africa and Eurasia spanning from three million to 20,000 years ago. It unifies geographical data with information about geological and archaeological stratigraphies as well as dating. ROAD assimilates information on archaeological assemblages and human fossils, faunal and botanical remains, climate, and bibliography. Since 2009, the multidisciplinary team of the research center "The Role of Culture in Early Expansions of Humans" (ROCEEH; https://www.roceeh.net) of the Heidelberg Academy of Sciences and Humanities has integrated over 2,200 localities containing more than 18,000 assemblages from over 4,300 publications written mainly in English, French, German, Italian, Spanish, Portuguese, Russian and Chinese. ROAD serves as a valuable resource for archaeologists and paleoscientists because it contains vast amounts of information that can be easily accessed, but also explored using innovative methods in data science. The ROAD Summary Data Sheets [1], which can be downloaded as a PDF, aggregate basic information about a selected locality to gain an overview of a site.

The broader functionality of ROAD is based on its georelational structure managed with a PostgreSQL system. The database allows user interaction through its web-based application called ROADWeb, written in php, javascript and html. The SQL query builder tool helps users formulate questions to the database. The resulting lists can be exported as CSV files, or visualized directly in ROAD using another application, the Map Module. With its basic GIS functionality, the Map Module allows users to display the results of several queries on a selected base map from a given period (e.g., sea level, temperature, precipitation, biome, vegetation, etc.). The Map Module also links external databases containing, for example, faunal data from the Neogene Quaternary Mammals Database (Burgos, Spain) or paleoecological data from NEOTOMA (Madison, USA), which in turn can be queried and mapped.

ROAD admits to the FAIR principles. To increase findability, accessibility, interoperability and reusability, ROCEEH teamed with the ARIADNEplus (https://portal.ariadne-infrastructure.eu/) data infrastructure and began mapping ROAD data onto ARIADNE's scheme. Since 2021, users can also search ARIADNE to find prehistoric data contained in ROAD. Additionally, ROAD is registered with the repository re3data (https://www.re3data.org/) and published under an open Creative Commons license. To make ROAD data more FAIR in the future, the research team is working to incorporate its data into the Semantic Web and Linked Open Data. The ROCEEH team began the development of an RDF data model (i.e., ontology) and the RDF export of ROAD data. In 2021 the beta version of both were completed, so that today we can explore the exported data with SPARQL queries.

We encourage you to visit ROAD (https://www.roceeh.uni-tuebingen.de/roadweb/) and discover what else it has to offer. Should you wish to explore further, we provide expanded access to anyone interested.

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Poster Presentation Number 13, Session 1, Thursday 18:15

Aurignacian split-based points from the Swabian Jura in a pan-European context

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Split-based antler points are present throughout many regions where the Aurignacian culture is documented. We present the recent work on this important chronological and technological marker in the Swabian Jura of SW Germany, increasing the sample size three-fold as a result of continuous and ongoing excavations [1]. Split-based antler points count among the most numerous and wide-spread examples of early osseous hunting equipment across cave deposits in this region, including Geißenklösterle, Hohle Fels and Vogelherd. They exist alongside some of the earliest evidence of artwork including figurines, musical instruments and personal ornaments. We use typological, technical and experimental study to gain new insights into these antler points.

Their overall abundance correlates with the frequency of bony reindeer remains and current evidence points to shed reindeer antlers as the main source of raw material. Our study documents the life histories of antler points and demonstrates templates for manufacture of these archetypal artifacts from the Aurignacian, including the transformation of preforms to finished products through the reduction of the base. One exception is the absence of tongued pieces, which suggests that multiple methods were employed to create a split on the proximal end for hafting. Thus, split using wedges, employed in the Swabian Jura, can be as effective as split through double incisions, depending on the thickness and the size of the finished products. This research underlines the supra-regional patterns as well as variability in the manufacture process. The average and range in the size of the antler points also reveal extended use and recycling of tools that provide insights into the osseous as well as hunting technology employed by the Aurignacian people within in the vast spatial distribution of this cultural group. In addition, the results underscore the diversified use of osseous materials employed by modern humans in the early Upper Paleolithic.

This work was funded by SFB 1070 ResourceCultures at the University of Tübingen.

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Poster Presentation Number 79, Session 2, Friday 18:15

Bone as a resource in the South African Middle Stone Age (MSA): The development of operational networks and 'primary-poly-problems'

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During the MSA of Southern Africa, roughly from 100 to 77 ka, bone gained importance as a raw material in tool production. For the first time in human history bone was used to produce a variety of everyday items like arrow heads, spear tips, smoothers, pressure flakers and wedges. By analyzing the MSA bone tools from an action-oriented perspective, reconstructing the operational sequence of the underlying behaviors in effective chains, it is possible to trace a new technological system associated with this specific raw material. This system is designed for the material properties of bone and comprises several processing techniques. Bone tools amplified the scope of action of MSA groups. They were applied in new behavioral patterns, expressing innovative ways of thinking. Instead of approaching problems directly, humans took ways of solution that comprised a wide array of often interlinked behavioural options, resulting in complex operational networks. This web of problems and solutions becomes especially prominent if we switch our focus from bone to the whole animal. The study shows a major shift in the handling of prey in the MSA. Whereas for a significant part of the history of mankind animals were hunted primarily for their meat and nutritional purposes, in the MSA they became a source for a variety of raw materials, such as bone, skin, fur, and sinew, in different activities all inferable from the MSA bone tools. Prey was increasingly perceived as a set of solutions to solve a multitude of primary problems. With the emergence of such "primary-poly-problems" the complex operational systems are developing even further into full-blown three-dimensional networks. Problem-solution complexes did no longer show explicit starting or end points. Prey was needed to attain bone, which was used to produce arrow heads or spear tips to hunt that same prey. The bow, used to shoot the bone tipped arrow, comprised a bowstring probably made from sinew, again requiring an animal as the source for that raw material. This shows the close entanglement of various primary problems, such as the need of bone, meat and sinew and results in hunting and exploiting prey being the solution to those daily tasks. The change in the perception of prey also indicates a distinctive expansion of the resource space during the MSA opening a whole new world of possibilities by adopting bone as a raw material for tool production.

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Podium Presentation Session 3, Thursday 15:40-16:00

Anthracological recalibration: effects on Middle Palaeolithic environmental reconstruction and Neanderthal behavioural studies

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Palaeoenvironmental reconstruction is dependent on a number of sources, including palynological, sedimentology and microfaunal studies. An important aspect is arboreal species reconstruction from charcoal, either from anthropogenic or natural fire events. This is particularly important in the Iberian Peninsula, where anthracological research has enabled the landscape particularly of late *Homo neanderthalensis* to be accurately mapped [1]. However, a number of aspects confuse this issue, including humans actively selecting for prime fuels within the environment, and differential loss of anthracological material [2]. A further aspect of confusion can result if different species of wood create different amounts of charcoal when burnt [3], as this can affect all methods of quantifying charcoal (mass, volume or fragment-counting).

To understand this issue better, I created charcoal from 35 genera of wood found in Neanderthal hearths, finding significant differences in the amount of charcoal produced when burnt under identical reducing conditions (foil and sand for 1h), at 350°C and 700°C. These two temperatures respectively represent the optimal charcoal-producing temperature, and the highest temperatures that prehistoric fires would normally have reached. I found that softwoods produce approximately one fifth less charcoal than hardwoods, with maximum wood-to-charcoal conversion rates of all genera in these experiments ranging from c.25-40% at 350°C, but only c.0.5-5% at 750°C. However, resinous softwoods, including the Pinus genus, a dominant tree in many Middle Palaeolithic European contexts [4], are among the higher producers of charcoal at 350°C, presumably from the resinous content acting as a further reducing agent. A genus' production rate at 350°C (high or low) did not necessarily correlate to their production at higher temperatures.

I recalibrated published results on 50 Neanderthal anthracological diagrams, based on these differences in production. My results suggest that certain previously dominant species may appear thus only because of increased charcoal production, and underrepresented species may in fact have been burnt, and grown in the landscape, in higher quantities. *Pinus* in particular, which dominated the Middle Palaeolithic Iberian anthracological record, may be overrepresented by its relatively high charcoal production when burnt. However, these calibrations do not wholly alter the discrepancies between Palaeolithic charcoal and pollen records. Other taphonomic destruction of either charcoal or pollen, or anthropogenic fuel choice may be responsible for this. In particular, if Neanderthals burnt dead wood, this would affect charcoal production [5]. Further taphonomic destruction studies will be needed for accurate palaeoenvironmental reconstruction, and for understanding Neanderthal, or any human, fuel foraging.

This project was funded by AHRC CHASE, and uses facilities provided by UCL Geography Department and Birkbeck Geology Department

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Poster Presentation Number 69, Session 2, Friday 18:15

Dietary reconstruction of Pleistocene Australian herbivore megafauna through calcium and strontium isotopes in dental enamel

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Dietary interactions and niches in Pleistocene faunal communities are key variables in hypotheses on megafauna evolution, persistence, and extinction in Australia. However, food web of Pleistocene Australian megafauna has been understudied due to previous lack of a suitable trophic level proxy in the absence of preserved collagen. Calcium (Ca) isotopes allow for trophic level reconstructions from the mineralised component of teeth and bones (i.e., bioapatite) and are highly resistant to diagenesis. Prior to applying Ca isotope analyses to extinct fauna with unknown ecologies or higher trophic levels, it is essential to delineate the Ca isotope composition of primary consumers and to understand dietary behaviours at the base of the Pleistocene Australian food. We investigated Ca isotope compositions of fossil remains of marsupial herbivores, including megafauna, from Wellington Caves and Bingara (New South Wales, Australia). These analyses were combined with strontium (Sr) isotope analyses in the same individuals to compare dietary niches with roamning ranges and spatial niches.

Strontium isotopes suggest small home ranges in both large- and small-bodied taxa. This may indicate rich ecosystems that can support a diversity of taxa. Calcium isotopes in Pleistocene marsupial herbivores cover the same range as those in modern wombats and placental herbivores. Distinct Ca compositions between taxa can be interpreted as dietary niches. Some niches conform to previous dietary reconstructions of taxa and support niche differentiation across Australian herbivores, while others provide new insights into their dietary flexibility throughout the Pleistocene.

The Ca and Sr isotope characterization of marsupials with varying herbivore diets provides new insights into the dietary behaviour at the first trophic level of food webs that included marsupial megafauna. Furthermore, it provides an isotopic baseline of available prey in Pleistocene Australia. This baseline offers the opportunity to reconstruct dietary behaviour of extinct species and decipher prey-predator relationships. Further Ca isotope analyses on Australian megafauna bear potential to answer long standing hypotheses on the drivers of megafauna extinction, such as juvenile overkill and cascade extinction, and can illustrate how the trophic structures influences the sustainability of Pleistocene ecosystems.

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Poster Presentation Number 34, Session 1, Thursday 18:15

The use of fire is a synchronization event in Palaeolithic tar production techniques

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The study of technological remains from the Palaeolithic archaeological record is one of the most common methods for understanding changes in ancient human behaviour and technology through time. For example, formal bone tool production [1], adhesive manufacture [2], and the habitual use of fire [3], are often seen as indications of significant behavioural and technological development during the Middle to Late Pleistocene. The manufacture of birch tar adhesives is regarded as clear evidence of the controlled use of fire by Neanderthals as early as 200,000 years ago. But how exactly does fire use fit into birch tar manufacture? We used Petri nets to model three different birch tar production techniques and analyse the complexity of the processes in relation to the use of fire. Petri nets are a modelling language with formal mathematical semantics that are used in process modelling to study complexity. Petri net models can identify the number of different configurations, or states, that a modelled system can reach, which serves as a proxy for the amount of information embedded in that system. Petri nets can also identify the possibility of concurrent actions, which can be executed out of order, paused, or started at the same time with one or more makers. Concurrent actions can thus enhance flexibility and scalability of processes. We compare the number of total reachable states, and the possibility of concurrent actions before and after the use of fire in three varying methods of birch tar production. A comparison of the models indicates that the number of reachable states and the possibility of concurrent actions that occur before or after the use of fire depends on the method of birch tar production being employed. Results suggest that fire acts as a synchronization event for concurrent sub-processes associated with resource collection. This has potential implications for using birch tar to describe the use of fire by Neanderthals. Little investment in the production process before the use of fire, shown by fewer reachable states, is suggestive of a more opportunistic approach to using fire in birch tar manufacture. Heavy investment and a higher possibility of concurrent actions before the use of fire shows the opposite; where fire appears more as an integral part of the process, acting to synchronize different threads such as collecting bark and making the tar collection vessel. This variability clearly highlights the need to further study and identify the methods of tar production employed during the Middle Palaeolithic.

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Poster Presentation Number 66, Session 2, Friday 18:15

The potential resource space for hominids in Sangiran

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The Sangiran dome is one of the richest hominid localities outside of Africa. There are three successive hominid bearing layers at Sangiran, which cover a large time span from Early to Middle Pleistocene. These constitute the upper part of the Sangiran formation, the Grenzbank zone and the Bapang formation. This study focuses on the resource space for hominids by the time of the Grenzbank formation.

At that time at least two hominids, *Homo erectus* and *Meganthropus paleojavanicus*, inhabited the Sangiran area [1]. These two species differ in their dentognathic morphology and therefore presumably in their dietary strategies. In order to reconstruct the diet composition of both kinds of hominids, the reconstruction of the available resource space is crucial. Do their diets differ due to the exploitation of different vegetation units? Or does the difference relate to physiological or socio-technological factors? This study establishes the basic framework to answer these questions.

We identify five distinct vegetation units which are found within a 50 km radius around Sangiran. These vegetation units are reconstructed on the basis of palaeotopography and climatic maps. The resource space includes all edible resources and is divided into five categories: plants, insects, aquatic resources, as well as small and large vertebrates. The categories differ in habitat, behaviour and morphology, therefore necessitating particular ways of acquisition and technology to exploit them efficiently. The actual diet comprises a selection from the resource space available based on the socio-technological skills of the hominids and the seasonal availability of the resources.

Therefore, for each edible species data on required processing and seasonal availability are collected. Processing data indicate what actions are required to collect and consume the resource. This ranges from simple picking and raw consumption, to several sequential processing steps, which may require the controlled application of diverse techniques. The selection of resources from the available resource spectrum differs by processing techniques available for specific hominin groups. Consequently, although certain resources are part of the available resource space, they can only be consumed by hominids who mastered a specific technological level.

The presence of the resource categories and/or their accessibility changes along with the seasons. For instance changes the availability of fruits in the Lowland monsoonal forest over the year. In this way the different vegetation units can be compared in terms of their resource availability in the dry and wet season. This allows to address seasonal shifts in the hominid diet.

In this way we analyse the resource space of hominids inhabiting the area around Sangiran at 1 Ma and pave the way to answering crucial questions about their potential diet composition.

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Poster Presentation Number 115, Session 2, Friday 18:15

Combining geometric morphometrics and paleoproteomics to enlighten the paleodiversity of *Pongo*

Jülide Kubat[1,2], Ryan Paterson[3], Graeme Barker[4], Fabrice Demeter[5,6], Arnaud Filoux[7], Ottmar Kullmer[2], Meaghan Mackie[3], Tomas Marques-Bonet[8], Nguyen Thi Mai Huong[9], Nguyen Anh Tuan[9], Sytha Pheng[10], Jessica Rippenga[14], Friedemann Schrenk[2], Viengkeo Souksavatdy[11], Lim Tze Tshen[12], Athiwat Wattanapituksakul[7], Wei Wang[13], Clément Zanolli[14], Anne-Marie Bacon[1], Enrico Cappellini[3]

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The spatio-temporal distribution of orangutans (*Pongo*) is evidenced by the numerous Pleistocene sites in Southeast Asia ranging from southern China to Insular Indonesia (Vietnam, Laos, Cambodia, Thailand, Malaysia; [1]). Modern and fossil *Pongo* show a high degree of variation in tooth size and morphology, which obscures taxonomic identifications at species level [2]. The fossil record of *Pongo* largely consists of dental remains, hence several attempts to distinguish taxa at (sub-)species level have been proposed exclusively based on odontometric measurements and non-metric features recorded on isolated teeth [3]. However, there are still debates regarding the recognition of fossil species of *Pongo*. In order to attempt characterizing and distinguishing extinct orangutan species, we investigated the internal structure of 73 lower molars of Pleistocene *Pongo* from various sites and origins (Punung and Sangiran from Indonesia; Lang Trang, Tham Om, Hang Hum, Mai Da Dieu, Thung Lang and Duoi U'Oi from Vietnam; Tam Hang South and Tam Hay Marklot from Laos; Niah Cave from Malaysia; Ganxian and Chinese Apothecary Collection from China). For comparison, we have analyzed 25 modern orangutan lower molars, representing the species *Pongo pygmaeus* and *Pongo abelii*. We used geometric morphometrics to analyze the shape of the enamel-dentine-junction (EDJ) by placing five landmarks on the tip of the main dentine horns, and 142 semilandmarks along the marginal ridges. We also applied paleoproteomic analyses on 14 dental specimens of Late Pleistocene *Pongo* from Vietnam, Laos, Malaysia and Thailand by utilizing high-resolution tandem mass spectrometry to sequence ancient proteins [4]. Our results show that fossil molars have a lower EDJ relief height with lower dentine horns than modern molars. Extant *Pongo* molars are morphologically quite distinct with relatively higher dentine horns and a more elongated and narrow molar shape than the fossil counterparts. Moreover, *P. pygmaeus* and *P. abelii* show a large morphometric overlap in EDJ shape. Specimens from various sites in Vietnam are dated to the final Middle Pleistocene to Late Pleistocene and share the same morphospace, which is consistent with their allocation to the same chrono-geographical variant. This also applies to fossils from the Middle Pleistocene of China as well, which tend to group in a separate morphospace with some overlap with specimens from Vietnam. The Late Pleistocene site of Punung, Indonesia shows the highest variability, with a mix of specimens exhibiting a modern morphotype and others grouping with Pleistocene *Pongo*. As published recently [5], it suggests that the Punung assemblage might be a mix of Pleistocene and Holocene remains. Preliminary paleoproteomic data does not allow a consistent discrimination of fossil specimens as either *P. pygmaeus* or *P. abelii*. This is partially confirmed also by the morphometric results indicating that a clear attribution of the fossil specimens to modern species is not possible, except for one sub-sample from Punung. The morphological differences between fossil *Pongo* molar crowns and living orangutans reveal a higher diversity in the genus *Pongo* during the Pleistocene than today. Combining EDJ morphology and paleoproteomics provide a promising basis for further studying the evolutionary biodiversity in the only nonhuman great ape genus living today outside of Africa.

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Poster Presentation Number 113, Session 2, Friday 18:15

Plasticity of the pelvis shape in *Homo sapiens*

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The pelvis (i.e., the two pelvic bones, the sacrum and the coccyx) is highly plastic during ontogenetic development due to several factors. The genetic (e.g., heritability) factor, type of locomotion, activity, hormones, number of offspring, climate and age are expected to explain variation in pelvic anatomy. This pelvic developmental plasticity achieves the most adequate morphology during an individual's lifetime, however, has different purposes for females and males. The question is, how plastic is the shape of the pelvis in terms of body mass during the ontogeny? Therefore, the aim of the study is to analyze the association between pelvic girdle morphology and body mass in humans and non-human primates.

The analyzed material included CT scans of 304 human pelvis (155 female pelvis, 149 male pelvis) in the age range between 0 and 75 years. The material divided into 16 age categories (5-year intervals) with 20 pelvis (10 for each sex). The potential influence of bone-loading conditions such as body mass on the developmental trajectories of pelvises in females and males remains relatively unexplored. The study focused on forensic/clinical sample of anonymized individuals with known age, sex, body weight and height. For each CT scan, the 3D reconstruction of the pelvic girdle was prepared. One 3D reconstruction of a pelvic girdle was set as a template on which 61 landmarks and 372 sliding semilandmarks (sLM) were distributed. Next, all sLM were automatically warped from the template to each 3D based on 61 LM. This part of the study was carried out using 3D Slicer software.

Raw data containing the point coordinates of all pelvises was analyzed using Generalized Procrustes Analysis. Further, a multivariate regression was performed to determine whether pelvic shape (LM and sLM coordinates) correlates with size (centroid size). The regression revealed a significant association between the pelvis shape and size ($p<0.05$, RV=18.00%), therefore further morphometric geometric analysis will be calculated taking into account the allometric component.

The statistical analysis of the proposed study is ongoing. The obtained results will show whether body weight is a significant factor influencing the pelvis shape and how the level of plasticity changes during development depending on the sex. The potential influence of bone-loading conditions such as body mass on the developmental trajectories of pelvises in females and males remains relatively unexplored.

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Poster Presentation Number 118, Session 2, Friday 18:15

Entheseal patterns elucidate differences in hand use between humans and great apes

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The way humans use their hands is known to be unique among animals. It involves not only the dexterous opposition of the thumb but also the precise and controlled handling and manipulation of objects. Several studies sought to determine at what point in the hominin lineage human-like hand use first emerged, with a particular focus on the advent of stone tool use. This is often done through comparisons of early hominin hand bones with those of humans and non-human great apes. However, to be able to draw meaningful conclusions from the fossil record, it is crucial to know what characterizes habitual human-like hand use when compared to great apes and how this is reflected in the osseous remains.

Therefore, this study aimed to provide important insight into how differences in habitual hand use among humans and other great apes are reflected in their muscle attachment sites. Using the Validated Entheses-based Reconstruction of Activity (VERA) method [1-2], we examined the manual muscle recruitment patterns of later *Homo*, including early and recent modern humans and Neanderthals, and non-human great apes, including gorillas, chimpanzees, and orangutans. VERA has previously been successfully applied to various different species and populations, revealing clear links between multivariate entheseal patterns and habitual activity. In an exploration of distinctive patterns between the two groups, we analyzed a set of attachment sites on the metacarpal and proximal phalanx of the first and fifth ray, as well as the *flexor digitorum superficialis* (FDS) attachment on the third intermediate phalanx.

Our results show that entheseal patterns can clearly distinguish non-human great apes from later *Homo*. Modern humans and Neanderthals are characterized by proportionally large attachment sites of the first dorsal *interosseus* (DI1), *extensor carpi ulnaris* (ECU), *abductor* and *flexor digiti minimi* (ADM-FDM). On the other hand, all non-human primates display larger entheseal proportions of muscles related to thumb ab- and adduction, as well as proportionally large FDS entheses.

The importance of the DI1 in human-like manipulation has been reported by a previous study investigating muscle recruitment patterns of the thumb [3]. In our study, a relatively large attachment site of this muscle is correlated with proportionally large entheses of the fifth digit. The significance of this ray for human hand use is often overlooked in favor of the thumb. However, it plays a crucial role in stabilization and in-hand manipulation [4], as well as during power grasping [1]. Moreover, electromyographic studies have pointed out the importance of the DI1, ADM, and FDM for tool production (e.g., see [4]). In contrast, the entheseal pattern seen in great apes, including larger attachment site proportions of the muscles associated with thumb ad- and abduction and finger flexion, is in accordance with their modes of locomotion and grasping [5].

Our study identified a set of muscles that appear to be characteristic of human-like hand use in comparison to other great apes. The pattern particularly emphasizes the importance of the fifth ray, as the muscles attaching to it appear to be frequently activated in later *Homo*, irrespective of species, population, geographical or chronological context. Its significance in human-like hand use and its involvement in tool production render the fifth ray and its muscle attachment sites an important target for future studies investigating the hand use of early hominins.

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Virtual Pecha Kucha Presentation Session 8, Friday 17:30-17:55

Dental maturity scores reveal subtle differences between the African great apes and shed new light on early hominin life histories

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Hominin life history studies are at the center of palaeoanthropological enquiry. Modern humans are unique in their delayed maturation and have evolved a unique phase of childhood dependency that probably aided cognitive evolution in *Homo*. Understanding the evolutionary history of these changes in our lineage continues to be a subject of debate. Dental maturity features prominently in such studies, owing to the high correlations between dental development and other life history variables [1]. Ideally, known-age specimens are required to produce a dental development chronology, but such data are rarely available for skeletal material. In fossil specimens, age at death can only be determined in exceptional circumstances, requiring the use of destructive histological techniques or high-resolution (synchrotron) imaging that restricts widespread use. Furthermore, complete fossil dentitions are rarely available. Here, we use the 8-stage dental maturity score (DMS) system developed by Demirjian, et al. [2] and calculate DMS for different tooth classes (e.g., incisors, molars etc.). Our aim is to compare the relative patterns of dental development in Plio-Pleistocene hominins and great apes to determine whether subtle developmental shifts between tooth classes (e.g., anterior tooth advancement; molar tooth delay) can be detected among species. As baboons are generally considered good ecological models for early hominins (i.e., they are eclectic feeders that evolved in the same habitats), they are also included in the analyses.

Dental maturity scores for the permanent teeth were recorded from X-rays or CT scans of immature specimens of *Pan* (n=53), *Gorilla* (n=50), *Papio* (n=67), and data for Plio-Pleistocene hominins were compiled from the literature. RMA regressions were calculated between DMS scores for tooth classes (or sets thereof) in extant species and slope differences were tested for significance (t-tests). DMS for fossil hominins were plotted with extant data and the residuals from respective RMA models were calculated and statistically analysed.

Traditionally, differences in dental maturity scores between the great apes are considered negligible, leading to suggestions that hominins had a broadly 'ape-like' or 'human-like' developmental schedule. However, our analysis yielded statistically significant differences between the great apes in a number of tests, notably in the RMA models for incisors vs molars, and for canine vs premolars. *Gorilla* models tend to have higher slopes, indicating that anterior tooth development is more advanced relative to postcanine teeth compared to *Pan*. Plio-Pleistocene hominin fossils also demonstrate relatively advanced anterior tooth development, and they are more advanced than either extant ape. Dental development patterns in *Papio* are broadly similar to the apes, but do not demonstrate advanced anterior tooth development relative to the molars.

Our analyses throw light on two issues. First, all great apes cannot be characterized with a single 'ape-like' dental development pattern. Second, hominins appear more similar to *Gorilla* than to *Pan* in their overall pattern of development, despite being phylogenetically more distant from the former. This raises questions about the possible plesiomorphic state of hominin life histories [3], and whether chimpanzees are the appropriate comparative model for understanding early hominin life history – they may be too derived. When early hominin developmental patterns are assessed in their ecological context, and in considering the developmental and ecological differences among extant primates analysed, it is reasonable to suggest that ecology had a major impact on the pace of development [4]. Hominins evolved in an increasingly open, seasonal and variable environment, which may ultimately have driven the evolution of our unique life histories.

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Pecha Kucha Presentation Session 2, Thursday 12:20-12:45

Evaluating reindeer carcass transport patterns by Neandertals at Jonzac Level 22 using a novel multilevel skeletal part representation model

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Patterns of skeletal part representation (SPR) in archaeological faunal assemblages are often used to infer subsistence behaviors, site use, and mobility for prehistoric hunter-gatherer groups, including Pleistocene hominins such as Neandertals. The assumption is that hunter-gatherers will often maximize energy returns from hunting efforts by preferentially transporting parts of carcasses from kill sites to butchery and residential sites depending on nutritional factors that make some parts more valuable than others, such as meat, marrow, and grease content. Though SPR pattern interpretations may be valid in principle, less dense bones or portions of bones are more likely to incur damage from post-depositional impacts from carnivores, trampling, and physical and chemical weathering that can effectively remove them from the archaeological record through complete destruction or reduction in identifiability. Therefore, bone-density-mediated effects must be investigated along with nutritional factors. Typically, density effects and preferential transport are assessed separately in non-parametric bivariate analyses with density-mediated attrition assessed first so that the reliability of the subsequent nutritional indicator analyses can be better understood and interpreted. However, though results of density analyses can be used intuitively to estimate the potential reliability of nutritional analyses, the separated analyses mean that nutritional trends are not formally adjusted for the density effects.

We introduce a new multi-level model for studying SPR that explores how the relative proportion of studied elements from a faunal assemblage relates to nutritional indicators like marrow cavity volume [1] and the food utility index [2], given the effects of bone density [3]. Though the model is novel in its application to this research question, it is a conventional model in the field of applied statistics for hierarchical datasets. Our model is a major improvement on earlier attempts at analyzing skeletal part representation because it 1) simultaneously accounts for bone density and nutritional indicators, which are typically analyzed separately, 2) incorporates variance in the density measurements, which usually only include the mean value, and 3) uses a more comprehensive portion of the faunal assemblage, which is often restricted to a smaller subset of elements. The primary aim of the model is to detect evidence of preferential transport of carcass elements according to nutritional factors, though confidently demonstrating that an observed pattern reflects a specific intended behavior is challenging in archaeological contexts. Our test case for the model is the Quina Mousterian Level 22 (72.7 +/- 7.9 ka) reindeer assemblage from the Middle Paleolithic site of Jonzac in southwestern France. A previous study of the Level 22 reindeer assemblage using standard bivariate analyses found no preferential transport of skeletal elements [4] but our model showed that marrow cavity volume had a positive relationship with element counts, indicating possible preferential transport favoring marrow-rich elements. Our work also highlights issues with using nutritional utility indices that are constructed with multiple components that would be better incorporated as separate factors, and the pitfalls that come with using partial subsets of elements in analyses that might not accurately represent the overall assemblage pattern.

This research was supported by funding from the National Science Foundation Graduate Research Fellowship Program (Award ID: 1650042), a Leakey Foundation Research Grant (Award ID: UCD2018G097-0), the Sacramento Archaeological Society, and the Department of Anthropology at University of California, Davis. We used R (R Core Team 2021) for all data analysis and model visualization; packages used include the R base package, rethinking, cmdstanr, and Epi. We derived our model script from R code templates provided in Richard McElreath's *Statistical Rethinking* (2020, 2nd ed.), specifically codes 5.5 (p.127), 11.45 (p. 352), and 15.5 (p. 496). Much gratitude is owed to colleagues and staff at PACEA/Université de Bordeaux, particularly Dominique Armand and William Rendu, for their help with accessing the Jonzac Level 22 faunal assemblage, comparative collections, and work space. We are also highly appreciative of Laura Niven's assistance with the previously generated Jonzac faunal data. Finally, we would like to thank S.E.L.'s dissertation committee members, Dennis Sandgathe and Nicolas Zwyns, for their invaluable input and guidance, as well as fellow members of the Steele Lab at UC Davis and students in the Winter 2022 ANT 216 (Advanced Zooarchaeology) course at UC Davis for participating in thoughtful and constructive discussions of this work.

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Poster Presentation Number 47, Session 1, Thursday 18:15

How old is the Montmaurin-La Niche hominin mandible in the Middle Pleistocene? A state of the question

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The hominin mandible known as La Niche (LN) has been famous since its discovery by R. Cammas, on 18 June 1949, in a small cavity uncovered by the exploitation of a quarry in the Montmaurin limestone massif, south-west of Toulouse and in the context of the Pyrenean piedmont. H.-V. Vallois and G. Billy had highlighted the archaic characters of this fossil [1] which we have re-examined, considering an increased fossil record since the 1970s and analysing the internal dental features now accessible [2-3]. On the basis of the faunal remains and lithic tools collected, Cammas [4] argued an *in situ* position of this material and a stratigraphy of the infilling composed by 3 main levels (B-C1-C3), with the mandible and three other human remains from the deepest level (C3). Later, based on biochronology of the mammals, an attribution to marine isotopic stage 7 (i.e., between 250 and 190 ka) was proposed [5].

However, the history of the deposits is complex and the possibility of archaeological material in a secondary position is not excluded. It could indeed be the result of the extraction of elements from the upper karst level situated at 40m high overlying the LN chimney 12m.

To test this hypothesis, as part of an ongoing multi-disciplinary project, we carried out a pit at LN, through the spoil from the old excavations, to reach the clay level *in situ*, about 1.40m below the level of the mandible. This level has been dated by the cosmogenic nuclide method applied on a quartzite flake. In addition, dates were obtained for levels C3 and C1 using ESR/U-series on herbivorous teeth. In parallel, the geological processes that could explain the history of this infilling were clarified by analysis of the clay minerals.

All these results are discussed here in an attempt to constrain the chronological interval of the C3 level bearing the human remains.

It should be remembered that the mandible combines archaic features such as a marked *planum alveolare*, downward located *fossae digastrica*, a sub-parallel mylohyoid line, a deep pterygoid fossa or a regular gonion profile with some neandertal traits like a well-marked *fovea anterior* and a mid-trigonid crest on M1, M2, M3. As a result, it seems that the Montmaurin-LN mandible is not fully neandertal. An earlier dating than the MIS 7 as previously proposed would have been consistent with its primitive state. If a more recent dating is confirmed, it should be considered that this famous fossil represents a primitive specimen at a time of the emergence of the Neandertal lineage. This may correspond to the coexistence of two or more populations during the late Middle Pleistocene in Europe, one being more primitive than the others.

Acknowledgements to the French Ministry of Culture (DRAC Occitanie) and the Occitanie Region for supporting the Montmaurin research program.

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Pecha Kucha Presentation Session 2, Thursday 11:30-11:55

Combustion features at Langmahdhalde Shelter provide new insights into Magdalenian lifeways in SW Germany

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Following many years of excavation at Vogelherd in the Lone Valley of the Swabian Jura, in 2013 we began a new phase of research focusing on systematic survey and excavation of previously unstudied sites in this karstic region. Although the team had successes studying geogenic, biogenic and anthropogenic input to the sites of Fetzershaldenhöhle, Lindenhöhle, Wolftalhöhle and Kälbermahdhalde [1], our most important results come from seven seasons of excavation from 2016 to 2022 at Langmahdhalde on the right bank of the Lone two kilometers downstream of Vogelherd. Here we have defined a sequence of 19 stratigraphic units covering the period from 30 ka BP to the present and containing an excellent record of the Last Glacial Maximum [2]. Within this sequence, the Magdalenian corresponds to Archaeological Horizons (AH) V - IX with radiocarbon dates falling between 13 and 17 ka cal BP. This well-preserved Magdalenian sequence reflects the first important new discovery for this phase of the Upper Paleolithic in southwestern Germany since the 1970s, and has thus attracted considerable attention in the research community.

Within the archaeological sequence at Langmahdhalde, AH V is the richest deposit containing ca. 1000 lithic artifacts, several hundred faunal remains and considerable quantities of charcoal and burnt bone [2-4]. Additionally, AH V contains six well-defined combustion features of various forms that date to ca. 15.4 – 15.0 ka BP. Some of the combustion features are partially surrounded by limestone blocks, and they range in size from over 1m² to ca. ¼ m². Features 1 and 6 are the largest of the features and are associated with large amounts of heated limestone. The other four features are smaller and likely reflect less intensive episodes of burning. This paper presents the first micromorphological results from the combustion features at Langmahdhalde and discusses how the Magdalenian inhabitants of the Lone Valley selected and used fuel, while contextualizing the function of these features within a more general assessment of Late Pleistocene pyrotechnology, settlement dynamics and site function.

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Poster Presentation Number 73, Session 2, Friday 18:15

Stone Age occurrences in the Wadi Abu Subeira (Aswan region, Egypt) – preliminary results

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North-Eastern Africa is often considered as a key area in questions related to hominin dispersals out of Africa. In particular, favourable environmental conditions during more humid periods (particularly during MIS 5), may have facilitated human movements in the Eastern Desert of Egypt [1]. However, very few Stone Age archaeological sites are known from the Eastern Desert. In this presentation, preliminary results of surveys carried out in the Wadi Abu Subeira (Aswan region, Egypt) are reported. Surveys for stone age localities took place as part of the 2022 field season of a Franco-Egyptian project directed by Dr Gwenola Graff in a section of the wadi located between 15 and 25 km away from the Nile Valley, in the Eastern Desert of Egypt. One Middle Stone Age locality had already been reported by Fred Wendorf in the Wadi Abu Subeira [2] and several Late Palaeolithic rock art stations are known [3-4], but these are all located at the entrance of the wadi. Very few Stone Age sites are documented in the Eastern Desert of Egypt [5] and it is particularly true for its south-eastern part, which remains virtually unexplored for Stone Age human occupations. Here, we report preliminary results on several Earlier and Middle Stone Age occurrences documented during the 2022 survey. Occurrences take the form of isolated artefacts, concentrations of artefacts in secondary contexts and lithic workshops. The latter shows evidence for the intensive exploitation of sandstone outcrops. This led to the accumulation of large quantities of material, on the surface, but with their original spatial distribution virtually intact. Preliminary analysis of the artefacts show that diverse qualities of sandstone were exploited in the Earlier and Middle Stone Age. We then discuss the potential significance and contribution of these new finds to a better understanding of the complex links between the Nile Valley and adjacent deserts during the Stone Age.

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Pecha Kucha Presentation Session 11, Saturday 15:05-17:25

Did hominins control hammer strike angles while knapping?

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One important way for understanding the origin and evolution of hominin tool use is to study the knowledge that early knappers possessed to make chipped stone artifacts. We now have a good understanding of hominins' knapping strategies from a wide range of aspects such as raw material selection and procurement, core management, platform preparation, and hammer selection [1-3]. However, how these knappers manipulated their manual gestures during knapping needs further investigation. In this study, we aim to connect a currently invisible aspect of stone tool production, namely the angle at which the hammer strikes the core (hammer strike angle) with measurable lithic attributes. This allows an investigation of technical decisions made by hominins.

We develop a new method to measure the hammer strike angle from flakes based on the basic fracture mechanics of conchoidal flaking [4-5]. More specifically, the hammer strike angle changes the orientation of the Hertzian cone, which is a key feature of conchoidal flaking. Using a controlled experimental approach, we prove that a feature of the flake's bulb of percussion, which we termed bulb angle, can reflect changes in the hammer strike angle. In controlled and naturalistic flintknapping contexts, we conclude that bulb angle can be used as a reliable proxy for the hammer strike angle. Using the bulb angle method, we analyze a series of Early Pleistocene assemblages (1.95 Ma-1.4 Ma) to examine how hominins controlled their hammer strike angle. We find evidence for increased control over the hammer strike angle through time. During this time, hominins began adjusting the strike angle in relation to other platform attributes when making flakes of different sizes. Acheulean hominins especially employed a more oblique hammer strike angle to make smaller flakes. Conversely, they used a more direct hammer strike to make larger flakes. We analyze a Middle Paleolithic assemblage to help contextualize observations made from the Early Pleistocene record as a point of comparison. The similarities in our observations of the relationships between bulb angle and some of the other basic flake attributes suggest the possibility that by 1.4 Ma hominins may have controlled hammer strike angle during flaking to an extent that is comparable to Neandertals.

Overall, our results indicate that hominins began to gain a more comprehensive understanding of the role of hammer strike angle in flake production around the time of the Oldowan-Acheulean transition. Furthermore, this study demonstrates the importance of linking basic flaking mechanics to knapping actions to understand the technical decisions made by the hominin knappers. This not only provides us with a robust framework to quantify hominin knapping strategies from the archaeological record but also allows us to investigate the evolution of hominin technical understanding through time.

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Virtual Pecha Kucha Presentation Session 8, Friday 17:30-17:55

The genetic architecture of modern human dental morphology

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Among the most common and well-preserved elements within the hominin fossil record are the teeth which have been intensively used in evolutionary studies. In addition, much of the recent and contemporary human diversity has been assessed using dental morphological traits, including applications in forensic sciences. However, the genetic bases underlying variation in dental morphology continue to be poorly understood. A number of studies have indicated that this variation is highly heritable but very few genes influencing dental morphology have been reliably identified (e.g., *EDAR*). The unprecedented power provided by current genomic technologies offers a great opportunity for a detailed assessment of the genetic basis of modern human dental morphological variation. Here we present a study aimed to identify genes responsible for variation in tooth morphology through multiple genetic tests including genome-wide association studies (GWAS), Wald-test, admixture mapping, etc.

We examined distinct cohorts of unrelated individuals from Latin America of mixed Native American, European and African ancestry (Colombians ~1000 and Chileans ~2000). The Latin American persons have been studied as part of a similar project focused on the genetics of physical appearance (CANDELA consortium) and were genotyped using genome-wide SNP data. We obtained dental plaster casts from the studied individuals and 3D models were acquired through a high-resolution blue light scanner (Artec Space Spider). Distinct dental features such as standard dental measurements and indexes (using manual and automatic approaches), nonmetric traits (with the ASUDAS method) as well as 3D mesh geometric attributes (area, volume, centroid size, etc.) were obtained through the 3D models after automatic segmentation procedures.

Our results reveal that several genes (*PITX2*, *WNT9b*) are associated with the normal dental diversity among living humans including a pervasive and decreasing effect of EDAR across the dentition from anterior to posterior teeth. For tooth dimensions, more than 30 traits showed significant associations (P-value $<5\times10\text{-}8$) with at least one genomic region. Eleven dental nonmetric traits showed genome-wide significant associations with SNPs in at least one genomic region while for mesh attributes 10 genomic regions were significantly associated with at least one trait. According to previous studies, several genetic variants here detected influence a number of oral, craniofacial, and skeletal features including some disorders, syndromes, and dysmorphologies. Interestingly, some of these genes are also associated with both tooth development and eruption as well as with the presence of supernumerary teeth or agenesis, and with normal and abnormal variation in facial/cranial features revealing their pleiotropic effect across the craniofacial complex and the coordinate and modular nature of genetic correlations.

The present study supports previous hypotheses about the strong genetic basis underlying the development of normal dental variation in modern humans, thus warranting the use of tooth features in taxonomic, phylogenetic, and biodistance assessments. The link between genes and tooth features enhances our understanding of the genetic pathways involved in tooth development. Finally, through the identification of specific genes operating across the dentition, the present study possesses wider implications for the investigation of living and extinct hominin evolution and diversity, especially on how genetic mechanisms underlie some of the major events in hominin craniodental evolution. Future work with larger sample sizes and using experimental follow-up analyses to endorse the discovered associations will provide additional insights into the complex relationship between genotype and dental phenotypes.

We thank the volunteers for their enthusiastic support for this research. We are very grateful to Universidad de Antioquia, Medellín, Colombia and Universidad de Tarapacá, Chile for kindly providing facilities for the assessment of volunteers. Work leading to this publication was funded by grants from the: Leverhulme Trust (F/07 134/DF), BBSRC (BB/I021213/1) (to ARL), Excellence Initiative of Aix-Marseille University - A*MIDEX (a French "Investissements d'Avenir" programme) (to ARL), National Natural Science Foundation of China (31771393) (to ARL), Wenner-Gren Foundation for Anthropological Research Grant/Award number 9391 (to MD), Universidad de Antioquia Grant/Award CODI 2014-1124 (to MD), and UCL Global Engagement Fund (to KA).

Poster Presentation Number 62, Session 2, Friday 18:15

Between old and new behaviours: core technology in the earliest European Acheulean from El Barranc de la Boella (La Canonja, Spain)

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Traditionally, the presence of Large Cutting Tools (LCTs) has been considered the best cultural marker of the Acheulean or Mode 2 industries. However, the adoption of new perspectives in technological studies has made it possible to further define new behaviours associated with this technocomplex. Thus, the emergence of Mode 2 on the African continent implies the manifestation of new technological behaviours, characterized by a greater complexity in the management of raw materials, by the diversification of knapping strategies, as well as by changes in the use and management of the environment, among others [1].

In Europe, the discovery of new archaeological assemblages and the revision of known sites have made it possible to draw a complex scenario for the emergence of the Acheulean. However, changes or continuities in technological behaviour that may be associated with the presence of LCTs have not yet been studied in depth, although some advances have been made. The Unit II of El Barranc de la Boella (La Canonja, Spain) dated back between 900-780 ka, appears as the oldest Acheulean site in the European subcontinent [2], representing a valuable source information to evaluate the technological features accompanying the appearance of LCTs [3].

In this paper, we present a technological analysis of the cores (n=42) recovered in the localities of La Mina, El Forn and La Cala 1 of El Barranc de la Boella (BB). Our approach is based on the combination of quantitative and qualitative parameters. Following previous studies [4], different Volumetric Structures of Exploitation (VSE) have been defined according to a series of morpho-technical characteristics, such as the number and relationship of flaking and percussion surfaces, type and length of flaking surfaces, and general polarity. This approach is complemented with quantitative attributes such as the angle between percussion and flaking surfaces, as well as the percentage of non-cortical surface, and the Scar Pattern Index (SPI) [5], measured in the 3D models of the cores.

The core reduction strategies identified in these assemblages show features that may indicate a greater degree of complexity regarding Mode 1 assemblages. There are certain continuities too, which seem to imply that it does not represent a total break with respect to the European Mode 1 [4].

Regarding innovations, there is a better volumetric management allowing greater independence on the application of knapping strategies to overcome raw material constraints. In this regard, it has been possible to document the presence of cores with a certain degree of volumetric structuring, in which the removal of flakes is oriented to prolong the knapping sequences. This suggests the existence of a procedural template, -a more effective organisation of the actions carried out during the knapping sequences-, allowing to reduce the influence of the morphological features of the raw material. Continuities are reflected in a partial management of volume through knapping strategies, combining more structured strategies with others of an expedient and/or opportunistic type. The latter could be linked to the occupational patterns reflected on these localities.

In conclusion, the knapping strategies recorded in the three localities of BB show a trend of gradual change between Mode 1 and Mode 2, which contrasts with the break identified in the configuration processes of LCT. The Early to Middle Pleistocene European assemblages are consistent with this trend of gradual innovations in the exploitation dynamics that reflect a greater anticipation degree and a volumetric management more independent of raw material characteristics. However, these changes are neither homogeneous nor linear from a temporal and geographical point of view. This approach opens a new window to the study of the emergence and generalization of the Acheulean in Europe from new technological behaviours beyond the presence of the LCTs.

We are grateful to all the participants in the Barranc de la Boella fieldwork. The research at Barranc de la Boella was performed with the financial support of: Spanish Ministerio de Economía y Competitividad projects PGC2018-093925-B-C32 (MINECO/FEDER) and CGL2016- 80000- P (MINECO); the Generalitat de Catalunya, AGAUR agency, funded projects 2017-SGR-1040 and 2017-SGR-859, and the Universitat Rovira i Virgili (2021PFR-URV-126). Financial support for the Barranc de la Boella fieldwork and archaeological excavation was provided by the Ajuntament de la Canonja and the Departament de Cultura (Servei d'Arqueologia i Paleontologia) (2014/100574) of the Generalitat de Catalunya. The Institut Català de Paleoecologia Humana i Evolució Social (IPHES-CERCA) has received financial support from the Spanish Ministry of Science and Innovation through the "María de Maeztu" program for Units of Excellence (CEX2019-000945-M). D.L. is funded by Post-Doc Xunta de Galicia Grant (ED481B-2022-048). The research of J.I.M. was supported by the Spanish Ministry of Science and Innovation through the "María de Maeztu" excellence accreditation (CEX2019-000945-M). We are grateful to Oriol Cortes and the Boella staff for providing field assistance at the BB site.

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Poster Presentation Number 83, Session 2, Friday 18:15

Trabecular distribution of distal femur in extant apes and *Australopithecus sediba*

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Knee morphology of fossil hominins is of particular interest to paleoanthropologists due to longstanding debates about relative degrees of arboreality and terrestrial bipedalism in the hominin clade. In addition to external bone shape, the investigation of trabecular bone in the knee joint can provide insights into in vivo locomotor behavior of hominins [1, 2]. The nearly complete right distal femur (U.W. 88-63) of Australopithecus sediba (1.98 Ma) shows a unique combination of condyles that resemble other australopith species and Homo-like anatomy of the patellar surface, which has been used to infer a unique locomotor pattern in this species [3]. Here we analyze the trabecular morphology of distal femoral epiphysis of Homo sapiens (N = 26), [italics]Gorilla gorilla[italics] (N = 14), Pan troglodytes verus (N = 15), [italics]Pongo sp. [italics] (N = 9), and A. sediba (MH2) in order to 1) establish patterns of joint loading in extant taxa of known locomotor behaviour and 2) investigate joint loading in the knee of A. sediba. A canonical holistic morphometric analysis (cHMA), combining holistic morphometric analysis (HMA) and statistical free-form deformation model (SDM), approach was used to analyze the patterns of trabecular bone distribution following published protocols [4].

A principal component (PC) analysis of relative bone volume (rBV/TV) distribution shows clear separation between extant ape taxa. Positive values on PC1, PC2 and PC3 are mostly driven by rBV/TV concentrated on the patellar surface and on the posterior articular surface of the medial condyle separating humans from great apes (PC1, PC2) and chimpanzees (PC3) from humans, gorillas and orangutans. Negative PC1 is mostly driven by rBV/TV concentrated beneath the insertion of posterior cruciate ligament discriminating non-human apes from humans, negative PC2 by loadings on the patellar surface separating gorillas from others, and negative PC3 by loadings on the patellar surface and on the posterior articulation surface of the medial condyle discriminating orangutans from others. Results suggest that differences between humans and apes are primarily in the patellar articular surface.

Relative bone volume in humans is concentrated in the posteroinferior region of the lateral condyle and on the lateral patellar surface, which is consistent with loading in an extended knee position during locomotion. In non-human apes relative bone volume is found to extend from the inferior margin of the patellar articulation to the posterior region of both condyles. However, in gorillas it does not extend as posterosuperiorly in the medial condyle as it does in chimpanzees and orangutans. Trabecular bone is concentrated in the lateral condyles in apes, with the greatest values in the posterosuperior and the posteroinferior regions. Unlike humans, ape like a trabecular concentration at the distal regions of both condyles (i.e., those assumed to be loaded in an extended knee), with the lowest values in orangutans. We suggest that this reflects predominant loading in a more flexed knee posture in great apes compared to humans. Finally, among apes, we found the most homogenous distribution of trabecular bone across both condyles in orangutans, which we relate to their more variable knee joint postures during locomotion. A. sediba shows trabecular concentrations on the patellar surface and on the posterior area of the lateral condyle. Values in the posteroinferior and posterosuperior regions of lateral condyle are generally higher than in medial condyle. We interpret these fossil results as reflective of loading the knee joint with a degree of flexion that differs somewhat from modern humans. However, taphonomic erosion of parts of the condyles hinders a complete assessment of trabecular bone distribution in *A. sediba*.

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Poster Presentation Number 116, Session 2, Friday 18:15

The postnatal ontogeny of the modern human and chimpanzee thoracolumbar intervertebral discs and its importance for sagittal curve development

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Modern hominoid vertebral column studies concentrate on the bony vertebral morphology when comparing it to fossil hominin taxa. However, some studies recognise the importance of the intervertebral disc in assessing function/pathology of the hominin spine by inferring its contribution from the surrounding vertebrae [1].

Postnatally, the modern human intervertebral disc height plays a key role in shaping the development of the characteristic sagittal curves of the human spine, which are important for the maintenance of the upright human body posture and relevant for bipedal locomotion. The pattern of human intervertebral disc height is characterised by increased growth of the lumbar discs and growth spurts slightly ahead of growth spurts of the vertebral bodies [2]. Great ape thoracolumbar intervertebral disc height and how this is established postnatally is not known. We report here the actual measurements of the intervertebral discs and explore how adult disc height is established postnatally in the chimpanzee, and in comparison, to modern humans.

Disc and vertebral body heights were measured in the midsagittal plane on soft tissue CT scans. Disc and vertebral measurements were compared to individual body weight or estimated weight (some chimpanzees, based on femoral head and species/age-specific algorithm [3] to scale disc height across taxa. We analysed disc height from the first thoracic disc (T1) to the last lumbar disc of sex-balanced samples of 80 humans (0-75 years) and 17 chimpanzees (0-47 years), which we divided into comparative age groups, based on dental developmental stages [4]. We studied the patterns of disc height within and across species, using ANOVA to determine which age groups differ most in disc height.

Human adult thoracolumbar discs are taller than chimpanzee ones, we observed 0.5 to 8 mm (region-dependent) difference, with the lower lumbar discs (L3-L4/L5) most different. These differences were statistically significantly different ($p<0.05$), with exception of the lower thoracic discs (T7-T12/13). In contrast, vertebrae were statistically significantly different in all regions. Neonate and early infant human and chimpanzee disc differences were also non-significant in the upper lumbar region (L1-L2).

The human disc growth pattern is characterised by an early growth spurt in the first year of life, followed by another spurt at the infant to early juvenile stage (approx. 7-10 years of age). By about 12 years or late juvenile stage, the disc has reached adult size. Lumbar discs grow particularly fast during the second growth spurt.

The chimpanzee pattern differs by much less growth spurt in the first year of life. The second growth spurt occurs around the same developmental stage (late juvenile) but extends further into the subadult phase. Particularly, the lower lumbar discs are not showing large increases in height.

The vertebral growth pattern on the other hand is more similar between humans and chimpanzees, with both having growth spurts in the early infancy period and then again om the early to late juvenile period, which is marked but continues until the subadult to adult transition in chimpanzees.

The intervertebral discs of the bipedal modern human are important in shaping the sagittal curves of the spine, acting as a flexible system to adapt the individual spine to its upright position in the complex interactions between the spine, pelvis, sacrum and lower limbs. Having access to accurate measurements of chimpanzee intervertebral disc measurements can lead to better calibration of models investigating axial loading of the great ape spine and fossil hominis in locomotion studies. Given that human disc morphology achieves adult size at earlier developmental stages might be important for specialised locomotor behaviour and should be considered when exploring fossil hominin vertebral column reconstructions and how the fossil adult vertebral morphology developed postnatally.

We thank curators of various collections for access and permission to use chimpanzee CT scans: Takeshi Nishimura and the Digital Morphology Museum at the Primate Research Institute, Kyoto University, 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

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Podium Presentation Session 7, Friday 15:10-15:30

Preliminary palaeoproteomic insights into the Plio-Pleistocene australopiths from South Africa

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Palaeoproteomics allows for the recovery of genetic information beyond the limits of ancient DNA preservation. Dental enamel proteins older than 900 thousand years from temperate and subtropical areas can be phylogenetically informative about phylogeny, as recently demonstrated by the analysis of fossil teeth from *Gigantopithecus blacki* (1.9 Ma) [1]. Recent work on *Homo antecessor* (900 ka) [2] has demonstrated the viability of applying these approaches to ancient fossil hominins.

Here we recovered dental enamel proteins from australopith remains from South Africa: in particular, four *Paranthropus robustus* specimens from Swartkrans, dated to 2.2-1.8 Ma, and 1 specimen of *Australopithecus africanus* from Sterkfontein, dated to 2.8-2.2 Ma. This enabled us to determine the sex of these individuals and learn about their phylogenetic placement relative to present-day and ancient hominids.

We employed a digestion-free enamel extraction protocol [3] to recover ancient hominin proteins from the South African specimens SK 830, SK 835, SK 850, SK 14132, and Sts 63, and leveraged tandem mass spectrometry for deep sequencing. To confidently assign the retrieved MS/MS spectra to peptide sequences, we used reference database-dependent and open searches, using MaxQuant [4] and Peaks [5] software. The reference database included enamel and dentine protein sequences from publicly available repositories (Uniprot and NCBI) taxonomically restricted to hominids. For those taxa whose enamel and dentine protein sequences were not available, we translated protein sequences from publicly available genomic archives

Our results show that it is possible to retrieve enamel proteins from these ancient South African hominins. This is an encouraging step forward in ancient protein studies and is the first ancient proteome recovered from African Plio-Pleistocene fossils. Specimens SK 835, SK 850 and Sts 63 are identified as biologically male individuals. This opens the possibility of reassessing our understanding of sexual dimorphism in these and other early hominins and differentiating variation due to dimorphism from that resulting from taxonomic distinctiveness. Although the recovered enamel proteome is small, we also identified phylogenetically informative single amino acid polymorphisms. Future work will focus on expanding our sample, to better understand variation within and between early hominin taxa in Africa.

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Poster Presentation Number 85, Session 2, Friday 18:15

The time has come: revisiting the South African Plio-Pleistocene faunal record

Megan Malherbe[1], Martin Haeusler[1], Deano Stynder[2], Robyn Pickering[2]

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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 - namely *Australopithecus africanus, Australopithecus sediba, Paranthropus robustus, Homo erectus* and *Homo naledi* [1]. However, lack of a detailed chronology for the sites has meant that these significant fossils are yet to be placed within a precise climatic framework [2]. 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. Now, recent research has provided precise ages via uranium-lead dating of cave flowstones for eight of the most vital fossil-bearing sites in the Cradle [3]; namely Bolt's Farm, Cooper's Cave, Drimolen, Haasgat, Hoogland, Malapa, Sterkfontein, and Swartkrans. Therefore, the bovid assemblages – found in abundance and crucial indicators of palaeoenvironmental conditions at hominin sites – 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, which up until now have been the only way that South African chronology could be estimated.

Our research is the first direct comparison of the fauna and associated environments from these sites and those of corresponding time periods in eastern Africa. We aim to provide insight on dietary ecology and species responses to environmental changes within six narrow intervals between 3.2 and 1.3 million years ago, conducting ecomorphological analysis on bovid metapodials and astragali via 3D geometric morphometrics. A surface scanner is used to acquire the 3D data, and the models are then landmarked from existing protocol [4]. This method of ecomorphology allows determination of the relationship between bovids' functional morphology and ecological variables such as diet, habitat, and predator avoidance strategies, in a taxon-free way [5]. Shape data from metapodials and astragali of extant bovids with known habitat preferences are used as a reference to place fossil specimens in their respective habitat categories. By comparing the South African Plio-Pleistocene data with those from Kenya and Ethiopia, we can systematically determine what have, up until now, been assumed similarities and/or differences between these two centres of human evolution. Our results are two-fold: firstly, we do not see a progression in aridity from 3 to 1 million years ago, but rather stasis is observed, with mostly consistently dry/open environments across all sites in South Africa. This is in accordance with inferences from the cave site formation and flowstone analysis [3]. Secondly, differences in landscape and environment are seen between southern and eastern sites of corresponding ages, in contrast to what has been reported historically. It is highly unlikely that exact correlations exist between sites up to 4000 km apart, that are also subject to such different environmental and climatic regimes. These findings fundamentally advance understandings of a pivotal period in hominin evolution, as well as how species responded to changing climate and environments over the last 3 million years.

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Poster Presentation Number 16, Session 1, Thursday 18:15

Geoarchaeological insights on human activities at the Paleolithic site of Hohle Fels (Swabian Jura, Germany)

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Hohle Fels is a cave located in the Swabian Jura (Southwestern Germany). Archaeological excavations at the cave site of Hohle Fels, Swabian Jura (Southwestern Germany) have exposed a remarkable Pleistocene sequence, which covers the transition from the Middle to Upper Paleolithic. Combustion features, i.e., sedimentary deposits of fire remnants of various origins, have been identified in most layers. For this study, we applied micromorphological, micro-XRF, and fabric analyses to define the characteristics of the features and to assess how the combustion features relate to human actions. One prevailing question at Hohle Fels has been whether the combustion features are in primary position, or are a result of relocation due to slope movement. To answer these questions, we studied a total of 16 combustion features from Hohle Fels that have been sampled in the layers excavated until the 2020 field season. With this, the first combustion feature reported from the Middle Paleolithic, GH 14 feature 1, is included in this study.

The results show that the combustion features are mostly the outcome of anthropogenic dumping. In a few cases, the dumping action was repeated over a relatively brief period. Among them, one feature indicates the presence of a laminated and trampled surface. The surface includes burnt material, mostly bones, that likely derived from hearths nearby. Furthermore, by applying fabric analysis we were able to determine that the combustion features are mostly in primary position, albeit dumped. Slope movement, the main secondary deposition process at the site, has not significantly affected most features.

Thus, exploring the nature of the combustion features and proving the intentionality of the action, we can conclude that the excavated area was the designated location for dumping of fire remnants. Further, due to the scarce trampling evidence, we are more inclined to consider that the Upper Palaeolithic occupation was at the entrance of Hohle Fels, without excluding the use of the interior for secondary activities.

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Poster Presentation Number 65, Session 2, Friday 18:15

"Snakes and Ladders" in Palaeoanthropology: from cognitive surprise to skillfulness a million years ago

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Our proposal is methodologically significant for the study of the evolution of early *Homo* by introducing the Free Energy Principle (FEP) as an aid not only to inquiry into some behavioural continuities and discontinuities seemingly detectable in the Pleistocene record, but also most particularly to understanding how they may happen. This abstract is based on an article with the same title published in PsyArxiv https://doi.org/10.31234/osf.io/9rkgh.

According to Bayesian cognitive science, sensory inputs about our surroundings underpin generative statistical models whose probability densities form prior beliefs that undergo continual updating for recognition as posterior beliefs inferred from posterior probability distributions. When we react - active inference – we implicitly effect approximate Bayesian (variational) inference by the statistical (generative) model of our sensory exchanges with our econiche, thereby realising a dynamic that bounds variational free energy - as determined by the FEP that has proved its worth in advancing neuroscientific understanding. Two aspects need special mention. First, perception and action often merge as spontaneous enactment with the econiche. Secondly, the default position is to avoid untoward surprises.

Cognitive surprises, favouring anomalous behavioural propensities to sporadic expression, can explain "snakes-and-ladders" appearances and disappearances of Palaeolithic skills in the Early and Middle Pleistocene record, such as bifacial flaking of large cutting tools like handaxes. We apply the principle of stationary action, which underpins the FEP, to self-organising systems, namely early *Homo*, at an evolutionary timescale. Unusual personal attainments, often explained by invoking progressive ascent of evolutionary phylogenetic "ladders" of cognitive and technical abilities, could be disregarded in a community that failed to imagine or articulate possible advantages for its survivability. Such failure, as well as diverse fortuitous demographical accidents, could erase from collective memory the recollection of exceptional individual conduct which disappeared down a "snake", so to speak, of the Pleistocene human evolutionary "puzzle". The puzzle discomforts palaeoanthropologists who sometimes explain it away with the self-justifying assertion that separate palaeospecies of *Homo* differentially possessed cognitive abilities that allegedly underlay the differential presence or absence in the Palaeolithic record of traces of particular behavioural outcomes or skills. We propose an alternative methodological perspective, grounded in fundamentally coherent biophysical and neurobiological relationships between creatures and their environments, which allows for a parsimonious, prosaic, deflationary account for appearances and disappearances of behavioural outcomes and skills in the Pleistocene record of early *Homo*.

Virtual Pecha Kucha Presentation Session 8, Friday 17:30-17:55

Does buccal microtexture pattern suggest a seasonal ecology for *Paranthropus*?

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The dietary econiche exploited by *Paranthropus* has challenged the interpretations of paleoanthropologists, especially because there is no consensus between morphological, microwear and isotopic analyses [1-2]. The derived masticatory apparatus of *Paranthropus* suggests that East and South African species would have exploited a similar specialized herbivore econiche. However, carbon isotopic data seems to reflect different diets for south African *Paranthropus* compared to *P. boisei. P. robustus* isotopic signal suggest only a 30% of C4/CAM consumption whereas *P. boisei* had a diet over 75% of C4/CAM resources [3], similar to values of *T. gelada*, that inhabit Ethiopian highlands and ate primarily grasses, but also forbs and underground storage organs seasonally [4].

In addition, buccal microwear and occlusal microtexture revealed no evidence of hard object consumption in *P. boisei*, suggesting a diet based in grass, leaves or sedges. The buccal microwear pattern of *P. robustus* has not been studied yet. Therefore, the aim of the present study is to analyze the 3D buccal microtexture pattern in an extant sample of primates to improve the dietary discrimination among primates and characterize the buccal surface of 52 *Paranthropus* individuals from east and south Africa.

The extant sample consisted of 60 second lower molars casts from 4 primates' species that inhabit open savanna ecosystems, grasslands, and gallery forests in Africa nowadays (*Mandrillus sphinx, Cercocebus atys, Papio anubis, and T. gelada*). Replicas were obtained following standard procedures [5]. The microtexture data acquisition was done by a confocal microscope Sensofar Plu Neox using a 20X objective lens with a field view area of 650x 500 microns. The photosimulations were imported to Mountain 8 software to file processing and for each individual four areas of 138 by 102 microns were sampled and all the images were first leveled and secondly, the form was removed. We tested the potential of 38 ISO parameters to discriminate between extant primate's diets and this model was used to classify *Paranthropus* individuals. The parameters were normalized, and the outliers were removed from the final dataset. Analysis of Variance (ANOVA) was used to account for significant differences between groups followed of pairwise testing comparisons and a Linear Discriminant Analysis. Seven parameters were selected to better discriminate between species with a correct classification of 75%. Based on the extant primate model, *Mandrillus* differentiate from the rest for having surfaces with coarse high peaks and pronounced dales (high Sal, Smr2, Vmc and Sdv). On the other hand, *Theropithecus* surfaces showed thin features with a high density of peaks (the lowest Sal values and high Spd) while *P. anubis* had surfaces with less peaks but high hill and valleys areas (large Sda/Sha). *Paranthropus* samples were inserted into the LDA and then classified into the extant primate model. Most specimens of *P. robustus* were classified as hard fruit eater *C. atys* and the graminivorous *T. gelada*, accounting for nearly the 70% of the sample. On the other hand, *P. boisei* specimens were classified as *P. anubis* and *T. gelada.*

3D Buccal microtexture results partially support the isotopic signal described for both *Paranthropus* species, suggesting a diet with the incorporation of small hard particles that produced thin striations with flatter textural reliefs surfaces in *P. boisei*. However, *P. robustus* showed a more heterogeneous surfaces while some individuals showed a greater texture relief (heigh and volume) with rough features while other individuals had flatter surfaces with high density of peaks, that could be related to the incorporation of fallback foods seasonally.

We are grateful to all Institutions, curators and technical personnel where the specimens were molded. This research was supported by MCIN/ AEI /10.13039/501100011033/ FEDER "Una manera de hacer Europa" PID2020-112963GB-I00) and PDC2021-121613-I00, funded by MCIN/AEI/10.13039/501100011033 and the European Union "NextGeneration EU"/PRTR . www.paleobaboonproject.science

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Poster Presentation Number 53, Session 1, Thursday 18:15

Levallois technology half a million years ago? A view from late Acheulian Jaljulia, Israel

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Particular technical behaviours, usually associated with the Middle Palaeolithic, were identified in late Acheulean sites in the Levant. However, these "hierarchical systems" or "prepared cores", considered as Levallois or associated technologies, are usually present in low proportions within these assemblages. The discovery of late Lower Palaeolithic Jaljulia offers an unprecedented opportunity to perform a detailed analysis of the hierarchised productions, by providing significant numbers of associated cores and products.

Jaljulia was excavated in 2016-17 and yielded six archaeological localities, all attributed to the late Lower Palaeolithic and dated between 500-300/200 ka [1]. Recently, an account on prepared core technologies from area B (ca. 340ka) was published [2]. In this presentation we focus on the earliest locality at the site, area D, dated to ca. 513 ka by TT-OSL and ESR, thus pushing the evidence some 150 ka earlier. The lithic assemblage is made of flint and composed mainly by debitage reduction processes, alongside numerous bifaces. We performed a technological analysis of all debitage chaînes opératoires of the locality, including attributes analysis coupled by morphometric data and diacritic diagrams.

Within the core reduction concepts identified at area D (Discoid, Algorithmic, Cores-on-Flakes), Levallois-like productions are not anecdotal, representing a significant proportion of the production methods. We highlighted two different core management processes: a typo-Levallois and a more classic Levallois. The first does not fulfil all the criteria defined by Boëda [3] while the second one does [3]. Both modes can be considered within a same volumetric concept. Exploitations are mostly recurrent unipolar and bipolar, including sometimes a search for laminar products. A specific selection of fine-grained flints for these productions is of note, originating from the immediate vicinity of the site [4]. This selection of good quality pebbles/cobbles with specific morphologies allowed the knappers to perform less gestures in order to set up and manage core convexities and striking platforms. It can be considered as a technical shortcut within the knapping processes, which sometimes resulted in relatively low productivity in comparison to Middle Paleolithic Levallois technologies. We argue thus that a Levallois technology variant is present in Jaljulia already half a million years ago, which is different to those identified during the Early Middle Palaeolithic.

Levallois technologies recognised during the Late Acheulean in the Levant are however seemingly absent from later Acheuleo-Yabroudian sites, dated to 420-200 ka. Fully fledged Levallois technologies re-appear once again in the Near-East around 200 ka during the Early Middle Palaeolithic, suggested by some to be a manifestation of specific human dispersals. The site of Jaljulia offers the opportunity to follow the trajectory of an Acheulean invention, its genesis and becoming. The results allow us to consider assimilation and transmission of the Levallois concept in the Paleolithic Levant and discuss the fluctuations of its implication during significant phases of human biological and cultural evolution in the Near East.

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Poster Presentation Number 42, Session 1, Thursday 18:15

Dating the hominin footprints from Matalascañas (Spain): taxonomic and palaeoanthropological implications

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The dating of sites occupied by hominins is a key element in order to understand their evolution. It provides information on the spatio-temporal distribution of taxa, which is essential to infer their appearance, migration and disappearance. The knowledge of the chronological context is particularly important when studying hominin footprints since their taxonomic attribution is done in the vast majority of cases only from their dating, the association of archaeological artifacts or skeletal remains with footprints being particularly rare.

In 2020, 87 footprints were discovered in a single sandy surface near Matalascañas (Spain; [1]). These footprints were then attributed to Neandertals based on initial chrono-stratigraphic studies conducted by Zazo et al. [2] that provided an age of approximately 106,000 years for the surface where the footprints were found.

Here we report new datations of this footprint surface and their implications for the taxonomic attribution of the Matalascañas footprints. A sampling of 4 stratigraphic units, including the paleosol where the footprint surface is located, was conducted in 2021 to realise Optically Stimulated Luminescence dating. According to this new dating, the footprint surface is dated at 295.8 ± 17 ka, nearly 200,000 years older than the initial dating of the surface.

This new dating to the Middle Pleistocene, at the transition between MIS 9 and MIS 8 has a considerable impact on the taxonomic attribution of the Matalascañas footprints. While the first dating at 106,000 years clearly implied an attribution to Neandertals, taxa well known during this period in Eurasia from both skeletal remains and archaeological artifacts, the species attribution for footprints dating to nearly 300,000 years ago is much less consensual. Indeed, the evolution of hominins in Europe during the Middle Pleistocene remains poorly known, the fossil record being particularly scarce during this period and in particular for the MIS 9 and MIS 8. The Matalascañas footprints represent the only paleoanthropological material discovered in the Iberian Peninsula for these isotopic stages. According to studies carried out on Middle Pleistocene European fossil material, some hypotheses point to the presence of a single evolutionary lineage (that of the Neandertals), while others consider that several contemporary evolutionary lineages coexisted. Therefore, the Matalascañas footprints could have been left by pre-Neandertals or by another evolutionary lineage. These new dates thus highlight an important dilemma in the study of hominin footprints: attributing a taxon to footprints only on the basis of chronological context for lesser-known periods can be highly uncertain.

We thank to the Territorial Delegation in Huelva of the Ministry of Agriculture, Livestock, Fisheries and Sustainable Development of the Junta de Andalucía for the permission to carry out research work. This work has been financial support by the Ministry of Science and Innovation of Spain (grant no. PID2019-104625RB-100), the Andalusian Government to the Research Group RNM276 and Basque Government to the Research Group EJ IT1418-19.

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Poster Presentation Number 12, Session 1, Thursday 18:15

Order in the Forecourt: new zooarchaeological investigations of reindeer exploitation at Petersfels (Hegau Jura, Southwestern-Germany)

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Reindeer (*Rangifer tarandus*) were an important aspect of Magdalenian subsistence in Western and Central Europe – a characteristic already established by 1861 with Lartet's coining of the phrase "l'Âge du Renne" to describe early Magdalenian findings from France. The faunal material from Petersfels, located in the Hegau Jura of southwestern Germany, is no exception. Here, tens of thousands of butchered reindeer remains; artifacts made from reindeer bone, antler, and tooth; and depictions of reindeer in figurative art and engravings attest to the importance of this species for Magdalenian hunter-gatherers at the site [1-2]. The quantity and diversity of such finds is one line of evidence pointing to the use of Petersfels as an aggregation site for groups across southwestern Germany and Switzerland [3]. Such aggregations would have served as important "cultural transmitters and population renewers" [4], providing a means for seasonally distant groups to establish and maintain their social relationships year after year [5].

Although much is already known about Petersfels from over 100 years of prior excavation and research, new analyses have the potential to provide valuable context for deciphering the abundant evidence of human subsistence preserved at the site. Thus, this study presents the zooarchaeological analysis of ~2500 unstudied faunal remains from the forecourt of the cave, focusing on the role of reindeer as a central node of human subsistence. Reindeer aging and sexing data inform on the demography of the hunted population as well as human prey choice. Butchery traces, including cut marks and impacts, indicate the systemization of butchery practices and the full exploitation of carcasses for meat, marrow, tendons, and other tissues. Body part profiles suggest that, after initial butchery, certain elements were subsequently transported from the kill site to the forecourt for secondary processing. In this area, heads and limbs were specifically exploited for marrow and as a raw material for osseous tools (e.g., needles), providing evidence for the differential use of space across the broader site complex.

Overall, these results support prior interpretations of the site as a fall/winter aggregation camp and provide new information on the diverse relationship between Magdalenian people and reindeer at Petersfels.

We would like to thank the members of the Zooarchaeology working group in Tübingen for their advice and support, Dr. Gerd Albrecht and Dr. Hubert Berke for their valuable insights on Petersfels, and the Landesamt für Denkmalpflege im Regierungspräsidium Stuttgart for access to the materials.

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Poster Presentation Number 67, Session 2, Friday 18:15

Experimental combustion of fuels and Terminal Pleistocene fire evidence from Cuncaicha rock shelter (4480 masl)

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Human adaptation to cold environments depends on biocultural factors of physiology and technology. Pertinent to understanding initial human occupations of cold environments, such as high-elevation and arctic landscapes, is a thorough understanding of resource availability and use in these apparently fuel-scarce environments.

Here, we focus on the high-elevation Puna ecosystem of the Central Andes in southern Peru (15°S). The Puna is an extensive high-elevation ecosystem that expands through parts of Peru, Bolivia, and Chile above 4000masl. In the study area at 4500 masl in southern Peru, the mean annual temperature is 3°C, with strong diurnal temperature fluctuation and lows well below zero every night of the year.

Adaptations to deal with the cold are critical and among the main challenges thinking about human occupation of the high-elevation landscape, especially when compared to lower, more moderate elevation regions.

Fire holds a unique adaptive role in mitigating cold because of its multifaceted technological and social uses. Yet, while fire plays an essential role in the early adaptation and migration through South America and into the High Andes, key information on pyrotechnology in these regions remains understudied. Moreover, the lack of trees on the Puna presents a potential challenge for using fire to mitigate extreme cold.

In the Puna of southern Peru, Cuncaicha rock shelter represents the highest and most ancient archaeological site in the Andes. Macro-scale evidence of fire in the Terminal Pleistocene includes burned and calcined bone, heat-damaged and treated lithics, carbonized botanical remains, and fire cracked rock. A micro-analysis of sediments identified anthropogenic ashes, providing further evidence of fire throughout all time periods. While the use of fire is confirmed, we have not been able to securely identify the fuel(s) used by the earliest occupants.

With this study, we seek to identify the most likely fuel for the occupants of Cuncaicha and to evaluate fuel availability in the region through a theoretical framework and the experimental burning of the three most likely locally available fuel resources.

In the field, we first collected the different fuels, recording gathering time, gathered volume, number of people helping for each fuel: Llareta (*Azorella compacta*), Queñual (*Polylepsis besseri*), and Tolar (*Parastrephia quadrangularis*). Then we built the fires and measured temperatures with a pyrometer throughout the experimental burn to obtain temperature-time curves. Upon extinction, we sampled the fire residues.

Comparing the experimental residues to the archaeological combustion residues that we encounter at Cuncaicha, we observe that out of the three fuel sources that we chose for this experiment, only Llareta has direct links to the ash that we see in Cuncaicha. Looking at gathering time and the gathered volume, Llareta is the most efficient fuel. Based on our experiment, a modest-sized fire using Llareta gathered in only 30 minutes provides a heat source that lasts more than 24 hours. Llareta is a key resource that would have facilitated the initial exploration and settlement of the high Andes.

In conclusion, the study helped us understand that multiple combustible fuels are available on the Andean Puna. Not depending on a single fuel source has important implications for how habitable a landscape is. Furthermore, we understood that multiple fuels produce fires that can account for the calcined bone and burned lithics at the site of Cuncaicha, out of which Llareta would present the preferred choice based on the experiment outcome. This study further highlights that the earliest occupants of Cuncaicha rock shelter were well adapted and familiar with the particularities and challenges of the high-elevation Puna landscape.

Poster Presentation Number 64, Session 2, Friday 18:15

A sequence of six pre-1.2 million-years Acheulean levels at Simbiro (Melka Kunture, Upper Awash, Ethiopia)

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The MS is a 5m high and 15m long cliff with a sequence of Acheulean levels exposed in full view, the last remnants of what was once much more extensive Lower Pleistocene deposits. The environment was of alluvial plain facies, with interbedded volcanic deposits. Then a major tectonic event, the Kella Formation or Kella Event, dated ~1.2 Ma years [1], caused a major erosional unconformity which affected the volcaniclastic deposits. Accordingly, the remnant ones, which make the MS, pre-date 1.2 Ma. Then more sediments accumulated; among them, the topmost tuff layer was 40Ar/39Ar-dated ~0.9 Ma [1], providing a minimum age for the MS. At the bottom of the gully, 80m downstream, an earlier level stratigraphically extends below the MS. Pending more 40Ar/39Ar dates, comparisons with other sites of MK suggest an age in the range of 1.4 Ma [2].

The five archaeological levels within the MS are named levels A, B, C, D and E from top to bottom. Excavations since the 1970s exposed 19m² in the cliff, while in the gully site ongoing excavations opened 29m². The sample of lithic tools is substantial (level A=211; level B=636; level C=578; level D=13; level E=107; gully site=215). Large flakes (LFs) and Large Cutting Tools (LCTs) such as handaxes or cleavers, allow attribution of them all to the Acheulean technocomplex. Faunal remains, notably including both *Pelorovis oldowayensis* and *P. turkanensis* were found poorly preserved in the cliff, whilst remains are generally abundant and better preserved in the gully site, including large carnivore bones.

The six pre-1.2 Ma Acheulean assemblages display a large variability. In level A there are just a few choppers and handaxes, but many cores and flakes. In level B, LCTs occur in large percentage. Level C stands due to few cores but many handaxes and products from knapping large bifacial tools. In level E, cores and small-medium flakes are abundant, with some LCTs, and – finally – in the gully site, LCTs are not many while cores and flakes are numerous. As is the rule at MK, the raw materials were selected from the abundantly available volcanic rocks. However, while basalts are overwhelming in most levels, ranging between 52% and 82%, with obsidian in variable percentages, in level C handaxes and other implements are almost exclusively in obsidian.

The variability of Acheulean assemblages is often explained by evolutionary trends, but site functionality, availability of raw material, and ecological constraints are better understood as the main explanatory factors. At Simbiro, the variability does not reflect an evolutionary process, but rather changes in behaviour and raw material availability, probably coupled with distinct activities.

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Poster Presentation Number 117, Session 2, Friday 18:15

ROCA - An ontology to capture and study primate tool behaviour

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Here we present a novel method for the analysis of behaviours. We created an ontology for tool use and tool making in non-human primates. Ontologies, such as the CIDOC Conceptual Reference Module [1] and the ARIADNEPlus infrastructure [2], are an information science structure. They are widely used in domains like linguistics, medicine, and cultural heritage, to help experts organize, reason on, and discover new knowledge. Ontologies can be considered more expressive taxonomies: they give hierarchical structure to sets of concepts to express, for instance, that a Japanese macaque is a macaque. Furthermore, they can express more complex relations, for example that a specific chimpanzee may prepare a specific branch to fish for termites at a specific place and hour, or to organize actions in a flow-like manner, taking inspiration from formal automata. For example, picking up a branch, stripping the branch of its leaves, inserting the branch in a nest, pulling off the branch and eating the termites stuck to it. Thus, we can fit ecological, anatomical, phylogenetic, and behavioural data, amongst others, within the same data structure. With an ontology, it is easier to handle knowledge obtained from textual literature because the data is now uniform, unified, acentric, dynamic, and human-readable [3]. Potentially an ontology allows for deeper (automatized) analysis of these data [4].

We built a novel ontology, ROCA (Robotics, COgnition, and Archaeology) to capture descriptions of tool behaviours of non-human primate from well-known primate ethograms, chaînes opératoires, Petri nets, and textual descriptions. First, we collated a representative corpus of articles and books on primate tool use and tool making (sources N = 75). Then, we extracted and provided semantic structure such as taxonomical relationships to relevant vocabulary, both manually and automatically, for the latter using state-of-the-art NLP text mining techniques. The ROCA ontology (https://rocaontology.github.io/) contains 900 concepts to describe physical movements down to the anatomical level, tools and their materials, ecology, and primate features. It also contains concepts and relations that allow us to describe behaviours in a graph-like manner, adding to the ease of interpretation.

We then tested the viability and effectiveness of the ontology to give structure to textual descriptions of behaviour. We collated an additional corpus (sources N=65) and from these extracted textual instances of behaviour (N=200) that we automatically structuralized in a machine-readable format with the concepts and relations from our ROCA ontology. As a proof of concept to show that new knowledge can be obtained, we queried the ROCA ontology to extract instances related to nut-cracking and 'taught' a machine-learning algorithm how to properly crack nuts. We propose a measure of complexity of this behaviour based on the minimal grammar needed to describe it. We concluded that our ontology can capture dissimilar information on behaviours. Besides being a hierarchical dynamic dataset, the ROCA ontology can thus also be used to automatically derive new knowledge on non-human primate tool use and tool making behaviour.

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Poster Presentation Number 14, Session 1, Thursday 18:15

Exploring taphonomic and selection pressures at Geißenklösterle Cave (Swabian Jura, Southwestern Germany) using ZooMS

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Osseous material within archaeological assemblages is often affected by taphonomic and anthropogenic factors to such a degree that morphological approaches to identification break down. In those cases, Zooarchaeology by Mass Spectrometry (ZooMS) is increasingly applied, utilizing collagen, for example, to identify the origin of bone fragments to the lowest taxonomic level in a process called 'peptide mass fingerprinting' [1]. Here, this method is applied on material from a cave site in the Ach Valley of the Swabian Jura, Southwestern Germany.

Geißenklösterle is a nowadays largely collapsed cave that was found to contain Paleolithic material in 1958. Over many excavation campaigns between 1974-1993 under Joachim Hahn and 2000-2002 under Nicholas Conard, an archaeological sequence spanning the Middle Paleolithic (MP), Aurignacian, Gravettian and Magdalenian periods was uncovered there. The cave is of great importance for the study of the Paleolithic in Europe, since it covers the Middle to Upper Paleolithic transition and shows, along with the nearby Hohle Fels, the earliest signals for the Aurignacian so far found in Central Europe, with a highly developed toolkit of figurines, ornaments and musical instruments. It thus serves as an important source for questions regarding Cultural Modernity and the development of human behavior and was awarded UNESCO World Cultural Heritage status in 2017, together with other major cave sites in the Ach and Lone Valleys [2].

For the present study, ZooMS analysis was carried out on morphologically unidentifiable material from the MP, Aurignacian, and Gravettian, with around 100 single finds and between 200-250 *Sammelfunde* for each context. In total, approximately 1000 samples were analyzed.

Preliminary results offer the following insights: the collagen preservation within Geißenklösterle Cave was exceptional, across the sequence, in comparison with other Middle and Upper Paleolithic cave sites [3-4]. Of the samples analyzed, 99% contained sufficient collagen to be identified, with the only fragments that failed originating in the more recent Upper Paleolithic horizons of the Aurignacian and Gravettian. Moreover, the emergent data roughly agrees with the results from morphological studies [5]; the signal for Ursidae (most likely *U. spelaeus*) is dominant overall, followed by mammoth (*Mammuthus primigenius*) and reindeer (*Rangifer tarandus*). There is a slight increase in the relative amount of woolly rhinoceros (*Coelodonta antiquitatis*) compared to the traditionally identified specimens, which could be due to the fact that those bones are hard to distinguish from mammoth visually and often categorized into the mammoth/rhino size-class only. Additionally, it seems that the inclusion of *Sammelfunde* enhances the signal for the ibex (*Capra ibex*) as a small ungulate, and generally leads to a slightly wider range of identified species, enhancing the diversity of taxa within the ZooMS sample groups.

Overall, the data collected so far shows the potential of gaining a more holistic insight into the ecological behavior of the Neanderthals and modern humans that once occupied the Ach Valley when combining morphological and biomolecular methods of bone identification. Furthermore, the exceptional collagen preservation is extremely promising regarding further in-depth studies of the faunal material found within the cave site of the Ach and Lone Valleys. In the future, such studies could lead to a more complete understanding of the interaction between hominids and their environment in the Swabian Jura.

The project was funded by the Excellence Initiative of the University of Tübingen, the Senckenberg Centre for Human Evolution and Palaeoenvironment, the DFG (Deutsche Forschungsgemeinschaft), the Ministry of Science in Baden-Württemberg and the ROCEEH-Project (Role of Culture in Early Expansions of Humans). We would also like to thank Àngel Blanco-Lapaz and Alexander Janas for their assistance throughout the project.

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Podium Presentation Session 10, Saturday 11:20-11:40

Lower to Middle Paleolithic transition in the Balkans - evidence from Velika and Mala Balanica Caves

Dušan Mihailović[1], Vesna Dimitrijević[1], Katarina Bogićević[1], Predrag Radović[1], Senka Plavšić[1], Joshua Lindal[2], Mirjana Roksandic[3]

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Until recently, there was no data on the transition from the Lower to Middle Paleolithic in the Balkans. Lower Paleolithic sites from this period were almost unknown, while the earliest evidence from the Middle Paleolithic did not exceed the age of 170-200. Furthermore, apart from the Mala Balanica specimen with its primitive, non-Neanderthal morphology, we had no information on which hominin populations were present in the Balkans before MIS 7-6, by which time both *Homo sapiens* and Neanderthals were recorded in Apidima, Greece [1] and Neanderthals in Kozarnika in Bulgaria.

The excavations at Balanica Cave Complex have dramatically changed this picture [2-3]. Before 300-240 the Balkans were inhabited by Neanderthals, who already used some of the key elements of the Middle Paleolithic behavioral "package" [4], including regular use of fire, the Quina system in lithic technology and exploitation of resources in mountainous landscapes [5]. Somewhat surprisingly, the technological package of Balanica was very similar to that observed in the Acheulo-Yabrudian complex in the Levant, showing that Neanderthal populations in Europe had almost identical behavioral packages as the contemporaneous populations in the Middle East such as Qesem.

The exact nature of changes that marked this period has yet to be reconstructed. At this point, it appears that population shifts and/or cultural transmission from the Middle East to Southeast Europe have taken place in MIS 9-7, and that Neanderthal populations adopted behavioral patterns that emerged in the Levant somewhat earlier. Balanica's research has shown that certain elements of the MP package in Eastern and Western Europe did not appear independently, but that their shift is most likely based on population shifts and cultural diffusion which occurred during MIS9-7 and covered the entire area of the eastern and northern Mediterranean.

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Pecha Kucha Presentation Session 9, Saturday 9:40-10:05

Does pelvic shape variation in females reflect stabilizing selection?

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Medical and biomechanical evidence suggest that the human pelvis has been subject to antagonistic selective forces: a larger birth canal is advantageous for childbirth but at the same time it is disadvantageous for pelvic floor stability and perhaps also bipedal locomotion [1-3]. Together, these selective factors impose stabilizing selection on the dimensions of the pelvic canal [1]. For heritable traits, stabilizing selection reduces individual variance because then more individuals express a trait value close to the fitness optimum. Stabilizing selection on the pelvic canal is clearly stronger in females than in males because both childbirth- and pelvic floor-related factors mainly affect females. In this study we assessed if the sex-specific selective regime is reflected in pelvic shape variance.

The pronounced average sex differences in the human pelvis mainly emerge during puberty in response to sex-specific levels of steroid hormones and a higher number of estrogen and relaxin receptors in the female pelvis. The pelvis thereby undergoes a greater magnitude of shape change in females compared to males [4], which may lead to a higher overall variance in female pelvic shape than in males. But such potential sex differences in variance are likely not uniform across all parts of the pelvis. For birth-relevant aspects of pelvic shape we expect that females show less variance than males due to the stronger stabilizing selection, whereas other pelvic shape features may be more variable in females. We expect these sex-specific variance patterns in humans to differ from those in chimpanzees, where females experience less, if any, antagonistic selection on the pelvis because of their different locomotion. Chimpanzees also show less pronounced pelvic sex differences as compared with humans. The differences in variance between sexes and between pelvic regions are thus expected to be smaller than in humans.

We tested these hypotheses by a geometric morphometric analysis of 109 three-dimensional landmarks measured on 99 human pelvises and 34 chimpanzee pelvises. We compared total shape variance among the sexes and extracted shape features with maximal variance ratios between males and females by relative eigenanalysis [5].

For humans, total variance in pelvis shape was 24% higher in females than in males. When decomposing human pelvic shape variation into relative eigenvectors, only one component showed a clearly reduced variance in females compared to males. This component mainly reflected the width and overall capacity of the pelvic canal. By contrast, the components with higher female variance reflected other sexually dimorphic features, such as sacral length, subpubic angle, and iliac flare. In chimpanzees, variances were more similar between the sexes.

These results are in line with our hypotheses: Strong stabilizing selection in females has reduced individual variation in the dimensions of the pelvic canal as compared to males. The absence of strong sex differences in variance among chimpanzees aligns well with the fact that chimpanzees face less obstetric selection and also much less antagonistic selection than humans, but the chimpanzee sample size was small. Together with the well-known sex differences in average pelvic shape, these differences in variance thus confirm that a complex selective regime has affected the shape of the human pelvis.

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Pecha Kucha Presentation Session 9, Saturday 9:15-9:40

A new virtual reconstruction and geometric morphometric analysis of Kocabaş hominin fossil from Turkey

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The Kocabaş specimen comes from a travertine quarry near the homonymous village in the Denizli basin (Turkey). The specimen is composed of three main fragments: portions of the right and left parietal and left and right part of the frontal bone. The fossil was assumed to belong to the *Homo erectus* s.l. hypodigm by some authors [1-3], while others see similarities with middle Pleistocene fossils such as Kabwe and Bodo [4] or Ceprano and Arago [5]. However, a geometric morphometric (GM) analysis of a fully reconstructed specimen is still lacking. Here, we present the first attempt to make a full reconstruction of the missing medial portion of the frontal bone and the results of a comprehensive GM analysis.

We restored the calotte by aligning and mirroring the three preserved fragments. Afterward, we restored the missing portion by applying the Thin Plate Spline (TPS) interpolation algorithm of target fossils onto the reconstructed Kocabaş specimen. For the GM analyses, we collected a total of 80 landmarks on the frontal bone (11 osteometric points, 14 bilateral curve semilandmarks, and 41 surface semilandmarks). The comparative sample includes 21 fossils from different chronological periods and geographical areas and 30 adult modern humans from different populations. Shape analyses highlighted the presence in Kocabaş of some features usually related to middle Pleistocene humans, such as a big supraorbital torus associated with a relatively short frontal squama and absent post-toral sulcus. Cluster analysis and linear discriminant analysis classification procedure suggest Kocabaş to be part of the same taxonomic unit of Eurasian and African specimens usually described as *H. heidelbergensis* s.l.. In light of our results, we consider that an attribution of the Kocabas hominin to *H. erectus* s.l. is unwarranted. The results of our analyses are compatible with different evolutionary scenarios, but a more precise chronological framework is needed for a thorough discussion of the evolutionary significance of this specimen. Future work should aim to further clarify its geological age, given uncertainties regarding its stratigraphic provenance.

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Poster Presentation Number 25, Session 1, Thursday 18:15

Music – Non-material cultural heritage. Research on reconstructions of the 40,000 years old Palaeolithic wind instruments from the Swabian Jura (SW-Germany)

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The oldest known musical instruments were found in the caves of the Swabian Jura [1-3]. The fragmented state of these Palaeolithic wind instruments raises a number of questions regarding their voicing method, timbre and tonal material. Consequently, our work attempts to answer these questions through a systematical comparison of tonal results with different reconstructions.

First musical analyses of experimental reconstructions were conducted in the 1990s by Joachim Hahn and Wulf Hein, and Fritz Seeberger [4].

Drawing from these works and responding to an ongoing discussion of how these instruments were played and what kind of tonal material they offer, Anna Friederike Potengowski started her musical analyses by comparing reconstructions of the four most complete wind instruments, namely the swan flute (GK1) and the mammoth ivory flute (GK3), both from Geißenklösterle cave, the vulture flute (HF1) from Hohle Fels cave and the vulture flute from Isturitz (F3α) [5].

Furthermore, the influence of the voicing method on pitch, resulting basic notes and musical intervals was studied by applying four different voicing methods on the same instrument following the designs of quena, nay, clarinet, and oboe.

A similar analysis was carried out on eight reconstructions of GK3 differing in length and number of finger holes. The focus was placed on the influence of total length on playability, resulting pitch, basic notes and musical intervals.

Beside the large variability of tones and pitches (glissando effect), especially on the swan radius instrument GK1 played as a nay, systematic comparisons of different reconstructions of the wind instrument reveal consistencies concerning the intervals as well as differences in the resulting tonal material. The interpretation of these results brings us closer to the original musical language of these instruments and its Palaeolithic players and offers an additional dimension for exploring cognitive and artistic abilities of Anatomically Modern Humans.

In this sense, Palaeolithic wind instruments from the Swabian Jura as well as musical work coupled with the analyses of their reconstructions are to be considered as important research on the non-material part of the UNESCO world heritage. This kind of study is crucial for understanding the evolution of humankind.

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Poster Presentation Number 88, Session 2, Friday 18:15

New additions to the Koobi Fora *Paranthropus boisei* mandible collection

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After teeth, mandibles and mandible fragments are the best represented element in the early hominin fossil record. Among these, the mandibular hypodigm of *Paranthropus boisei* is the largest ascribed to a single early hominin species. Fossils of *P. boisei* originate from eight fossil localities covering 1,800 km N-S – Malema in Malawi, Olduvai Gorge and Peninj in Tanzania, West Turkana, Koobi Fora, and Chesowanja in Kenya, and Omo Shungura and Konso in Ethiopia. However, the vast majority of the remains originate from Koobi Fora.

Most of the Koobi Fora (and Ileret) hominins were discovered during the first decade of exploration of the site (1969-1979), and (besides those singularly important fossils that were published in scientific journals) were described in a major monograph by B. Wood in 1991. Some of the fossils discovered since have yet to be described and analyzed.

Here we describe two previously unpublished hominin mandibles found by the Koobi Fora Research Project led by Meave and Louise Leakey. The fossils –KNM-ER 42709 and KNM-ER 42801– were discovered at Koobi Fora within areas 6A and 8B respectively. KNM-ER 42709 is a left edentulous mandibular corpus with roots of M3 to I1 present, and derives from a stratigraphic context consistent with an age of c. 1.38 Ma. KNM-ER 42801 is a mandibular corpus fragment with the crown of the M3 present, and the stratigraphic context suggest a date of c. 1.6 Ma.

Both fossils show mandibular and dental dimensions, as well as autapomorphic traits, typical of *P. boisei*, as identified at the time of discovery. We explore this taxonomic attribution through a geometric morphometric comparative analysis of the mandibular corpus that confirms their affinities to *P. boisei.*

Yet, besides its size, the Koobi Fora fossil assemblage of *P. boisei* mandibles is also exceptional for its high levels of variation. We investigate the morphological relationships of these new specimens and the *P. boisei* mandibular sample from Koobi Fora and characterize the increase in morphological variability that these fossils ascribe to the hypodigm.

Poster Presentation Number 20, Session 1, Thursday 18:15

Palaeolithic raw material procurement strategies in the northern Tian Shan piedmont, Kazakhstan

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The piedmonts area between the northern Tian Shan and the arid deserts of Moyunqum and Betpaqdala has served as a corridor for human movement since early prehistory. However, only two stratified sites (Maibulaq and Rahat) are currently known. These are located in loess sedimentary contexts and dated to the Early Upper Palaeolithic. Even though these sites have been studied, lithic procurement activities, which can reveal both economic and mobility-related behaviors, remain unknown. To address this deficiency, we present the results of the first systematic raw material surveys in the piedmont zone of northern Tian Shan and provide a petrographic characterization of lithologies exploited during the Palaeolithic. Both sites contain assemblages predominantly knapped on volcanic porphyritic rocks with visible phenocrysts, and some tools knapped on exogenous materials (e.g., chert and siliceous shale). We located a potential source of higher quality siliceous shale located 20 km west of Maibulaq. Based on the results of the field survey and raw material counts of lithics from Maibulaq, we suggest that prehistoric inhabitants had predominantly a direct procurement strategy which implies direct provisioning of local raw materials. However, the presence of lithics knapped on exogenous materials suggests that these materials were collected while carrying out other tasks, in other words, as a result of embedded procurement. Despite the availability of higher quality shale and fine-grained felsitic rocks, the Maibulaq settlers provisioned local porphyry. This indicates that the toolmakers were highly selective in their choice of local materials. To better understand the physical characteristics that were preferred by ancient people, we carried out mechanical tests of the different rock samples. The results suggest that the mechanical properties of porphyry, which appears difficult to knap on first impression, are comparable to those of chert. Therefore, we hypothesize that prehistoric groups optimized other qualities rather than knappability, or that they utilized a different strategy for exploiting these nodules. These results call for a detailed investigation of various mechanical properties of porphyry and other less studied materials to answer questions regarding their preference over other knappable lithologies.

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Poster Presentation Number 40, Session 1, Thursday 18:15

Covariation of endocranial shape and cranial vault thickness in present-day humans and Neandertals

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A better understanding of the patterns of brain growth and development in extinct but also in extant great apes informs discussions about the evolution of cognitive abilities and behaviors in the human lineage. In fossils, brain shape and its cortical organization can usually only be inferred from the shape of the endocranial cavity and from the brain imprints in the cranial bone. However, the shape of the braincase results from different mechanisms: the patterns of brain growth and development [1], the evolutionary and developmental changes affecting facial size and shape [2], the development of soft tissues [3] and the pattern of growth and development of the entire neurocranium [4]. It has been shown that present-day humans and Neandertals achieved similar endocranial capacities via different developmental pathways, suggesting underlying differences in the tempo and mode of brain growth and development [5].

Here, we assess the influence of bone thickness on endocranial shape. Specifically, we examined to what extent differences in bone thickness of the cranial vault can explain the endocranial shape differences between present-day humans and Neanderthals. Our sample comprises 75 computed tomographic scans of adult present-day humans and 6 Neandertals. Endocranial shape was measured using 935 landmarks and semilandmarks and analyzed after a Procrustes registration. Cranial vault thickness (CVT) was computed from 472 landmarks and semilandmarks as the distance between the endocranial and the ectocranial surfaces. We first quantified CVT standardized for the size. Second, we explored the covariation between endocranial shape and the cranial vault thickness using a two-blocks partial least-squares analysis (PLS). Last, we established a predictive regression model of endocranial shape using cranial thickness as an input variable and endocranial shape as an output. We built this model from the present-day human sample only, and measured the fitness of the model in explaining the endocranial shape that characterizes the Neandertal individuals.

Our results demonstrate that even though Neandertals tend to have a thicker cranial vault, these values are still comprised within the range of variation of present-day humans. The first dimension of covariation in the PLS analysis was driven by variation within present-day humans. Individuals displaying elongated shapes showed an overall thinner CVT, while those with rounded vaults had a thicker cranial vault. Scores along the second axis of covariation displayed a shift between present-day humans and Neandertals. Along this axis, present-day humans were characterized by bulged, vertically stretched and thin parietal bones, while Neandertals displayed vertically shorter, wider and thicker parietal bones. Finally, our regression model failed to predict the Neandertal endocranial shape from their CVT values. Altogether, our results suggest that endocranial shape differences between present-day humans and Neandertals are not likely to be explained by their CVT, and strengthen the hypothesis of different brain shapes between these two human groups.

We are thankful to all curators and technicians for access to and CT scanning of fossils and present-day humans. We acknowledge the Fyssen foundation and the Max Planck Society for funding. This research was supported by Marie Skłodowska-Curie Grant #101025719 (ZJT).

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Poster Presentation Number 2, Session 1, Thursday 18:15

Milovice IV (Southern Moravia, Czech Republic): genius loci for the Upper Paleolithic settlement and hunting

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The poster presents preliminary results of our new rescue excavation at mid-Upper Paleolithic site Milovice IV held in 2021. The site belongs to well-known and complex settlement area Dolní Věstonice – Pavlov – Milovice and its importance was already proved in 2009 and 2010, based on the evidence of a total mass of cultural layers and a diverse structure of findings. However, our previous finding situation was limited by the collapsed cellar ceiling and its floor plan, due to which our research concerns the main cultural layer with a highest thickness and safest accessibility [1]. Our recent excavation on 6 x 4 m allows us to document significant human activities again within the main cultural layer and newly extended in its overburden and subsoil.

The upper finding situation belongs to Late Gravettian period based on radiocarbon dating, a smaller collection of lithic artifacts and dispersed skeletal remains of large and extra-large mammals. The position represents a periphery toss zone of the settlement and most probably is connected to a part of a larger mammoth bone deposit. The main cultural layer falls into the Evolved Pavlovian and is presented by a rich lithic and osteological assemblages, hard animal tissues artifacts and art, Tertiary and Quaternary mollusks, ochre, charcoals and a hearth with red burned hearthstone slabs. The presence of such findings together with their distributions allows us to interpret the situation as a part of a base camp settlement zone, where activities connected to game skinning and butchering, nourishment and production of lithic and organic artifacts were realized. The layer bellow contains older settlement activities connected to the Early Upper Paleolithic. A low amount of lithic artifacts vertically dispersed in the soil horizon bellow the Last Glacial loess and occasional faunal remains´ fragments were documented here. The lithic techno-typological features and used raw materials are strikingly different from those originating from the main layer above and place these findings to Aurignacian.

The amount of archeological findings, their intensity, spatial distribution and connection to certain settlement activities, together with exploited animal species, supports the significant role played by Milovice IV site within the complex settlement structure around the Pavlov hills. And horse hunting oriented economy seems to be crucial for its evolved phase. Finally, such complex socio-economic adaptations in rapid environmental changes repeatedly confirms the strategic position of Milovice IV settlement at the bottom of the valley as being an important *genius loci* for several Upper Paleolithic human societies.

This contribution results from the research funded by the Czech Science Foundation as project no. 20-26094S "Hunters at a camp: Reconstruction of spatial behaviour at Moravian Gravettian sites".

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Poster Presentation Number 27, Session 1, Thursday 18:15

Re-examining faunal patterns at Grotta di Castelcivita through collagen peptide mass fingerprinting (ZooMS)

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The Palaeolithic site of Grotta di Castelcivita (Campania, Southern Italy), investigated by the University of Siena, contains a key late Middle and early Upper Palaeolithic archaeological sequence exhibiting Late Mousterian occupations followed by the Uluzzian techno-complex and a Protoaurignacian sequence, the latter capped by a multi-layered flowstone interbedded with layers of the Campanian Ignimbrite tephra. Numerous faunal remains are present throughout the sequence but, like many Pleistocene sequences, much of the faunal assemblage is fragmented and unidentifiable. The morphologically identifiable faunal remains provide valuable information on species abundance and diversity to reconstruct subsistence behaviours. Here we analyse the unidentified fragmentary bones in an effort to retrieve human remains as well as attempt to add greater dimension to changes in hominin diet and subsistence patterns. Collagen peptide mass fingerprinting (ZooMS) of 1263 unidentified bone fragments revealed distinct changes in NISP values in the Uluzzian and Protoaurignacian layers where Equids and *Bos/Bison* sp. nearly doubled in quantity compared to the original morphologically identified macrofaunal assemblage. Patterns in the shift from red/fallow deer dominating in the Mousterian then shifting to Equids and *Bos/Bison* sp. dominating in the Uluzzian and Protoaurignacian remain. Whether the changes in the NISP % values suggest variations in fragmentation rates between different faunal bones or perhaps an even greater presence of Equids and *Bos/Bison* sp. than first recorded in the Uluzzian and Protoaurignacian is explored. This will be discussed in terms of methodological approaches comparing ZooMS and zooarchaeology data and how additional identifications and taphonomic data may improve our understandings of site formation. Taken together we interpret the data in view of the biocultural shifts assumed to be witnessed at the site and involving the disappearance of the Mousterian-producing hominins (Neanderthals) and the emergence of the Uluzzian and the Protoaurignacian technocomplexes (modern humans).

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Poster Presentation Number 31, Session 1, Thursday 18:15

Nahal Dimona 24: A new perspective on the role of centripetal Levallois knapping mode in the Middle Paleolithic of the Levant

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Nahal Dimona 24 is a Middle Paleolithic (MP) rock shelter near the town of Dimona in the arid Negev region, southern Israel. The site exhibits at least one well preserved in situ archaeological horizon, dated by OSL to the Late MP. It is the first MP sheltered site excavated in the Negev region. The lithic assemblage from ND 24 is dominated by the centripetal Levallois knapping mode, sharing technological characteristics with earlier MP sites from the southern Levant such as Qafzeh Cave and Nesher Ramle Quarry.

It is widely accepted that most MP lithic assemblages from the southern Levant conform to a general classification of Levantine Mousterian, characterized by Levallois technology and shows similar typology to the European 'typical Mousterian'[1]. Hence, most of the known lithic variability is manifested in the frequency of the combinations of different methods and modes of production (e.g., the Levallois preferential or recurrent production methods and unidirectional, bidirectional or centripetal modes for shaping the core flaking surface). This technological variability has been explained for many years by a linear chronological model built on the long sequence in Tabun Cave, a model that has been challenged in the last two decades based on ongoing research [2]. Within this framework, dominance of centripetal Levallois knapping mode is still frequently associated with MIS 5 chronology and is seen by many as a cultural marker for human adaptation and migration. Recently, it was associated with both the migration of modern humans out of Africa [3] as well as with a newly defined human population in the Levant [4].

Based on the lithic assemblage and OSL ages from ND 24, we suggest that within the technological variability of the MP in the Levant, the dominance of a specific production mode is not a sufficient cultural or chronological marker. We further propose that since long stratified sequences may be a result of many visits by different human groups, short- term occupations like ND 24 may shed new light on the use of the different modes of Levallois preparation in the late MP. The dominance of a specific mode of production in a short-term occupation may help us examine the reasons for the specific cultural and adaptive choices made by the group visiting the site.

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Poster Presentation Number 105, Session 2, Friday 18:15

Symbolism: a cognitive perspective

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The material record often provides scant insight into prehistoric culture and tool functionality, and interpreting potential symbols in the prehistoric record presents a major challenge. The default position seems to be interpreting an archaeological artifact as symbolic, particularly if it occurs within the last 150,000 years, in part because definitions for symbols in anthropology are often undefined or nebulous. This paper provides a multi-level construct for symbolism: (1) Minimally symbolic cognition, which can be accounted for by basic learning principles such as non-associative learning (habituation and sensitization) and associative learning (classical conditioning, operant conditioning, and observational); and (2) Fully immersed symbolic cognition, which requires enhanced working memory, full Theory of Mind, and all of modern language's pragmatics. It is suggested that the temporal context of fully immersed symbolic cognition might correlate with the evolution of the modern human brain, whose final size and shape emerged between 100,000 and 35,000 years ago [1]. Three arguments might explain why fully immersed symbolic cognition would have arisen only within the last 100 thousand years or so and only for *H. sapiens*. The first is based on the paleoneurological evidence that the fully modern brain (smaller and rounder), emerged during this period [2]. Further, it has been established that there was parietal and temporal lobe expansion, cerebellum and olfactory bulb expansion, and diminishment of the occipital lobes in *H. sapiens* within the past 100 thousand years, in contrast to Neandertal brains, which remained enlarged but retained the shape of earlier hominin brains. The smaller, rounder shape of *H. sapiens* brains would have mitigated some of the evolutionary disadvantages of larger brains by needing fewer long connections between brain regions and having fewer metabolic requirements. These morphological implications are often overlooked, ignored, or discarded by those proposing that Neandertals were indistinguishable from contemporary *H. sapiens* [3]. This first argument implies two things: First, brain differences in *H. sapiens* entailed small but significant differences not just in tool use but also in symbolling capacity; second, parietal enlargement in *H. sapiens* marks a terminus post quem in the emergence of fully immersed symbolic cognition. The second argument for fully immersed symbolic cognition is genomic. Numerous studies have substantiated that genes regulating brain size have evolved under strong positive selection in the last 100,000 years in *H. sapiens* [4]. The third argument resides in a purported explosion of culture beginning about 50,000 years ago (although this idea is contested). The confluence of these three pieces of evidence is consistent with the concept of enhanced working memory [5]. Wynn and Coolidge hypothesized that a beneficial genetic mutation resulted in an increase in working memory capacity sometime within the last 100,000 years. Thus, it is possible that fully immersed symbolic cognition arose with and is synonymous with enhanced working memory capacity. It seems reasonable to hypothesize that enhanced working memory, full Theory of Mind, and all of modern language's pragmatics (including subjunctive thinking) were a synergistic phenotypic consequence of the well-documented changes in the brain shape of *H. sapiens*. Given the intense popular interest in Neandertals, especially in the form of recent evidence for their non-utilitarian engagement of materials like painted shells, feathers, and colored mineral pigments, a program based on cognitive processes should be able to distinguish the symbolism in coloring the body with pigments, wearing beads, and engraving bones because other people are observed doing these things (practice-embedded) and the more cognitively complex thinking associated with European Upper Paleolithic artifacts like the Hohlenstein-Stadel figurine.

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Poster Presentation Number 3, Session 1, Thursday 18:15

Linya. A new Late Glacial partial skeleton from Cova Gran de Santa Linya site (Lleida, Spain)

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In the Iberian Peninsula there are many Upper Paleolithic archaeological sites with long sequences, especially in the northern, Mediterranean and Atlantic regions. However, it is remarkable the scarcity of human fossil record for this period. Most of the (scarce) fossils consist in cranio-dental remains, but just a few preserve postcranial *Homo sapiens* remains [1-3]. This is more relevant if we compare this human record with the wealth of human fossils and burials from France, Italy, Germany and Central Europe. In this work, we present, describe and comparatively study a new human partial skeleton from Cova Gran de Santa Linya site (Lleida, Catalunya, Spain) belonging to the Late Glacial period.

The Cova Gran de Santa Linya site is located in the first ranges of the SE Pre-Pyrenees, ca. 385 m a.s.l.. It represents a large archaeological rock shelter with a long chrono-cultural sequence spanning the Middle Paleolithic, Early Upper Paleolithic, Late Upper Paleolithic to Late Prehistory [4].

In a recent excavation of 9 m2 test-pit called "Sector V" several human remains were discovered corresponding to a human partial skeleton preserving fragmentary long bones, fragments of the pelvis, and some cranial, vertebral, hand and foot remains. Until now, it is remarkable the absence of teeth and the small representation of cranial, hand and foot fossils. Direct ultrafiltered radiocarbon dating of a human fibular fragment provided a date of 12,310 ± 40 BP (Beta-587946) deriving the chronometrical range 14,808-14,091 cal yr BP (2 ∂; 14,808-14,707 cal BP (14.3%) /14,468-14,091 cal BP (81.1%)) that frames the discovery in the Late Pleistocene.

Before the anthropological and taphonomic study, an in-depth restoration and conservation process was necessary due to the fragility and fragmentary nature of the bones. We provide a complete metric and morphological study of this individual for the first time within a chronologically and regionally comparative framework. The age at death determination for all the human remains suggests an adult age, based on the completely fused epiphysis on all the bones. There is no age at death or laterality incompatibilities, and therefore probably all the human sample belonged to the same individual, a likely adult female. Some probably pathological traumatic lesions and periosteal reactions have been observed in the radius, the ulna, the phalanges, the tibia and the fibula.

The taphonomic analysis of the skeletal remains reveals the total absence of anthropic intervention of the skeleton such as cut or percussion marks. This, rules out cannibalism as is the case with other individuals of Magdalenian chronology in Europe [5]. Tooth marks compatible with a small carnivore have been documented on both tibiae. This allows inferring punctual scavenging of the skeleton and could explain the absence of some anatomical elements. Finally, postmortem modifications typical of processes occurring after burial such as postmortem fractures or modification by plant roots are the most common alterations in this individual. These taphonomic characteristics together with the anatomical relationship of the elements of the same individual suggest a rapid burial of the corpse, compatible with funerary practices as a provisory scenario without discounting her natural or accidental death. In sum, the partial skeleton of Cova Gran, nicknamed Linya, constitutes an important addition to the Late Glacial human fossil record of South-Western Europe.

We are deeply grateful to the Cova Gran research and excavation team. Without the work, help, effort and advice of those people this study would not have been possible. We are indebted to many people who have allowed access to some important skeletal collections. Cova Gran de Santa Linya is part of the project Human settlement during the Upper Pleistocene and Holocene in the Southeastern Pyrenees (PID 2019-104843GB-I00) and the 2017SGR-1357 research group. Fieldwork was funded by Servei d'Arquelogia i Paleontologia from the Generalitat de Catalunya (CLT009/18/00012) and the Leakey Foundation. AP is financed by a research grant from Junta de Andalucía, Spain (EMERGIA20_00403). NS is funded by the European Research Council (ERC) (Grant agreement No. 949330). NS and AGO were supported by the Ramón y Cajal program (RYC2020-029656-I and RYC-2017-22558 respectively). Part of this research was supported by the Spanish projects PGC2018-093925-B-C33 and PGC2018-093925-B-C31 (MCI/AEI/FEDER, UE).

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Poster Presentation Number 41, Session 1, Thursday 18:15

Tabūn C1: First taphonomic approach from a virtual perspective

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The Tabūn cave opens on the southern slope of Mount Carmel, near the city of Haifa, Israel. The site of Tabūn was first excavated in 1930s [1]. In a sequence 25m thick, seven layers were described: layer A (Iron Age); B, C and D (with Mousterian industry) and E, F, G attributed to the Lower Palaeolithic [1]. The most spectacular find was the almost complete skeleton of a Neanderthal, Tabūn C1, found in a burial, arguably form level C, during the excavations of 1929-1934 [1]. The small size of the skull and the gracility of the skeleton suggest a female assessment [2].

Layer C was dated by ESR analysis of tooth samples giving an age close to 100 ka [3-4]. Despite the debate revolving around the dating of Tabūn C1 individual, the work of Grün and Stringer [3] points to a chronology of 122 ± 16 ka.

Since the skeleton is fairly complete, its position in anatomical relation and the good bone preservation, it was surmised that the body of Tabūn C1 was buried in a grave [1]. Nevertheless, so far, to our knowledge there is not a taphonomic study of the skeleton. Here we present the first taphonomic analysis of Tabūn C1 using CT-images and virtual models.

In this work we have analysed about 130 bones that currently constitute the skeleton of Tabūn C1 curated in the Natural History Museum in London, including cranium, mandible, and postcranial remains. The analysis was carried out using microscopic techniques, including CT-scan (Nikon Metrology HMX ST 225 CT-scan) placed in the Computed tomography laboratory of the NHM. The computed tomography images allow us to observe the properties of the fractures since the bones are glue together and partially reconstructed.

More than 300 bone fractures have been measured and characterized. After the visual and virtual taphonomic analysis we can presume that all fractures present in Tabūn C1 can be interpreted as postmortem. Other post-depositional alterations have also been documented and there are no signs of carnivore nor human activity on the skeleton. These findings indicate a rapid burial of the body, which is compatible with funerary practices.

Finally, surviving palaeopathological alterations have been documented in the skeleton of Tabūn C1, including periosteal new bone formation in the lower limb. The implications of these changes may help to complete what we know so far about this classic individual.

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Poster Presentation Number 95, Session 2, Friday 18:15

PaleoProPhyler: an open-source reproducible pipeline for paleoproteomic analyses

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Ancient proteins can preserve longer than DNA in fossil remains, and can conserve phylogenetic information for up to millions of years, enabling a deeper look into the evolutionary past of extinct species. Recent publications [1-3] have shown that the enamel proteome can be used to reconstruct the phylogenetic history of extinct taxa, including hominids, supplementing insights from comparative studies of fossil morphology. However, the limited availability of ancient and present-day protein datasets heavily restricts the types of analyses that can be performed with paleo-proteomes. Ancient proteins also tend to be highly fragmented, which posits problems for accurate alignment and phylogenetic reconstruction. Finally, current paleoproteomic workflows involve the use of multiple different software tools and custom in-house scripts, greatly limiting their reproducibility.

To address these issues, here we present a pipeline that simplifies and standardizes these analyses, providing the user with a best practices toolbox for fully reproducible evolutionary analysis of ancient proteomes. This includes the in-silico translation of protein sequences from ancient and present-day genomes; expanding the available sequences that can be compared to ancient proteomes. Our pipeline also allows the user to easily align and prepare ancient proteomic datasets, while considering characteristic damage patterns in ancient proteins, and to construct phylogenetic trees. The pipeline can combine information across multiple ancient protein sequences from the same sample and perform species tree inference using multiple different methods, including fossil calibrated, multispecies coalescent trees.

Automated workflows in paleogenomics have enabled the consolidation and growth of the field and are essential for small or emerging labs trying to meet current standards. Our work here aims to facilitate the same kind of development in paleoproteomics and to unlock the field to people of different scientific backgrounds. Our pipeline is built from the ground up using state of the art tools such as Conda [4] and Snakemake [5], granting it accessibility, automation and computational scalability. As proof of principle, we deploy this pipeline in the reconstruction of ancient hominid history using publicly available proteomes, including that of *Homo antecessor* and *Gigantopithecus blacki*, in combination with translated genomes from hundreds of present-day and ancient hominid samples.

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Poster Presentation Number 94, Session 2, Friday 18:15

Climate under the microscope – retrieving n-alkane biomarkers from micromorphology blocks

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Climatic and environmental changes form the framework of key processes in human evolution. However, climatic conditions and landscape developments are spatially complex and difficult to relate to archaeological sites and materials due to the limitations of chronometric dating resolution available for much of the Pleistocene. At the same time, archaeological sites are formed of complex palimpsest deposits that have the potential to compress large stretches of climatic variability into a single macro-stratigraphic unit. Site-specific and microstratigraphically resolved climatic archives are necessary to overcome these limitations. One technique that can provide very highly resolved micro-stratigraphic context is micromorphology of resin-impregnated sediment slabs, and analytical research is increasingly looking to capitalize on this resource by adapting biomolecular techniques to sediment samples from such sediment slabs [1-2].

Analyzing the distribution and isotopic composition of *n*-alkanes, a class of plant lipids, is one of the most robust and well-established methods of obtaining palaeohydroclimatic and palaeovegetation data from sediments and it was recently shown that such plant lipids can be extracted from resin-impregnated samples [2]. However, further research is needed to ensure the reliable isolation of archaeological *n*-alkanes from resin components and contaminants and to test if a biogenic isotopic signal can be recovered. In this study, we characterized the lipids extracted from more than 20 polyester and epoxy resin samples commonly used for consolidating archaeological sediment slabs. We show the level of *n*-alkane contamination contained in different resin types and evaluate the variability of contamination levels across manufacturers and production batches. Further, we test the recoverability of sediment *n*-alkanes and establish sample size recommendations for archaeological samples. For use on archived slabs with little documentation on impregnation methods, we also present a Raman spectroscopy screening approach to distinguish between epoxy and polyester resins. Drawing together these first results we present a recommended workflow for sampling existing sediment slabs and suggest best practices for slap impregnation to ensure compatibility with biomarker analysis.

Further research on the recoverability of biogenic isotopic ratios of *n*-alkanes in resin-impregnated sediment slabs is needed to fully establish *n*-alkanes-based palaeoclimatic reconstructions. If successful, this research will enable a manifold increase in the resolution of site-specific climatic records that we can generate directly from archaeological sites, a key step towards high-quality climatic context for human evolution research. The results of this research are also relevant to the extraction of other lipid biomarkers (e.g., combustion markers) from micromorphology blocks.

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Poster Presentation Number 33, Session 1, Thursday 18:15

Neanderthals mobility and toolkit in Micoquian open-air sites of Piekary III and Zwolen (Poland)

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During the Weichselian, the rapid decrease of the temperatures and the following environmental changes caused significant difficulties to European Neanderthals that had to cope with an increased seasonality of biotic resources and faunal turnover. While in the Mediterranean regions the technical behaviours remained mostly unvaried, Central European Neanderthals reacted to these new ecological conditions designing a new toolkit composed of asymmetric bifacial knives, bifacial tools and foliate artefacts. This new facies of the Late Middle Palaeolithic is named Micoquian (or Central-Eastern European Micoquian – CEEM) spreading from Eastern France to Poland, Northern Caucasus, and Altai. In the last years, a greater attention has been addressed to understanding the mobility and the technological organizations of Micoquian Neanderthals (e.g. [1-4]).

In this paper, we present new data from two Micoquian open-air sites - Piekary III level 7 and Zwolen [5] – located in southern Poland. At Piekary III, the local Upper Jurassic flint was used in higher frequency and only one core attests the use of chocolate flint, a raw material distinctive of outcrops located at ~60 km in the Udorka Valley (central Częstochowa Upland) or at ~170 km in the Holy Cross Mountains. The technological analysis indicates knapping activities at the site related with cores' configuration and preparation of the toolkit for being transported in other locations. The few animal bones discovered suggest the occasional processing and consumption of the prey. These data indicate that the locality was used in a framework of mix strategies as workshop and bivouac. At Zwolen, the lithic assemblage is composed of artefacts made in allochthonous raw materials (chocolate flint – 35km; Turonian flint – 60km; Upper Jurassic flint – 200km). The technological study shows the transport at the site of toolkit composed of flakes, scrapers and bifacial knives. These latter were recurrently resharped by using a soft hammer. The rich collection of bones of horses and other cold-adapted species implies that the site served primarily as a hunting station. We also compared the 3D shapes of the Micoquian asymmetric bifacial tools by using geometric morphometric analysis. The results indicate some morphological differences between the assemblages, probably related to the different sites function. Further comparisons with other open-air sites will unveil the flexibility in the land use of Micoquian Neanderthals.

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Poster Presentation Number 89, Session 2, Friday 18:15

Assessing proximal fibular shape as an indicator of bipedalism in extant hominids

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Bipedalism and upright posture are considered unique traits of hominins.

Despite recent studies showing that fibular diaphyseal cross-sectional geometric properties can further our understanding of the degree of arborealism of early hominins [1], the fibula often remains overlooked in anthropology. The proximal fibular extremity is rarely investigated in humans, except for clinical purposes [2] and even less data is available for great apes. On the other hand, the distal fibula has been the object of morphometric analyses, focusing on both linear measurements and a 3D geometric morphometric evaluations of the whole extremity, and revealed its potential as a signal of locomotor patterns in hominoids.

This work aims at providing a detailed comparative assessment of shape variation of the proximal fibula in extant humans and great apes. Further, our goal is to explore the link between proximal fibular shape and the degree of arborealism by genus.

The analyzed sample includes 94 left proximal fibulae belonging to 37 *H. sapiens*, 15 gorillas (*Gorilla gorilla gorilla*=5; *Gorilla beringei beringei*=3); 17 orangutans (*Pongo abelii*=11; *Pongo pygmeus*=1); and 25 chimps (*Pan troglodytes verus*=13; *Pan paniscus*=1). The human fibulae were expressly acquired by CT-scanning for this project, while 3D digital models of the non-human ape fibulae were obtained via MorphoSource and Digital Morphology (KUPRI).

A 3D template configuration of 16 fixed landmarks, 25 curve (semi)landmarks and 101 surface (semi)landmarks captured the proximal fibula and applied to targets. After Generalized Procrustes Analysis, Procrustes coordinates were subjected to Principal Component analyses was applied to explore the shape variations of different genera. Procrustes ANOVA was adopted to test shape differences among genera with a residual randomization procedure. Shape analysis was performed in R (v. 4.0.3).

Our results show that *H. sapiens* is clearly separated from the rest of the extant sample, with distinctive morphological traits such as a protruding styloid process, a medio-laterally oblique tibiofibular articulation and less pronounced muscle insertions compared to others. Orangutans and gorillas cluster close to each other, while chimpanzees are more separated. Without the *H. sapiens* sample, a clearer distinction is appreciated among the three genera of great apes.. Fibular heads of African apes are antero-posteriorly expanded, with shorter m. *peroneus longus* insertion and inferiorly more protruding m. *soleus* attachment area than *Pongo*, which by contrast possess a more posteriorly rounded fibular head with a slightly elongated and laterally protruding m. *peroneus longus* insertion.

These results seem coherent with different degrees of arborealism among genera and further support a functional role of the fibula. A more oblique proximal tibiofibular articulation, stabilized by the styloid process, as seen in the human sample may be interpreted as a less flexible articulation and associated with a reduced dorsiflexion axis inclination at the ankle, coherently with the requirement of a bipedal locomotion. An inferiorly elongated and laterally protruding m. *peroneus longus* insertion seen in *Pongo* also facilitates foot eversion by creating wider bony leverage to the main evertor muscle, coherently with expectations for the most arboreal ape [3]. The inferiorly protruding m. *soleus* in African apes is coherent with a relatively greater mass of this muscle as a percentage of total *triceps surae* mass in comparison with the Asian apes and relative differences in muscle fibre type distribution [4]. This data may reflect the higher frequency of quadrupedal locomotor behavior (both terrestrial and arboreal) of African apes [5].

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Podium Presentation Session 5, Friday 10:50-11:10

The genomic ancestry of European hunter-gatherers

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Modern humans reached Europe over 45,000 years ago and for the vast majority of their time they relied on a foraging lifestyle. Paleogenetic analyses on remains from hunter-gatherers have contributed to our understanding of population structure and genetic turnovers in prehistoric Europe and their relation to the archaeological and climatic records. To date, genetically analyzed individuals older than 40,000 years ago are found to represent deeply divergent out-of-African lineages that did not leave traces in the gene-pool of present-day Europeans [1-2]. On the contrary, individuals dating after 37,000 years ago belong to at least two main lineages that fall primarily within the European genetic variation. Those ancestries are considered to have survived in different European areas until at least the beginning of the Last Glacial Maximum (LGM, ~25-19,000 years ago), the coldest phase of the last Ice Age [3-4]. However, our knowledge of the genetic history of Upper Paleolithic and Mesolithic populations is still limited due to the relatively sparse and often poorly preserved human skeletal remains from those periods [5].

Here, the role of previously proposed climatic refugia for human populations during the LGM is investigated, as well as the re-peopling of Europe after this major climatic event. Particularly important is the appearance of a new lineage in southern Europe, found to carry genetic ties with ancient and present-day Near Eastern populations. This lineage further spread across Europe after 14,000 years ago in conjunction with an abrupt warming phase and is considered to have largely reshaped the preceding genetic landscape. However, as it currently appears, this demographic shift occurred in various degrees throughout Europe. For example, in the Iberian Peninsula the genetic turnover was more restricted while in eastern Europe a distinct population emerged after the LGM. During the Mesolithic, this eastern European hunter-gatherer population genetically interacted with central European groups followed by a progressive admixture with the gene pool of Neolithic farmers spreading from the Near East into Europe. By expanding the distribution of hunter-gatherer genomic data in time and space, it is thus becoming possible to study the genomic transformations that took place in Europe during the Upper Paleolithic and Mesolithic in much higher resolution.

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Podium Presentation Session 10, Saturday 12:20-12:40

Stone tool using macaques shed light on the emergence of hominin technology

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Identifying intentional flake production in the Plio-Pleistocene archaeological record is important for understanding the emergence of technology in our lineage [1-2]. The identification of these artefacts underpins many of our interpretations of hominin behaviour [3] and cognitive capacities [4-5]. The interpretation of flakes in the archaeological record as intentional products relies on assessing a suite of co-occurring technological and contextual attributes. Primate archaeological studies, where observed tool-use behaviour is linked to a tangible archaeological record, have provided new insights into the range of possible non-intentional mechanisms behind the production of lithic assemblages.

Here we report on the largest and most distinct lithic assemblage associated with a primate foraging behaviour undertaken by long tailed macaques (*Macaca fascicularis*). Macaques on Ao Lobi Island in Phang Nga National Park, Thailand, routinely crack oil palm nuts using a combination of stone hammers and anvils. As a consequence, they unintentionally produce a substantial archaeological record consisting of flakes and detached pieces, hammerstones and flaked pieces. We present the results of a landscape survey and technological lithic analysis of this new primate record and statistically compare the associated assemblage to an extensive sample of Plio-Pleistocene cores and flakes. We show that macaque nut cracking can result in a landscape wide record of flaked stone material, almost indistinguishable from early hominin flaked and detached pieces. Furthermore, we show that aspects of this lithic assemblage fall within the technological range of artefacts made by early hominins. Despite these similarities there are notable distinctions between the macaque and hominin records. In the absence of behavioural observations, however, aspects of this assemblage would likely be identified as anthropogenic in origin and interpreted as evidence of intentional tool production.

We contextualize the results of this study within the broader understanding of primate archaeological records and discuss the results in relation to three areas. Firstly, that interpretations of simple cores and flakes should not a priori assume intentionality. Secondly, that such primate data can provide a wider frame of reference for developing hominin behavioural interpretations. And finally, that as the antiquity of stone tool technology is extended, the importance of various non-flaking percussive activities must be better understood as a possible precursor to intentional flake production.

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Poster Presentation Number 119, Session 2, Friday 18:15

Can asymmetry in mechanical loading be accurately assessed from the analysis of skeletal material?

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The analysis of antimeric long bones in individuals from paleoanthropological and archaeological contexts is commonly used to reconstruct habitual physical activity in fossil hominins and past human populations. Long bones register variations in the distribution of cortical thickness along the diaphysis in relation to the magnitude, type, and direction of mechanical loadings. The comparison of antimeric bones from the same individuals offers the opportunity to quantify asymmetry in mechanical loading due to side preference and physical activity [1]. Nevertheless, even though several studies have focused on the study of lateralization in long bones, the reliability of the existing analytical techniques has never been experimentally validated using controlled laboratory conditions.

Here, we used micro-computed tomography scans of left and right tibiae of Wistar rats that were produced in previous experimental research. In six out of nine rats, the left common peroneal nerve was repeatedly stimulated inducing muscle contraction at the maximum force. Three out of nine rats define the control group. On each left and right tibia (n=18), we extracted 28 cross-sections along the diaphysis from the 12.5% to the 90% of the biomechanical length by using morphomap [2]. Each cross-section was defined by 24 pairs of equiangular semilandmarks on the periosteum and endosteum. We used the set of cross-sections to create three different datasets of shape variables, cross-sectional geometry parameters, and morphometric maps of relative cortical thickness. A fourth dataset consists of the three-dimensional (3D) surface areas of three muscle attachment sites of the hind limbs [3], which was previously generated based on the Validated Entheses-based Reconstruction of Activity (VERA) method [4-5]. All the datasets were analysed using Principal Component Analysis (PCA) and multivariate regression, to quantify the proportion of the total variance related to lateralization.

The shape PCA showed that, when comparing stimulated to unstimulated limbs, the periosteum of the distal region is expanded, whereas the medio-anterior region at the midshaft is contracted. The analysis of cross-sectional geometry parameters highlighted an increase of biomechanical performance (polar second moment of area) at the distal portion of the diaphysis. Morphometric maps of relative cortical thickness indicated that muscle contraction led to an increment of the cortical thickness at the distal region between from the medial to the posterior margin of the diaphysis. The multivariate analysis of entheseal 3D surfaces (VERA) distinguished unstimulated and stimulated limbs, and its results do not appear to be unduly influenced by allometric factors.

All four approaches were broadly suitable in assessing the presence of lateralization in mechanical loading based on skeletal asymmetry. However, each approach provided different types of information. Even though geometric morphometrics was less efficient for identifying asymmetry, it showed better performance in identifying the bone regions associated with different mechanical loading between sides. Cross-sectional geometry identifies trends in variations of biomechanical performances, but the signal is largely influenced by allometric factors as well. Morphometric maps of relative cortical thickness are suitable for reconstructing average loading history. Finally, the analysis via the VERA method showed that the group associations among different entheseal 3D surfaces can reflect asymmetry in loading history (if that occurs). In conclusion, the combined application of recently developed open-access software packages for analysing long bone morphology [2] and a novel protocol for the multivariate analysis of entheseal 3D surfaces [4-5] can improve the reconstruction of past physical behaviour, potentially elucidating patterns of habitual limb preference (e.g., handedness) in the fossil hominin and bioarchaeological record.

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Pecha Kucha Presentation Session 9, Saturday 10:05-10:30

Inferring human neutral genetic variation from craniodental phenotypes

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Human craniodental phenotypes are widely considered to be heritable and shaped primarily by neutral evolutionary processes. As such, they are routinely used in bioarchaeological research as a proxy for neutral genetic data for reconstructing past population structure and population history. However, it remains poorly understood whether some craniodental data types preserve neutral genetic signatures to a greater degree than others. This could be problematic because investigations based on different craniodental data types may arrive at markedly disparate conclusions. In this study, we address this research gap and systematically test the relative utility of five craniodental data types typically used for inferring neutral genetic variation, namely, (1) cranial linear measurements; (2) cranial non-metric traits; (3) dental linear measurements; (4) dental non-metric traits; and (5) mixed-type data combining all four data types. To test the utility of a given craniodental data type, we first estimated pairwise phenotypic distances (Mahalanobis' D2) among worldwide modern human population samples for which all craniodental data types are available and that have been sequenced for single nucleotide polymorphisms (SNPs). We then quantified the correlation of D2 with pairwise neutral genetic distances (Weir and Cockerham's FST) estimated among the same set of populations using the SNP data. We repeated this correlation analysis several times, each time adding different analytical refinements, including corrections for sampling uncertainty, and adjustments to equalize the number of variables across craniodental datasets. Our results show that the highest associations with neutral expectations were consistently achieved when using all four craniodental data types together, followed by the dental non-metric trait and cranial linear measurement data, whereas the associations by the cranial non-metric trait and dental linear measurement data are lower. We discuss the utility of the different craniodental data types in light of adaptive and stochastic evolution, heritability, pleiotropy, and data collection methodology, among others. We recommend that future bioarchaeological research should strive for a holistic approach combining different craniodental data types in a single analysis which leads to a richer knowledge of neutral genetic affinities compared to using these data separately.

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Poster Presentation Number 8, Session 1, Thursday 18:15

Taxonomic identifications of morphologically unidentifiable bones from an Early Aurignacian layer at Le Piage (Lot, France) using ZooMS: a zooarchaeological perspective

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The good preservation of proteins compared to DNA in some Palaeolithic contexts and their potential to provide additional taxonomic identifications has led to a growing number of paleoproteomic studies in the past decade. Here we report on new analyses from the site of Le Piage (Lot, France) from which 1045 bone fragments were studied using peptide mass fingerprinting (Zooarcheology by Mass Spectrometry or ZooMS).

Le Piage was first excavated in the 1950s and 1960s. Since 2004 new excavations led by Jean-Guillaume Bordes have taken place at the site every year [1]. The site displays a high density of archaeological material and all the bone fragments included in this study come from a single sub-square meter (I5 C: 50x50 cm). The focus of the study was further on an Early Aurignacian layer (thickness 14 cm), a period critical to the understanding of early *Homo sapiens* settlements in Western Europe. All the analysed bone fragments were retrieved through sieving and were too highly fragmented to allow a morphological taxonomical determination. Their sizes range between 1.5 - 4 cm. The presence of numerous cutmarks suggests that this fragmentation is mostly due to human activities [2].

ZooMS [3] is based on the study of collagen, which is the most abundant protein in bones, and can discriminate, through peptide mass fingerprinting, different animal taxa on morphologically unidentifiable fragments. Glutamine deamidation values were also calculated as an indicator of collagen preservation and assemblage homogeneity [4]. Two different methods of collagen extraction were applied and their comparison shows that the rate of unidentifiable bones by ZooMS in the studied series is due to differential collagen preservation and not to the extracting protocol. The preservation of collagen was quite variable probably because of the water infiltrations known to influence the geological substrate at the site.

Still, ca. 70% of the bone fragments could be identified. The spectrum of identified species by ZooMS is similar to that established by the morphological analysis of the best-preserved bone material with a large predominance of reindeer, followed by bovids and equids. Through ZooMS we also identified less common taxa such as hare and Cervid/Saiga in similar proportions as in the morphological identifications. Carnivore remains are absent. Overall, this ZooMs study provides additional insights into the intensity of reindeer exploitation during the Early Aurignacian at Le Piage, which is evident in even the smallest fractions of the bone remain of this almost monospecific faunal assemblage.

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Pecha Kucha Presentation Session 11, Saturday 14:15-14:40

Supraorbital form in *Homo sapiens*: exploring size as a function of facial angles, frontal sinus size and geography

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Hominin species show a wide variation in supraorbital form. Early *Homo* have a prominent, bar-like supraorbital tori whilst Middle Pleistocene hominins (MPH) and Neanderthals show continuous, swollen browridges bordered by supraglabellar fossae [2]. In contrast, modern *Homo sapiens* lack a true supraorbital torus, instead showing a less pronounced, paedomorphic browridge believed to have emerged in the Late Pleistocene [1]. This striking difference in morphology therefore posits the question: what has driven the evolution of the modern human supraorbital region? Whilst there are a variety of spatial and mechanistic hypotheses for the evolution of this region in primates, there is comparatively little research exploring the pressures leading to the supraorbital form and variation in modern human populations. What is more, the modern human browridge has classically been difficult to define due to its gracility and the supraorbital region's lack of determinate borders and homologous landmarks. In addition, despite its striking gracilisation compared to earlier *Homo*, the supraorbital region remains variable within modern humans, showing a range of robust and gracile morphologies at an inter- and intrapopulation level. Hence, a second question emerges: what factors drive the observed variation of this region?

In this study, we aim to address both these questions by highlighting and exploring the dominant hypotheses for the evolution of the supraorbital region in modern humans, specifically addressing its size: the Neuro-Orbital Disjunction Model (a larger disjunction between the orbits and frontal lobe is expected to result in a larger supraorbital region; [3]), the Allometric Model (the size of the supraorbital region should correlate with the size of the components in the craniofacial region; [4]) and the Frontal Sinus Size Model (larger supraorbital sizes mechanically compensate for the presence of larger frontal sinuses; [5]), alongside additional geographical and climate-based analyses. We use CT data to model the supraorbital region of 164 modern human skulls across 8 localities, employing a 3D polygon model generated from 15 landmarks. Using traditional craniometric measurements, alongside a recently developed 3D imaging technique for documenting and measuring the volume of the sinus cavities, we address these dominant hypotheses whilst controlling for total cranial size, robusticity and sex. We demonstrate that the modern human browridge does not fit the predictions of the neuro-orbital disjunction nor sinus-based models regarding its size. An allometric model is rejected once controlling for sex, suggesting that sexual dimorphism is dominant in determining browridge size. Robusticity is also shown to correlate with the size of the supraorbital torus, although it remains difficult to fully quantify the effect of robusticity given the interpopulation variation in its expression.

In summary, we show that many of the suggested factors driving this morphological variation are not upheld in modern *Homo sapiens*. We suggest that the size and variation of the supraorbital region may be more closely correlated with robusticity, and remains a demonstration of sexual dimorphism in modern humans. The selection pressures driving this morphology remain unclear, and the variation observed in modern humans may indeed be a result of neutral evolutionary processes such as genetic drift across populations. In addition to our exploration of this region, we also bring to attention the incidence of frontal sinus agenesis amongst modern humans across localities, and suggest the further exploration of a potential thermoregulatory function of its structure.

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Podium Presentation Session 12, Saturday 17:20-17:40

Emerging technological landscapes in *Pan* and *Homo*

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The ability to modify the environment through the transport of tools has been critical to the evolutionary success of humans. Thus, explaining how this trait emerged is a major focus of human evolutionary studies. Stone tool-using primates have often served as a frame of reference for investigating the behavioral capacity of hominins at various evolutionary stages. In this regard, the core and flake technology of the Oldowan is often considered a major evolutionary milestone as it reflects a distinct departure from primate tool use. Landscape-scale patterning in the Oldowan archaeological record has been argued to indicate that hominins engaged in the long-distance transport of stones that facilitated access to otherwise inaccessible resources. Over time, this pattern of transport resulted in the aggregation of stone at specific places that could then be used as sources of raw material, in turn, enhancing the potential for future stone tool use. Taken as a whole, this inferred pattern of tool transport and utilization is argued to have been critical to the expansion of hominins across the African continent and western Asia [1].

However, it has been argued that the Oldowan is not an evolutionary milestone but rather falls within an ape adaptive grade [2]. Although chimpanzees primarily engage in short-distance tool transport bouts to crack nuts, the repeated movement of percussive tools between food sources has been shown to displace stone at the scale of kilometers [3]. This pattern of tool transport not only increases access to resources over time [4] but also produces a structured landscape archaeological pattern, which bears similarities to the Oldowan [3]. Some have suggested that an ape-like tool transportation strategy, comprised of multiple short-distance tool transport events, was practiced during the Oldowan [5]. However, chimpanzee nut-cracking and Oldowan core and flake technology represent fundamentally different patterns of tool utilization. Thus, to understand the relevance of a chimpanzee tool transport model for the Oldowan, it is critical to consider what an Oldowan archaeological record may look like if it were the product of an ape tool transport pattern.

Here we use agent-based simulation to model the ape pattern of tool transport to identify the conditions under which short distance tool transport bouts can displace percussive tools over long distances. We then apply this model to the Oldowan to investigate the efficacy of ape tool transport as an explanatory model for the Oldowan. Our results show that accumulated short-distance transport events can displace percussive tools over long distances when food resources are abundant. However, the substantially shorter use lives associated with systematic flake removal significantly limit the distances that Oldowan cores can move under the ape tool transport model. These results indicate that long-distance transport bouts may have been an important aspect of early core and flake technology. This work, thus, provides a basis for discussing behavioral and biological factors that likely facilitated the success of the Oldowan in the hominin lineage.

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Poster Presentation Number 51, Session 1, Thursday 18:15

Palaeoecological inferences using rodent's assemblages of the Middle to Late Pleistocene occupations in the Southern Caucasus

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Located at the crossroads between Africa, Europe and Asia, Southern Caucasus is a prime location to study *H. heidelbergensis*, *H. neanderthalensis* and anatomically modern human occupations. Azokh Cave is an important site for the understanding of human evolution in its archaeological, paleontological, environmental and ecological context. The cave has provided evidence of occupation by hominin from the Middle Pleistocene to Holocene and it is the only well stratified and dated sequence of this period in the region [1].

The main objective of this work, using rodents, is to infer the climatic and environmental conditions during the formation of the site. Small mammals' remains come from the archaeological excavation campaigns carried out in Azokh 1 in 2003, 2005, 2014, 2015 and 2018, in particular from: Unit V (uranium series dating indicated an age of ca. 200 ka, racemisation (D/LAsp) indicated an age closer to ca. 300 ka and ESR dating has suggested an age of 293 ± 23 ka), Unit III-IV (no dates are available for this unit) and Unit II (ESR dating indicates an age of 184 ± 13 ka for the bottom of the unit II and 100 ± 7 ka for the top). The small-mammals assemblage is composed by at least 13 taxa: seven arvicoline (*Clethrionomys glareolus*, *Microtus gr. arvalis-socialis*, *Microtus* (*Terricola*) spp., *Arvicola ex. gr. persicus*, *Chionomys nivalis*, *Chionomys gud* and *Ellobius lutescens*), two cricetine (*Cricetulus migratorius* and *Mesocricetus brandti*), two gerbilline (*Meriones gr. persicus- tristrami*, *Meriones gr. dahli-lybicus*), one dipodid (*Allactaga cf. williamsi*) and one murine species (*Apodemus* sp.).

Unit III-IV do not yield enough material to draw palaeoclimatic inferences (minimum number of individuals <30). Paleoclimatic conditions for units V and II, obtained with the Bioclimatic model method on the basis of the faunal spectrum, assuming that small- and large-mammal species can be ascribed to ten different climates, suggest temperatures and precipitations similar to today, the climate seems to be relatively warm-temperate in both units. The paleoenvironmental reconstruction, through the habitat weighting method, which is based on the current distribution of each taxon in the habitat(s) where it can be found today, presents an environment mainly composed of desert and steppe habitats. This interpretation differs from that obtained from large mammals and archaeobotanical data, and which indicate a woodland environment while small vertebrates mainly indicating arid environments, such as steppe and desert. These differences could be explained by the origin of the accumulation, where large mammals live in the vicinity of the cave whereas small vertebrates could come from open areas as they were accumulated by birds of prey that hunt over open areas.

Hominin populations from Azokh 1 lived between the end of the Middle Pleistocene and the beginning of the late Pleistocene. They were surrounded by warm- temperate climatic conditions in a landscape mainly composed of desert and steppe, but also had grassland and forest proportions. No major palaeoenvironmental or palaeoclimatic change between Middle and Late Pleistocene layers was evidenced, indicating favourable conditions throughout the study period.

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Poster Presentation Number 78, Session 2, Friday 18:15

Contextualising Middle Stone Age occupation at Njarasa cave, Tanzania, from the 1930s Kohl-Larsen collection

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In East Africa, a number of Middle Stone Age (MSA) sites and hominin fossils have been discovered in the area of Lake Eyasi, in Northern Tanzania. This region has been the target of several fieldwork campaigns since the early 1900s, including Njarasa cave, first excavated in 1935-36 by Margit and Ludwig Kohl-Larsen. The site yielded a long stratigraphic sequence documenting MSA occupation of unknown age that holds great potential for the discussion on modern human behaviour during this period.Since the Kohl-Larsen excavations, the archaeological material has been curated at the University of Tübingen in Germany, which was recently the object of a new inventory, including lithic, use-wear, petrography and zooarchaeology analyses [1]. Renewed archaeological fieldwork was also undertaken. However, the full potential of the site was not entirely explored because of the lack of reliable chronological controls.

In the context of the Covid-19 pandemic, the reinvestigation of the Kohl Larsen collection is a great opportunity to apply dating methods to curated material. The samples collected during the Kohl Larsen excavations were meticulously documented and include teeth and associated sediment that can be used for combined electron spin resonance and uranium series dating.

We present here the first age results obtained on teeth samples from the MSA layers (V and VI) of Njarasa cave, which date back to at least 70 ka years ago and allow for the first time contextualising the archaeological material collected more than 80 years ago. A detailed characterisation study was also conducted using Fourier transform infrared spectroscopy, in order to provide insights into diagenetic processes and better understand the geochemical behaviour of the samples.

Dating material from past excavations may appear challenging but represents an exceptional prospect to establish the chronology of prehistoric sites in the context of the global health situation. Thanks to the rigor of the Kohl-Larsen excavations, we were able to reconstruct the timeline of human occupation at Njarasa cave, which can be included in the discussion on the MSA cultural changes associated with early *Homo sapiens*.

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Poster Presentation Number 46, Session 1, Thursday 18:15

Morphometrics and functional morphology of the fossil second metatarsal from Sedia del Diavolo (MIS 7, Latium, Italy)

Alessandro Riga[1], Antonio Profico[2], Tommaso Mori[1], Alessia Nava[3], Lucia Mancini[4,5], Diego Dreossi[4], Davorka Radovčić[6], Luca Bondioli[7,8], Damiano Marchi[2,9]

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Sedia del Diavolo is an archaeological site located in the low valley of the Aniene river (Rome, Latium) that, despite being known since the end of the 19th century, has been thoroughly investigated since the 1930's.

The site yielded a lithic assemblage referrable to the Middle Palaeolithic as well as numerous fossil remains, including two human specimens: a fragment of a femoral diaphysis (SdD1) and a complete second metatarsal (SdD2). Initially the site was dated to the end of the Middle Pleistocene and, coherently with the intended chronology, the first anthropological analysis attributed the remains to *Homo neanderthalensis*.

Recently, a reappraisal of the geochronology of the sites of the low valley of the Aniene river redated Sedia del Diavolo to MIS 7, between 295-290 ka, making the site one of the oldest occurrences of the Levallois technology ever found in Europe.

This contribution presents new advanced morphological analyses of SdD2, which shows signs of a probable stress fracture on the distal portion of the diaphysis.

We obtained high resolution images of SdD2 by means of laboratory-based X-ray computed micrortomography at the FAITH station of the Elettra synchrotron in Trieste (Italy). We used cross-sectional geometry to investigate the robustness of the diaphysis and geometric morphometric approach to analyse the shape of the epiphyses. Results were compared to a series of modern human and fossil hominin second metatarsals.

SdD2 is characterized by thicker cortical bone than *H. sapiens* and *H. neanderthalensis*. This suggests that the individual likely experienced high levels of mechanical loading and mobility. Moreover, the distribution of the bone around the longitudinal axis as well as the morphology of the proximal epiphysis make it more similar to *H. sapiens* than to *H. neanderthalensis*. Although results may be influenced by the presence of the stress fracture, the analyses suggest that the metatarsal belonged to an individual whose morphology was less derived than the more recent Neandertal comparative specimens.

Podium Presentation Session 5, Friday 10:30-10:50

Mugharet el'Aliya: affinities of a juvenile enigmatic North African Aterian maxillary fragment

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North Africa has emerged as a geographical region of great interest in modern human origins, with recent research pointing to the Jebel Irhoud hominin fossils as the earliest anatomical evidence of our lineage ~300 ka [1]. Additional fossils recovered in the region have been associated with the 'Aterian' lithic industry but their chronology, originally thought to be quite late and not relevant to human origins, is being revised. Among these fossils is the juvenile maxillary fragment from Mugharet el'Aliya, Morocco, discovered in 1939 and dated to 35-60 ka (Coon in [2]; [3]). The taxonomic affinities of this enigmatic specimen have remained unresolved in part because it is only a maxillary fragment and its juvenile status. Mugharet el'Aliya was variously ascribed to the *Homo sapiens* or Neanderthal lineages, the latter based on its 'archaic'/'Neanderthal-like' features and apparent large size.

Here, we conducted a novel 3D shape comparative analysis of the preserved external morphology of the maxillary fragment to clarify its taxonomic affinities, considering its size and ontogenetic age. 80 Computed Tomography and surface scans representing ontogenetic samples of *Homo sapiens* and *Homo neanderthalensis* were used to capture species-specific differences. The toolkit of geometric morphometrics in combination with surface registration and an elastic iterative closest point algorithm were used to create a dataset of meshes with an identical number of corresponding vertices for the maxillae. Multivariate statistics were applied to Procrustes superimposed coordinates derived from the vertices of this dataset.

Our comparative analysis of the maxillary morphology could not clearly differentiate between *Homo sapiens* and Neanderthal subadults when focusing on individual characteristics. However, the overall shape of the preserved external morphology as a whole showed affinity with subadult *Homo sapiens* individuals, especially with the subadult Qafzeh 10. No size-independent affinities with Neanderthals of comparable dental age could be identified.

Our results add to the growing evidence connecting cranio-dental morphology from western Asia, especially Qafzeh, Skhul and Tabun, and the Northwest African Middle Stone Age (e.g., [4]). Furthermore, Mugharet el'Aliya adds to our knowledge of the ontogenetic development of adult morphology that is frequently used to characterize hominin groups, e.g., Neanderthals and modern humans.

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Poster Presentation Number 58, Session 1, Thursday 18:15

The paleoecology of the straight-tusked elephant (*Palaeoloxodon antiquus*) from the Middle Pleistocene locality Marathousa 1 (Greece) inferred from carbon and oxygen stable isotope analysis

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A partial proboscidean skeleton has been recovered during the systematic excavations at the Middle Pleistocene open-air site Marathousa 1 (MAR-1) in the Megalopolis basin (Peloponnese, Greece) [1]. The remains of the individual, an adult male of the European straight-tusked elephant *Palaeoloxodon antiquus*, display human-induced cut marks, which, together with the spatial and stratigraphic association of the skeleton with lithic artifacts, provide direct evidence for hominin exploitation of the carcass [2]. The stratigraphic sequence bearing the skeletal remains is dated to 480-420 ka and is correlated to the glacial Marine Isotope Stage 12 (MIS 12) [3].

In this study, we employ carbon and oxygen stable isotope analysis on enamel bioapatite to investigate the diet and infer the habitat of the individual. A sequential sampling strategy along the tooth growth axis of the third upper molar allowed the generation of intra-tooth isotopic profiles and the exploration of ecological changes during the last decade of the elephant's life. We compare our results with published isotopic data on *Palaeoloxodon* from Middle Pleistocene sites (La Polledrara di Cecanibbio, Casal de' Pazzi, and Poggetti Vecchi in Italy; Neumark-Nord 1, Steinheim an der Murr, and Mauer in Germany), and examine the MAR-1 elephant's ecology within the European context.

Our research indicates that the elephant from MAR-1 inhabited a C3-dominated ecosystem, likely composed of open woodland. Oxygen isotopic values suggest colder or wetter conditions for the MAR-1 *Palaeoloxodon antiquus* individual in comparison to Italian interglacial populations of the species, whereas warmer or more arid conditions are inferred when compared to the elephants from Steinheim an der Murr and Mauer. The intra-tooth isotopic profile demonstrates relatively stable environmental conditions, with low-magnitude fluctuations in carbon isotopic values corresponding to multi-annual shifts, rather than seasonal. Overall, the results are consistent with the attribution of the find-bearing levels to the glacial MIS 12 and further suggest that the individual possibly experienced buffered environmental conditions. In view of the direct evidence of hominin butchering of elephants and other mammals, our interpretation supports that, despite glacial conditions, the Megalopolis basin sustained a mesic habitat with sufficient plant resources and limited seasonal fluctuations, which favoured hominin subsistence strategies and, in turn, their survival. Therefore, the present results further corroborate the hypothesis that the region acted as a glacial refugium for both fauna and hominins.

Excavation at Marathousa 1 was conducted under a permit granted to the Ephoreia of Paleoanthropology Speleology, Greek Ministry of Culture. It was supported by the ERC Consolidator Grant ERC-CoG-724703 ("CROSSROADS") and the ERC Starting Grant ERC-StG-283503 ("PaGE"), both awarded to K. Harvati. G.E.K., V.T., and K.H. are also supported by the DFG Project no. 463225251 ("MEGALOPOLIS").

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Virtual Pecha Kucha Presentation Session 8, Friday 16:40-17:05

Schöningen: low density sites and human occupations. A technological and behavioral approach to the exploitation and use of the landscape

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The archaeological complex of Schöningen, in Lower Saxony (Germany), has been excavated for 30 years next to the border of an open air coal mine[1]. Consequently, for many years the works had the character of rescue excavations.

During the MIS 9, around 320-300,000 years ago, the landscape in Schöningen had one central focus: a lake, which attracted animals and hominins that left their traces behind. Once the lake level repeatedly rose, organic and lithic remains became embedded into wet and anaerobic sediments, which created the perfect environment for preserving the remains until their discovery. These comprise a large record of macro and micro vertebrates together with other numerous organic remains, including the famous wooden spears from the so-called Horse Butchery Site. The lithic record is not abundant and in many occasions it appears isolated. Because of these scarce accumulations we refer to low density sites. Nonetheless, although there are a small number of stone artefacts, they provide an understanding of the technological approaches along the sequence of occupation, and of the activities and goals that hominins might have planned when visiting the lake.

Most of the lithic record had not been reviewed after being stored following its discovery. Here we report the first detailed study of the lithic assemblages, which have consisted of a proper identification, classification and analysis of the stone artifacts using morpho-technical and low-power approaches. This work includes the lithic record from two main localities, Schöningen 12 and Schöningen 13, and 4 phases or silting events with different sedimentary layers. Broadly speaking, eight archaeological sites were studied and those from the two localities sharing the same phases were also compared, enlarging the record that has been destroyed and is missing because of the mining activities.

The results show differences in the availability of raw material that might have determined the size of some artifacts or the selection of blanks for the production of tools, which have a morphological length average of 5 cm. The typology also varies and goes from indeterminate retouched pieces to well defined scrapers. The reduction sequences are non-standardized, and levallois products or bifaces are not documented. Moreover, (pseudo) cores are quite rare and unretouched flakes are the most common category, which only at specific phases and areas are related to the maintenance of tools. In addition, it was recorded the presence of stone artifacts that combine the simultaneous use as cores and tools or have been worked one after the other; for these the term hybrid was coined.

On the other hand, even though a GIS data base of the horizontal distribution already existed, many lithic remains had not been introduced yet. This is the case of those finds recovered during the regular and the rescue excavations with an approximate location on the squares, or with the water screening and the sieve, and of those lithic pieces found *in situ* smaller than 5 cm that for many years were not drawn on grids. Therefore, the information has also been updated and all the stone artefacts plotted. Additionally, the profile views of the finds were also created. All this has provided an opportunity to understand the relationship between the artefacts at the sites, and also the possible interpretation of the use or occupation on the different areas. Moreover, the faunal remains were also included on the scatter plots, and when known, those bones with anthropic marks, enlarging the knowledge about the possible activities and the exploitation of the landscape that could have taken place.

Therefore, although the lithic record of the Schöningen complex is not very rich, the studies carried out allow us to recognize the technological behavior of the hominins that made sporadic visits to the lake.

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Poster Presentation Number 35, Session 1, Thursday 18:15

A multi-facetted analysis of the morphologically unidentifiable bone fraction from the Middle Palaeolithic open-air site of Salzgitter-Lebenstedt (Germany)

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Pleistocene faunal assemblages are often highly fragmented, leaving large portions of the animal bones taxonomically unidentifiable. This is also the case at the Neanderthal open-air site of Salzgitter-Lebenstedt (Germany), which is well known for its specialised exploitation of adult reindeer [1]. During excavations in the 1970's, over 1,300 morphologically unidentifiable bone fragments were recovered [2]. In this study we apply four different methodologies to this unidentifiable bone fraction to maximise data retrieval and explore its additional interpretive potential.

Firstly, a series of taphonomic and zooarchaeological attributes were recorded for all 1,362 unidentifiable bone fragments. Secondly, Zooarchaeology by Mass Spectrometry (ZooMS [3]) was applied to 761 bone fragments, alongside the calculation of glutamine deamidation values [4]. Next, the collagen preservation of 30 fragments was assessed by near-infrared spectroscopy (NIR [5]) screening, and ten bones with the best predicted values were subsequently pretreated for radiocarbon dating.

The ZooMS faunal spectrum (identification rate 75%) closely matches the identifiable fauna, with a dominance of reindeer, followed by mammoth, horse and bison. Carnivore remains are completely absent. This is also confirmed by the taphonomic study which showed a very low occurrence of carnivore modifications (<1%) and a high incidence of human modifications (23.3%), including all stages of carcass processing (scrape marks, chop marks, cut marks and marrow fractures). These human modifications are present in the ZooMS fraction across a range of species (reindeer, horse, bison) but absent on the mammoth remains.

Spatial information to explore links between various depositional contexts and differing taphonomic histories is limited. However, we observe significant differences between the bone preservation of the reindeer and mammoth remains. Combined with differing bone surface modifications, this suggests different site formation histories, with targeted reindeer processing contrasting with a more opportunistic mammoth exploitation.

The collagen yield of the ten bones preselected for C14 dating was excellent for specimens of this age range. Four specimens returned infinite dates (>56,000 BP) and the six others returned finite ages right at the detectable limit of the 14C method and beyond the IntCal20 calibration curve. These dates are older than previously obtained radiocarbon dates from the site, and demonstrate a Neanderthal occupation at Salzgitter-Lebenstedt older than 51,000 years ago. A more precise chronological assignment, to a specific interstadial in the MIS 5a-3 age range, remains to be determined.

We would like to thank Babette Ludowici and Michaela Scheffler for facilitating access to the Salzgitter-Lebenstedt fauna stored at the Braunschweigisches Landesmuseum in Wolfenbüttel (Lower Saxony, Germany). This project was funded through the Max Planck society. Karen Ruebens (grant agreement No. 745662) and Geoff Smith (grant agreement No. 101027850) received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie scheme. F. Welker has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 948365).

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Pecha Kucha Presentation Session 11, Saturday 14:15-14:40

Trabecular bone ontogeny as an indicator of brain maturation and life history in human evolution

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Age-related variation in locomotor loading conditions shapes the internal (trabecular) bone structure of joints throughout growth and development. Trabecular structure, in turn, can serve as a functional record of locomotor behaviour to be interpreted by paleontologists. Our aim is to situate the analysis of trabecular bone ontogeny into the broader developmental context of neural development, locomotor control, and ultimately life history.

We examine the ontogenetic trajectories of trabecular bone structure in the calcaneus of humans, chimpanzees, gorillas, and Japanese macaques. We test a model where species-specific ontogenetic trajectories of trabecular bone volume fraction are shaped by age-related variation in loading environment during ontogeny which is in turn the product of interaction of age-related maturation of the neuromuscular system and body size.

Using biomechanical data from a study on human locomotor development we show that age-related variation in foot loading predicts trabecular bone volume fraction in age-matched human calcanei ($R^2>0.91$). We also show that interactions between neuromuscular maturation and body weight strongly predict these biomechanical variables ($R^2>0.98$). We then show that an interaction between the onset of locomotion, percent adult brain size, and body weight is the best model to explain age-related patterns in trabecular bone volume fraction in all four primate species ($R^2>0.81$). Finally, using piecewise linear regressions we show that distinct changes in the slope of age-related variation in bone volume fraction correspond to the age of the onset of locomotion and the age at which adult-like locomotion is achieved.

Our findings compliment previous studies linking bone development to species-specific developmental variation in locomotor mechanics by demonstrating a fundamental link to brain development and the life history strategies associated with this. This implies that ontogenetic variation in trabecular structure in fossil species is a valuable proxy for the rate of neuromuscular maturation and major life history events like locomotor onset and the achievement of adult gait in fossil hominins. By linking locomotor development to other life history milestones this approach can shed new light on the evolutionary processes of hominin locomotor development.

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Poster Presentation Number 106, Session 2, Friday 18:15

DEATHREVOL: searching for the roots of the culture of death

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The nature of ancestral practices surrounding death is one of the most contentious questions in Paleolithic Prehistory due to the complexity of the evidence that can be traced in the fossil record. The identification of funerary activity in Pleistocene archaeology has traditionally been undertaken by identifying the practice of burial by the presence of a (grave) cutting, and/or an anatomical connection of skeletal elements, general completeness of bone, and the presence of objects in association with the body, which may be interpreted as grave goods. The effect of this is to restrict the search for funerary behavior to burials, which are exceptionally infrequent prior to the final Pleistocene. This complicates tracing funerary behaviors previous to burials and, therefore, limits our options for locating the moment at which mortuary practices became funerary behavior. In other words, it makes it impossible to trace the origin of the culture of death. Nevertheless, taphonomic and forensic analyses on human remains form a readily available dataset for exploring wider funerary activity, and hence could be essential for human evolutionary thanatology. The depositional origin of hominin fossils is usually interpreted in the light of their contextual framework, especially those originating from funeral activities, but rarely from detailed taphonomic observations of the bones themselves. In contrast, in cases of Paleolithic cannibalistic assemblages, taphonomic studies are abundant [1].

Two factors are crucial here: finding out the origin of deposition of the skeletons (space factor: place for the dead) and finding out if the accumulations are synchronous or asynchronous (time factor) [2]. These two factors can be addressed by taphonomic analysis of the remains. Multi-taphonomic/forensic analysis, including computer tomography techniques provide an opportunity to study critical aspects of fracture features and bone traumas. This virtual approach to the study of hominin fossils allows the application of both taphonomic and forensic criteria, which are decisive for approaching the study of the behavior of ancient populations [3-5].

DEATHREVOL project proposes multidisciplinary research to investigate the origin of funerary behavior during the Middle Pleistocene and to trace this behavior throughout the European Paleolithic archaeological record. The main working hypothesis is that funerary practices first emerged during the Middle Pleistocene among hominins predating the Neandertals and represent early manifestations of a culture of death. This hypothesis is based on promising data from Middle Pleistocene sites, such as Sima de los Huesos, which provides us with a unique opportunity to undertake a taphonomy of the dead and gain insights into the early appearance of an incipient culture of death in a Middle Pleistocene population. This project aims to address the dearth of taphonomic studies on Paleolithic hominins and represents the first large-scale project focused on a thorough multi-taphonomic study of the European fossil record.

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Poster Presentation Number 54, Session 1, Friday 18:15

Biface diversity and variability half a million years ago at late Acheulian Jaljulia, Israel

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This paper presents new results regarding the study of a large late Acheulean biface assemblage dated to half a million years ago from the site of Jaljulia, Israel.

Located in the central coastal plain of Israel, Jaljulia represents one of the few late Acheulean sites to have been extensively excavated [1].

The sample chosen for this study originates from an area of 16 m² (area D), that represents the earliest known human occupation of the site, dated to ca. 500 ka [1]. Faunal remains are rare but an abundant flint industry (n=24.100) was recovered in a conglomerate deposit corresponding to the rim of an ancient flood plain. The lithic assemblage is produced exclusively on local flint and is composed of bifaces, small to medium size cores and related debitage, and a significant number of items indicating recycling processes. Noteworthy is the application of prepared core technologies which bear similarities to Levallois [2]

The Late Acheulean is a period of major interest for the study of human cultural and biological evolution, as it precedes the emergence of new post *Homo erectus* species that appear in tandem with a regionalization process on the material culture. However, our knowledge of this period remains highly fragmentary, partly because of the lack of well dated and excavated sites.

Here we conduct a qualitative analysis of bifaces (n=150), based on a detailed technological analysis. The novelty of this work focuses on the attempt to explore internal variability in the production of bifaces by considering the technical stages involved in their manufacture and the knapper's technological savoir-faire. This approach pursuit a critical analysis of the lithic material while distinguishing knapping mistakes and discarded pieces from intended tools.

Three main biface types were identified: pieces with a rounded distal part, pieces with an ogival or pointed distal part, and pieces with a wide distal part achieved by a final tranchet blow. The use of this technical procedure it is of note, as it has been suggested as a regional marker of the late Acheulean of the internal part of the Levant [3] but it has rarely been documented in detail.

The Jaljuliya biface assemblage show a systematic use of tranchet, or similar, debordant removal, aimed at producing a sharp cutting edge and also for the regularization of the edges prior to retouching and thinning the volume.

All three biface types demonstrate a search for symmetry, regularity of the volume and a regular peripheral edge. However, a higher investment in the distal part is of note. Bifaces with a cortical or massive basal part are common, even among those showing high skill level. Even when the base remained cortical, a peripheral edge was set to the maximum extent possible, suggesting a hierarchization on the desired characters.

The morphological diversity of the bifaces is significant, and is not related to size diversity. Most bifaces were produced from brechiated Mishash flint and Turionian flint [4], all available locally in different size modules. The identification of the blanks used to produce the pieces confirm an intentional production of small, medium and large bifaces (c. 3-13 cm), probably related to different activities as suggested by usewear analysis [5].

Our results show a diversity in the late Acheulean tool kits, visible in the presence of different tool shapes and sizes, and a standardization on the biface production, visible by the hierarchization of the characters researched on the tools. The use of the tranchet blow at different moments of the shaping process support its value as a technical baggage of the group and a cultural marker.

This study contributes to a better understanding of regional diversity of Acheulean groups and evolution through time in the Near East and beyond.

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Poster Presentation Number 76, Session 2, Friday 18:15

Small lithics make a big difference - new results on the MSA/LSA transition from Umhlatuzana rockshelter

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The South African Later Stone Age (LSA) distinguishes itself as a period of dramatic technological changes, different subsistence strategies, and the appearance of behavioural innovations in human history. However, only a few sites so far have provided data on the latest phases of the Middle Stone Age (MSA), the MSA/LSA transition, and the dawn of the subsequent LSA. Due to the sparse evidence, our understanding of the nature and timing of this transition remains unsatisfactory vague, if the cultural process was more gradual and slower or radical and rapid.

The long chrono-cultural sequence of Umhlatuzana rockshelter (UMH) located in the Province KwaZulu-Natal, South Africa, comprises Stone Age deposits from the MSA of late Marine Isotope Stage 5 to the final LSA [1]. In particular, the site yielded in continuous succession final MSA, early LSA, and early Robberg occupations. However, even though UMH is known since the excavation in the 1980s directed by Jonathan Kaplan, the assumption of severe stratigraphic disturbances in the sequence led to doubts as to its significance. New excavations by Leiden University within the research project 'Finding resolution for the Middle to Later Stone Age transition in South Africa' effectuating a high-resolution geoarchaeological study evinced that the stratigraphic integrity was not compromised by large-scale sediment movement [2-3]. Thus, UMH forms a unique case study to investigate the dynamics and techno-cultural evolution from the MSA to the LSA.

We explore the developments in the latest MSA and earliest LSA phases as well as the origin of the Robberg technocomplex, which stands out through its technology geared towards to production of miniaturized blanks on fine-grained raw materials [4-5]. Following the *chaîne opératoire* and petrographic approaches, we present a technological and techno-economic analysis of the lithic material from the new excavations at UMH. We show that selection of raw materials differs substantially between the hornfels-dominated final MSA and the LSA sub-stages when quartz is more important. We identify the production of larger elements to be shaped into a variety of points, among others hollow-based points, for the MSA, and the use of different reduction strategies to obtain bladelets and small flakes for the LSA, including the application of freehand percussion and the involvement of anvil flaking. Cores and blanks of the latter demonstrate varying features indicating that craftspeople used anvils in different ways, namely for axial bipolar percussion and as an assistance for the cores. Our results demonstrate differing technical organisation, land use patterns, and behaviours in the final MSA compared to the LSA phases. Accordingly, we confirm the drastic technological discontinuity from the final MSA to the Early LSA. Yet, the succession from the early LSA to the Robberg is seemingly composed more gradually with subtle differences. UMH enriches our knowledge on technological turnovers and cultural trajectories in southern Africa. Due to its continuous sequence, the results from UMH fill blind spots caused by the discontinuous nature of archaeological deposits at nearby sites, such as Sibhudu Cave and Border Cave.

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Poster Presentation Number 15, Session 1, Thursday 18:15

The use of space at Geißenklösterle and its implications for Aurignacian settlement dynamics in the Ach Valley of SW Germany

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Geißenklösterle Cave is a key site for understanding the Aurignacian in Europe. The site has played a central role in assessing the beginnings of the Upper Palaeolithic and in contextualising the origins of Aurignacian technological innovations, as well as symbolic artifacts including personal ornaments, figurative art and music. The Aurignacian of Geißenklösterle is comprised by the archaeological horizons (AH) II and III. These layers date to between 42,500 and 35,000 cal BP [1]. The archaeological remains represent a pivotal phase in the spread of anatomically modern humans in Europe. The lower Aurignacian layer AH III is characterised by carinated pieces, nosed scrapers, splintered pieces, burins as well as by abundant debris from working ivory, antler and bone [2-3]. The lithic assemblage from the upper Aurignacian layer AH II shows the similar technological characteristics as AH III but is more diverse in lithic tools and yielded ivory figurines, flutes and personal ornaments [2-3]. This contribution presents the results of the spatial analysis of lithic and organic finds from the Aurignacian of Geißenklösterle. The find distribution of AH II reveals a concentration of finds in the central part of the excavation area, while the finds from AH III are concentrated in the northern part. The distribution of artifacts appears to be related to the presence of an ash layer in AH II and a hearth in AH III. Further activity areas for processing organic materials [4-5] and stone knapping can be identified within these find concentrations. The Aurignacian inhabitants of the site during the formation of AH III carved large amounts of mammoth ivory in the area south of the hearth, while leaving much fine debris from working ivory still closer to the hearth [4]. Additionally, operational sequences of lithic production can be reconstructed based on the distribution of refitted lithic artefacts. The results above document the differential use of space for specific activities within individual AHs, as well as a different use of space between the lower and the upper Aurignacian at Geißenklösterle. The different stages in the operational chains for lithic and organic technology in AH III and II [3] also reflect the dynamic use of Geißenklösterle Cave and allow for a more complete reconstruction of the Aurignacian settlement system within the Ach Valley.

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Poster Presentation Number 10, Session 1, Thursday 18:15

Reassessing the cultural stratigraphy of Vogelherd Cave and the settlement history of the Lone Valley of SW Germany

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Vogelherd Cave is located in the Lone Valley near the town of Niederstotzingen (Baden-Württemberg, Germany). The site was excavated by Gustav Riek from the University of Tübingen in 1931. In just three months Riek and four workers excavated the entire cave. Riek's team dumped the backdirt from the excavation directly in front of the southwestern and southern entrances of the cave. In his monograph from 1934, Riek described nine archaeological layers [1]. Some of these, especially the two Aurignacian layers IV and V, represent thick anthropogenic layers with high find densities. After nearly three quarters of a century, from 2005 to 2012 Conard led a re-excavation of the majority of the backdirt from Riek's dig. This work greatly increased the amount of all classes of archaeological materials available for study, while confirming Riek's assessment that the great majority of the artifacts and ecofacts originate from the Aurignacian deposits at Vogelherd. The recent phase of excavation led to the discovery of dozens of new fragments of ivory figurines, musical instruments, over 200,000 lithic artifacts, and well over a thousand artifacts of ivory, bone and antler [2-3], as well as vast amounts of faunal material that was overlooked during the excavation in 1931.

After examining both the assemblages from Riek's and Conard's excavations, we identified a number of areas in which the cultural stratigraphy of Vogelherd requires revision. Based on a large number of radiocarbon dates and more detailed studies of the artifact assemblages, we propose some revisions to Riek's stratigraphic assessments. In particular, the upper part of Aurignacian layer IV, as well as the overlying layers III and II require revision. Prior to our work, the presence of Gravettian groups in the Lone Valley has been debated, while in contrast the nearby Ach Valley preserves an exceptionally rich record of Gravettian occupation that makes the Swabian Jura a key point of reference for this crucial period in European prehistory [2]. Here we present a reanalysis of the lithic assemblages from Vogelherd. New techno-typological data and radiocarbon dates help to characterize the stratigraphy and provide insights into the history of occupation and site use at Vogelherd. These observations enable us to demonstrate the unambiguous presence of Gravettian hunter-gatherers in the Lone Valley. Other indications for the Gravettian settlement of the Lone Valley have been tentatively identified at Bockstein-Törle [2]. Geoarchaeological research in the Ach and Lone valleys [4] and at Langmahdhalde [5] show that sediments from the Gravettian and the Last Glacial Maximum (LGM), although occasionally preserved, have more often been lost due to major phases of erosion. The new geoarchaeological work and the current techno-typological study help to explain why traditionally, archaeologists struggled to identify an archaeological signal from the Gravettian in the Lone Valley.

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Pecha Kucha Presentation Session 11, Saturday 14:40-15:05

Midfacial ontogeny in extant hominids: shared and unique aspects

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The short and retracted midface of present-day humans is distinct from long, forward projecting midfaces of non-human great apes. On the cellular level, the developmental processes shaping the bones include an interplay of bone formation and resorption [1]. Here we study midfacial bone modeling in great apes as a framework for interpreting evolutionary changes in the hominin lineage.

Building upon prior work suggesting some similarities in facial bone modeling patterns of gorillas and chimpanzees [2], we investigated maxillary ontogeny on both the macro- (i.e., morphological) and microscopic (i.e., cellular) levels in a sample of 37 orang-utans, 35 gorillas, 33 chimpanzees and 59 humans. The sample was classified into five age groups according to dental development, ranging from birth to adulthood. We first visualized the patterns of bone modeling in each species. To do so, maps representing the mean bone modeling pattern for each age group were created and projected onto the corresponding mean forms. These forms were obtained using semilandmark geometric morphometric techniques. Secondly, the amount of maxillary bone resorption was quantified for each individual to compare the changes in bone modeling throughout ontogeny within and between species. Finally, a principal component analysis was employed to study the ontogenetic trajectories of each species, and a two-blocks Partial Least Squares analysis was used to investigate the patterns of covariation between the morphological and bone modeling changes.

We found that although maxillary shape differs among all species already at the time of birth, their pattern of bone modeling is relatively similar. For all species, including humans, bone resorption is found near the fronto- and zygo-maxillary sutures, as well as in the zygomatic process, the premaxilla and the post canine region. Humans differ the most from other great apes by having resorption on the entire maxillary arcade. However, the main differences between species are found in the timing of expression of bone resorption during ontogeny. For example, resorption in the fronto-maxillary suture decreases at a later stage in orang-utans (after the eruption of the M1) than in humans (prior to the eruption of the M1). In non-human great apes, we found that a decrease in bone resorption and an increase in formation on the maxillary arcade during their juvenile period corresponds to the expansion of the canine.

Our data suggest that all hominids share a common pattern of maxillary bone modeling. Thus, morphological variation is mostly due to changes in the rate and/or timing of expression rather than changes in the location of the cellular activities. Heterochrony, evolutionary changes in timing during ontogeny, are key to the evolution of morphological variation [3]. The large resorptive area in the human maxillary alveolar process is linked to an overall reduction of the midface and, as this study suggests, to the prior loss of the canine honing complex in early hominins. However, the similarities between the non-human great apes and early hominins maxillary bone modeling patterns [4,5] indicate that the ape-like condition was maintained in the latter even after the reduction of the canine honing complex.

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Virtual Pecha Kucha Presentation Session 8, Friday 17:05-17:30

Topology, functional morphology, and the interpretation of brain form in human fossils

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Brain morphology stems, partially, from constraints in the spatial arrangement of its structural components, as well as in relation to surrounding structures such as the skull [1]. The aim of the present research was to localize key regions in the geometric balance of the modern human brain, identify phenotypic patterns in their spatial arrangement and disentangle how these patterns influence brain morphology in evolution. To do so we applied network theory to the macroscopic anatomy of the brain [2], a methodology known as anatomical network analysis (AnNA) [3]. AnNA permits the evaluation of the brain's topological properties by modeling the physical contact among its regions [2]. The network model of the modern human brain designed for this study consists of a set of 101 nodes representing the brain regions, and 346 edges representing the physical contact among them. Local parameters comprised node centrality metrics, namely the relevance and role of each region in the brain's overall topology. Meanwhile, global parameters concerned the brain's morphological complexity and organization [3]. The potential of AnNA for revealing topological constraints makes it particularly interesting in paleoneurology, which deals with the form of the endocranial cavity to investigate human brain evolution in fossil species.

Concerning the individual brain regions, physical contact creates codependences that translate to topological constraints. In other words, highly codependent regions possess limited evolvability, as their modification would entail alterations to the entire brain [3]. In relation to the network as a whole, a community detection algorithm divided the brain into an inferior and a superior aspect, which is consistent with two distinct cranial morphogenetic conditions. In primates, the cranial base and the facial block are complex anatomical structures that participate in vital bodily functions (e.g., feeding). Conversely, the cranial vault is a much simpler structure, free of interactions with important organs such as the pharynx [4]. Considering this information, AnNA suggests that the morphological differences detected at the parieto-occipital cortex among human species [5], for instance, probably reflect primary brain changes due to cognitive adaptations or functional plasticity [1]. On the contrary, gross changes of the middle cranial fossa and temporal regions [5] may be due to several factors, including secondary effects stemming from structural constraints imposed by adjacent anatomical elements [1]. These include other brain regions, but also surrounding structures like the cranial base. Hence, in the case of the middle cranial fossa and temporal regions, secondary influences should be discarded before claiming that the cause behind their variation among human species is functional adaptation.

This information should be considered duly when analyzing the morphological diversity of the brain in both ontogenetic and phylogenetic studies.

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Podium Presentation Session 10, Saturday 11:00-11:20

Update on the excavations and research at Schöningen

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The Schöningen excavation is a long-term project that continues to advance through its new discoveries and developments in research. This, coupled with the excellent preservation at the site, has allowed for multidisciplinary insights into the behavior of hominins present at the lakeshore site about 300,000 years ago (MIS 9). This lecture is an update on the highlights of our recent excavation seasons.

One focus of our research is the sedimentary sequence of Schö 13 II-3, underlying the well-known spear horizon. Here we recovered several animal skeletons, including an elephant and an aurochs. The presence and absence of lithic artifacts allows us to better understand how regular exploitation of carcasses took place at the end of the Lower Paleolithic. The microwear and residue analysis of lithic micro artifacts reveals diverse activities including the curation and transformation of tools.

The research of cut marks on bones (e.g., Schö 12 II-1) clearly indicates a deliberate stripping of fur from selected animals, which documents the various forms of exploitation of different species. The impact marks on a wooden artifact show that hominins used this tool as a throwing stick (Schö 13 II-4). The analysis of stone, wood and bone artifacts in the different layers and sites reveals a clear chaîne opératoire, not only a depth of planning but also a clear, multi-layered record of technological adaptations. The study of fossil footprints (Schö 13 I, find layer 2, and Schö 13 II-2) adds a complementary line of evidence, useful to understand the ethology and ecology of Pleistocene mammals. Isotope analyses provide an insight into the diet of multiple animal species. Small mammal remains make a significant contribution to the reconstruction of climate and environment, as well as an independent approach to chronology. The detailed analysis of plants and other organic remains, including eggshells, documents the great potential of accessible natural resources. Finally, ancient DNA analyses have the potential to disclose new insights into the evolution of faunal taxa present at the site.

In summary, the Schöningen site complex offers the evidence necessary to reconstruct a more detailed view of life at a 300,000-year-old lakeshore

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Podium Presentation Session 4, Thursday 16:30-16:50

Investigating selective hunting behaviours during the Middle to the Upper Palaeolithic transition using ZooMS

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Palaeolithic faunal assemblages provide a wealth of information, notably on paleoenvironment, site formation and subsistence strategies. However, obtaining a secure interpretation requires understanding the context of these bone remains and their taxonomic identification, traditionally done through visual morphological comparison. Recent developments in biomolecular methods such as Zooarchaeology by Mass Spectrometry (ZooMS) allow us to now exploit a large portion of morphologically unidentifiable bones preserved in Pleistocene sites [1, 2]. The analysis of both the fragmented and morphologically unidentifiable faunal remains can contribute to a clearer understanding of the formation of these bone assemblages [3].

In this study, we have used untargeted ZooMS analysis to investigate three bone datasets spanning the Middle to the Upper Palaeolithic transition (MUPT) at Bacho Kiro Cave (Bulgaria), Les Cottés and La Ferrassie (France). Combining morphological and ZooMS taxonomic attributions, together with body part identifications and a detailed recording of a range of comparable taphonomic attributes (e.g., weathering, carnivore marks, human modifications), offers the opportunity to address methodological limits commonly faced during the analysis and interpretation of highly fragmented bone assemblages [4].

The results illustrate differences in species abundance between the ZooMS and morphology datasets. Specifically, the overrepresentation of reindeer and the underrepresentation of *Bos/Bison* and equids at Les Cottés and La Ferrassie highlight possible differences in identification rates between taxa. Conversely, the comparable taxonomic abundances obtained at Bacho Kiro Cave stress the idea that the fragmented portion of Palaeolithic bone assemblages can differ significantly from the morphologically identified component. Our results highlight a more diversified range of taxa modified by humans and carnivores and bring new insights on bone accumulators in these transitional assemblages. The progressive decrease of carnivore modifications across the MUPT at Bacho Kiro Cave and Les Cottés provide fresh and complementary perspectives on site occupation and duration. Moreover, the shift in abundance between *Bos/Bison* and Equidae observed at Les Cottés across the MUPT could reflect a change in prey availability or prey selection strategies.

These results illustrate the importance of assessing late Pleistocene bone assemblages in their entirety through different proxies in order to have a clearer understanding of their formation and to better understand how this reflects changing human subsistence strategies across the MUPT and throughout human evolution more generally.

This study was funded by the Max Planck Society. We thank the National Archaeological Institute with Museum, from the Bulgarian Academy of Science (Sofia, Bulgaria) and the Museum of Dryanovo for supporting the Bacho Kiro Cave fieldwork and storage of the faunal collection from Bacho Kiro Cave. We would like to thank J.-J. Cleyet Merle, C. Cretin, and B. Nicolas for facilitating access to La Ferrassie fauna stored at the Musée National de Préhistoire (Les Eyzies, France). M.S. is funded by the Dutch Research council (NWO) (VI.C.191.070 grant). F.W. received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement no. 948365). G.M.S. is funded by the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie scheme. (grant agreement No. 101027850).

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Poster Presentation Number 96, Session 2, Friday 18:15

BACBONE: An interdisciplinary approach to micro-scale taphonomy and BACterial bioerosion on BONE

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Fragmented animal bone assemblages 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 assess whether bones entered the archaeological record butchered or fully fleshed (complete carcass burial or natural death) [1-4].

The Marie Sklodowska-Curie funded project BACBONE will apply this approach to assess differences in bone taphonomy and subsistence practices 50,000-40,000 years ago, a time when both Neanderthals and modern humans were present in Europe. It will combine hard tissue histology with the high-throughput capacity of high-resolution microtomography (micro-CT) for non-destructive virtual histology. BACBONE will also incorporate the small bone fraction, now identifiable through Zooarchaeology by Mass Spectrometry (ZooMS) to provide unique insights into patterns of carcass deposition and processing.

This poster will introduce the theoretical and methodological rationale behind the BACBONE project. We will present initial data from micro-CT scanning of fragments from the large collection of Medieval human remains stored at the University of Kent, Canterbury [5]. These individuals were recovered from the excavation of a cemetery and provide a unique dataset for training and identification of bacterial bioerosion in human remains. Here we report on the identification and prevalence of this phenomenon and discuss the potential for using this as a proxy to differentiate between different depositional histories between taxa (human, carnivore or herbivore). We will further highlight next steps in the application of this methodology to bones (animal and human) from late Pleistocene sites across Europe.

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).

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Poster Presentation Number 80, Session 2, Friday 18:15

An experimental proof-of-principle for a minimal culture model of the Oldowan

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Cumulative culture of know-how is a phenomenon unique – among living primates – to modern humans and has been fundamental in the survival and success of *Homo sapiens* (e.g., [1]). Cumulative culture is based on the social transmission of know-how information [2] across individuals, typically via mechanisms like copying, teaching, and language. Over time, these processes result in behaviors and material outcomes that cannot be re-innovated independently by single individuals. This inevitable ratcheting process and its outcomes are not currently well-evidenced in the *minimal cultures* of non-human apes, which are instead based on transmission of other information types like know-what and know-where [2].

Consequently, archaeological researchers have attempted to pinpoint when would have been the beginnings of this very important behavioral and cognitive phenomenon within the human lineage. Prior research has often followed the implicit conclusion that the first unambiguous anthropogenic technology, the Oldowan industry, was produced by social learning types that transmit know-how (e.g., [3]). Even further, it has been proposed that the earliest Oldowan already would have signified cumulative culture (cf. [4]). In contrast to the cumulative culture hypothesis, alternative accounts have suggested instead that the technology of the Oldowan was a result of minimal cultures – as with non-human apes, but in this case, among pre-modern hominins (e.g., [5]).

Using a newly-developed methodology, we tested for the individual capacities to re-innovate Oldowan knapping techniques and technologies in the absolute absence of opportunities for the direct cultural transmission of know-how. In doing so, we performed the first baseline test for human knapping abilities, as well as the necessary control condition to complement past research (e.g., [3]). Participants were recruited for a "problem-solving study", and when they arrived at the testing space, they were provided with relevant raw materials and motivation (in essence, know-what and know-where information) but otherwise with no demonstrations of and instructions on knapping (i.e., no know-how information).

A large component of the study sample (n=25 out of a total of N=28 participants) were – based on post-test questionnaires – knapping technique-naïve, and yet, the vast majority of these participants were able to individually re-innovate valid Oldowan knapping techniques (categorized broadly as passive hammer, bipolar, freehand, and projectile techniques). In using these techniques, the participants created flakes via the initiation of conchoidal fracture, and the repetition of this flake-making resulted in core artefacts that not only fit into the classical Oldowan typology but also exhibit typical Mode I reduction patterns. The re-innovation of both the knapping techniques and the material outcomes of knapping in the absence of direct transmission of the pertinent, target know-how serves as a proof-of-principle that these behaviors and artefacts could have likewise been generated without cultural transmission of know-how in other contexts, namely – and most importantly – in the context of the hominins that were first responsible for early Oldowan assemblages.

Though the common interpretation that Oldowan, and more generally Mode I, technology was a result of cultural transmission of, and therefore cumulative cultural evolution of, know-how may still hold true, this can no longer be assumed to be true, unless additional lines of evidence can demonstrate the *necessity* of these processes for the generation of archaeological assemblages. For now, we recommend serious consideration of an alternative working hypothesis for the early stone tool record, i.e., the minimal culture model of the Oldowan.

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Poster Presentation Number 59, Session 1, Thursday 18:15

Luminescence dating of the Chibanian (Middle Pleistocene): fact or fiction?

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Few techniques are appropriate for reliably dating deposits of Chibanian (Middle Pleistocene) age and older, a time range crucial to our understanding of human evolution. Within the suite of routinely used luminescence dating methods, the only one which ranges that far is infra-red stimulated luminescence (IRSL) of potassium feldspar, which determines the last time the mineral grains were exposed to sunlight. However, a part of the IRSL signal is unstable due to a phenomenon termed anomalous fading, which leads to severe age underestimations if not accounted for. Repeated IRSL measurements at increasing temperatures enable the isolation of signal components with higher stability. For instance, the post-IR IRSL (pIRIR) method has yielded an age of ~700 ka for a sample near the Brunhes–Matuyama boundary [1], but correction procedures are often still necessary and reduce the precision of resulting ages, especially for old samples.

An alternative dating method currently in development is the radiofluorescence (RF) of potassium feldspar, in particular the infra-red RF emission (IR-RF), which reportedly requires no correction for signal instability [e.g., 2-3]. Significant methodological advances have been achieved since the technique's first introduction in the late 90's, such as automated instrumentation, the determination of appropriate measurement parameters and open-source data analysis tools. However, several aspects still require further investigation, particularly the differences in signal saturation between samples irradiated naturally in the field or artificially in the laboratory [4-5].

This contribution will review current cutting-edge luminescence dating methods of potassium feldspar, including IR-RF and pIRIR protocols, to discuss the current age range limitations. We will present multi-method dating results from samples of known ages and address the challenges that still need to be overcome before these methods can be routinely applied to date Chibanian sediments.

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Podium Presentation Session 1, Thursday 10:40-11:00

Fire making in the Aurignacian: Microwear evidence from Abri Pataud and Vogelherd Cave

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Archaeological evidence for the use of fire by early Upper Palaeolithic hunter-gatherers is well-attested to; yet artefactual evidence for fire production during this same period is virtually non-existent. This disconnect presents a glaring gap in our knowledge of the pyrotechnological capabilities of the earliest *Homo sapiens* entering Europe during the Last Glacial Period. In an effort to determine if this gap reflects an actual absence of fire making technology, focused microwear analyses of early Upper Palaeolithic lithic collections are presently underway in an attempt to identify mineral traces and associated residues on flint tools that are consistent with forceful contact with pyrite for the express purpose of producing sparks (i.e., strike-a-lights). Characteristic traces usually include a combination of localized, macroscopically visible crushing, rounding and/or percussion marks along tool edges and/or surfaces, which, depending on the degree of preservation, are associated with microscopic mineral polish containing oriented, parallel striations and "frictive tracks" (linear constellations of interconnected, small pits) [1]. Pyrite residue may also be present, and while appearing black when fresh, it can remineralize into reddish iron oxide minerals over time [2]. Presented here are the initial results from two such analyses of materials from Abri Pataud and Vogelherd Cave.

Abri Pataud (Dordogne, France) is a rock shelter site with a 9.25 m-thick sequence dating to between 40,000 and 20,000 Cal BP and contains 14 archaeological layers (Aurignacian, Gravettian and Solutrean), nearly all exhibiting evidence of fire having been used on site, including abundant hearth features [3]. Vogelherd Cave (Swabian Jura, Germany), known for its amazing collection of Aurignacian carved ivory animal figurines, has a long occupation history, with archaeological layers attributed to the Neolithic, Magdalenian, Aurignacian, Middle Palaeolithic, and Late Acheulean. For this study, all of the material recovered from the original Riek excavation (1931) corresponding to Aurignacian Layers V and IV were analyzed. Each layer possesses multiple hearth features, n=6 and n=5, respectively [4]. Moreover, a utilized pyrite nodule was recovered from Layer V, the band of damage exhibited by this nodule having been previously interpreted as having resulted from use for fire making [5]. Reanalysis of this nodule for this study could not refute this interpretation.

In total, 44 probable or possible strike-a-lights were identified in four of the eight Aurignacian layers at Abri Pataud: Layers 12 (n=4), 11 (n=16), 8 (n=9), 7 (n=15). This is a surprising result considering, to my present knowledge, no Aurignacian strike-a-lights have been identified in published literature. Perhaps equally surprising, given these findings, is that none were observed in the younger Gravettian (n=4) and Solutrean (n=1) layers. At Vogelherd, poorer preservation of the material made interpretation more difficult, especially at the micro-scale. Nevertheless, 28 tools from Aurignacian Layers V (n=11) and IV (n=17) retain traces that could be consistent with use as fire making tools, with varying levels of confidence: probable (n=3), possible (n=12) and ambiguous (n=13). Together, these initial findings suggest that percussive fire making technology was known among at least some Aurignancian groups. Possible explanations for the apparent absence of strike-a-light tools in the younger and negative Aurignacian layers at Abri Pataud will be discussed.

This project was funded through a Netherlands Organization for Scientific Research (NWO) Talent Program Veni grant.

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Poster Presentation Number 114, Session 2, Friday 18:15

A 3D morphometric approach of the skull versus endocast integration in *Pan troglodztes*, *Gorilla gorilla* and *Homo sapiens*

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Cranial morphology in fossil hominins is largely variable with different observed patterns of integration related to intraspecific and interspecific factors [1]. One of the key factors to understanding the evolution of *Homo* is the identification and quantification of patterns of integration in the skull and endocast [2]. By studying these patterns, we can obtain more information to understand how the brain affects or is affected by the morphology of the cranial structure and then apply this data to reconstruct partial fossil specimens [3]. During the last decades, numerous studies on cranial and endocranial integration and modularity have been carried out separately. We used new computational techniques and virtual anthropology methods to investigate the interactions between cranial and endocast regions. In detail, we focus the investigation on the patterns of covariation in *Homo sapiens* (N=20), *Pan troglodytes* (N=20) and *Gorilla gorilla* (N=20). The main goal is to detect shared or species-specific integration patterns that can later be applied to extinct hominin species.

We defined 6 regions on the skull –viscerocranium, frontal, parietals, temporals, occipital and sphenoid bones– and 8 regions on the endocast –frontal, parietal, temporal, cerebellum and occipital lobes, as well as brainstem, endo-sphenoid area and olfactory bulb– using 105 landmarks, 492 curve points and 1448 surface sliding semilandmarks. We performed a separate Procrustes registration on the skull and on the endocast. To establish the shared and species-specific pattern of integration among the three genera we have used the two-block partial least squares (PLS) method pooling the dataset by species and sex [4]. The PLS analyses has been performed by defining a network taking into account all the combinations of the 14 skull and endocast regions. To test whether the observed patterns of covariation were species-specific or not, we compared the slopes of the first axis of covariation through Bootstrap permutations [5].

Our results show that (i) frontal lobes covary significantly with 5 of the 6 cranial regions, except for the sphenoid bone. (ii) The facial complex covaries with the posterior part of the endocast base, mainly with the cerebellar region and, to a lesser extent, the brainstem. Occipital bone (iii) is integrated with the brainstem region, (iv) frontal bone with temporal lobes and endo-sphenoid area, and (v) temporal bones with temporal lobes and endo-sphenoid area. Finally, (vi) parietal and occipital lobes do not covary with any of the cranial regions, possibly due to the morphological differences in males and females. All the significant covariations patterns between skull and endocast –except for the covariation patterns of parietal bones with frontal lobes and frontal bone with endo-sphenoid that are common for the 3 taxa– are not fully shared but, in all cases, they are at least shared between 2 of the 3 groups. In conclusion, the investigation of the shared and species-specific pattern of covariations between skull and endocast can help us to understand in more depth the mechanisms of cranial and brain shape evolution in fossil human species.

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Poster Presentation Number 82, Session 2, Friday 18:15

Reconstructing hand use in *Australopithecus sediba* and *Homo naledi*: mapping variation in cortical thickness across the proximal and intermediate phalanges

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The inferred diversity of manual behaviors within the hominin lineage is exemplified by the mosaic morphology of the hands of *Australopithecus sediba* and *Homo naledi* [1-2]. Derived morphological features present in both fossil hominins point to human-like manipulation abilities, while curved fingers with well-developed flexor sheath ridges (FSRs) suggest the continued use of their hands for climbing and grasping [1-2]. The internal bone structure may reflect habitual locomotor and/or manipulative loading of the fingers due to bone's ability to (re)model throughout life in response to mechanical load [3], and thus variation in phalangeal cortical bone distribution holds the potential for reconstructing hand use among fossil hominins.

We investigated the distribution of phalangeal cortical thickness in extant great apes, *A. sediba* and *H. naledi* to inform our reconstruction of fossil manual behaviours. The sample included microCT scans of the proximal and intermediate phalanges of rays II-V of *Gorilla gorilla* (N=21), *Homo sapiens* (N=37), *Pongo pygmaeus* (N=9), *Pan* sp. (N=24), *A. sediba*, and *H. naledi* (Hand 1). We used the R package morphomap [4] to map diaphyseal cortical thickness and conducted a principal component analysis (PCA) on the cortical thickness values to explore patterns across species.

Results show clear separation among extant taxa across all phalanges. The extant taxa are separated along PC1, with some overlap between the African apes reflecting a pattern of thickness localised to the FSRs, with a different pattern of overall thickness of the shaft in *Pongo* and in humans. PC2 reflects differences in the location of greatest thickness; in African apes this occurs in the FSRs throughout the shaft, whereas in *Pongo* this is distally located with some dorsal thickening, and in humans it is primarily in the dorsodistal region of the shaft. The proximal phalanges of *A. sediba* consistently fall close to the African apes, reflecting maximum thickness localised to the FSRs, while *H. naledi* consistently falls close to humans, reflecting thickening of the dorsal region of the shaft and the FSRs distally. The intermediate phalanges of both fossil species fall between the African ape and human distribution, reflecting a thickening of the dorsal region of the bone and the FSRs, which are located in the proximal-to-midshaft region. The distribution of the *A. sediba* intermediate phalanges differs from those of *H. naledi* in that the thickening on the palmar surface extends further distally. This is consistent with external morphology of *A. sediba* intermediate phalanges that possess unusually long and prominent FSRs.

Overall, we show that variation in phalangeal cortical bone distribution clearly separates extant hominoid taxa that differ in their locomotor and manipulative behaviours. Within this comparative context, *A. sediba* proximal phalanges are most similar to the African ape cortical signal and intermediate phalanges are intermediate between all extant taxa. Along with a high degree of phalangeal curvature and prominent FSRs, this morphology better distributes stress and reduces strain on the bone during flexed finger loading (e.g., during climbing or suspension) [5]. In contrast, while *H. naledi* phalanges are most similar to humans in their cortical distribution, this appears to contradict their high degree of curvature, which may be a functional indication of arboreal locomotion [5]. The *H. naledi* phalanges indicate a hand uniquely adapted for arboreal behaviours in the degree of curvature but not cortical distribution, differing to that of extant great apes and *A. sediba*.

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Podium Presentation Session 1, Thursday 10:20-10:40

Weapon choice and hunting strategies in the Gravettian of Abri Pataud

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Projectile technology and hunting have significantly shaped the evolutionary trajectory of our species and continue to be among the most discussed and debated topics in Palaeolithic archaeology. In this contribution, we use the Gravettian of Abri Pataud (France) as a case study and argue that the examination of hunting equipment against faunal data can help refine our view of the causes of change in weapon technology and the lithic record. Insights gained from such work can also aid in interpreting older assemblages.

Gravettian hunters targeted a broad variety of large and small game and may have contributed to megafauna extinctions at least regionally [1]. The evidence for this versatile and at times intense exploitation of fauna co-occurs in the archaeological record with distinct artefact types suggestive of projectile function, including tanged points, Gravette and microgravette points, and fléchettes. However, few studies exist that would reliably confirm the function of these artefacts, and practically none have examined diachronic changes in Gravettian weapon design using lithic functional data. Our knowledge of how projectile design interacted with different hunting strategies and situations is therefore limited.

In this contribution, we present the first functional study on projectile material from the Recent Gravettian (c. 24,000 BP) and Final Gravettian (c. 22,000 BP) layers of Abri Pataud. We used low and high magnification use-wear analysis and experimental reference material to reliably identify lithic armatures in the two assemblages. We singled out the artefacts with strongest evidence of projectile use and recorded the attributes of impact damage on them in detail. By comparing these data, we were able to detect changes in weapon preferences from the Recent Gravettian to the Final Gravettian. While it has been previously proposed that the abundant backed bladelets in Final Gravettian assemblages represent the replacement of distally hafted Gravette and microgravette points by composite points [2], we could show that composite points were already in use during the Recent Gravettian occupations and that their dominance in the Final Gravettian therefore represents a shift in weapon preferences that drew on pre-existing technical solutions.

We examined these results against recent faunal data [3-4] and observed that prey choice alone does not explain the change in weaponry, as both Recent and Final Gravettian hunters at Pataud focused rather heavily on reindeer. Instead, the preference of composite points appears to be linked to seasonal organisation of hunting activities, motivated by the behaviour of the main prey species in different times of the year, and possibly to other factors having to do with the winter conditions during the Final Gravettian occupations.

Our reading of the lithic and faunal data implies that hunting technologies were subject to local changes in environmental conditions and social organisation. The global archaeological record suggests that composite points were used at different times in varying contexts [5], which can be interpreted as fluctuations in weapon preferences according to specific conditions. We therefore propose that large-scale patterns in the prehistoric lithic record should be explained with these particularities in mind. As a consequence, detailed study of individual site contexts with a good level of lithic and organic preservation can help defining the underlying causes of long-term technological change and stability.

We are grateful to Hugues Plisson (University of Bordeaux, CNRS) for providing us with the equipment that enabled the microscopic analysis of the archaeological material in Les Eyzies. We thank Christian Lepers, Justin Coppe and Lola Tydgadt (TraceoLab, University of Liège) for their work and insights that aided this research. This study was funded by the European Research Council under the European Union's Seventh Framework Program (FP7/2007-2013, ERC Grant Agreement No. 312283, EVO-HAFT, VR) and by the Kone Foundation (Grant No. 088817, NT).

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Podium Presentation Session 12, Saturday 16:00-16:20

Early human habitats linked to past climate shifts

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The impact of climate change on human evolution has long been suspected but has been difficult to demonstrate due to the paucity of climate records near human fossil-bearing sites. To bypass this problem, we conducted an unprecedented climate computer model simulation covering the past 2 million years (the longest of its kind) to investigate what the climate and vegetation were like at the times and places humans lived, according to an extensive database of well-dated fossil remains and archeological artefacts [1-2]. It is the first continuous simulation with a state-of-the-art climate model that covers earth's environmental history of the last 2 million years, representing climate responses to the waxing and waning of ice-sheets, changes in past greenhouse gas concentrations, as well as the marked transition in the frequency of glacial cycles around 1 million years ago [3]. The climate model and habitat simulations were further compared with paleo-climate, human paleo-DNA and other environmental data.

Our analysis [4] revealed the preferred environmental conditions of different species of archaic humans. From there, we looked for all the places and times those conditions occurred in the climate model, creating time-evolving maps of potential habitats or archaic human species. Even though different groups of archaic humans preferred different climatic environments, their habitats all responded to climate shifts caused by astronomical changes in earth's axis wobble, tilt, and orbital eccentricity (Milanković cycles) with timescales ranging from 21 to 400 thousand years.

To test the robustness of the link between climate and human habitats, we repeated our analysis, but with ages of the fossils shuffled like a deck of cards. If the past evolution of climatic variables did not impact where and when humans lived, then both methods would result in the same habitats. However, we found significant differences in the habitat patterns for the three most recent hominin groups (*Homo sapiens*, *Homo neanderthalensis* and *Homo heidelbergensis*) when using the shuffled and the realistic fossil ages. This result implies that at least during the past 500 thousand years the real sequence of past climate events, including glacial cycles, played a central role in determining where different hominin groups lived and where their remains have been found.

The next question we set out to address was whether the habitats of the different human species (*Homo sapiens, Homo neanderthalensis, Homo heidelbergensis*, *Homo erectus* and early African Homo) overlapped in space and time. Past contact zones provide crucial information on potential species successions and interbreeding and genetic admixture. From the contact zone analysis, we then derived a habitat-based human family tree, according to which Neanderthals derived from the Eurasian clade of *Homo heidelbergensis* around 500-400 thousand years ago, whereas *Homo sapiens'* roots can be traced back to African populations of late *Homo heidelbergensis* around 300 thousand years ago.

Confirming the conclusions of previous model simulations conducted with a human dispersal model [5], our human habitat study documents that climate played a fundamental role in the evolution of our genus *Homo*.

We are who we are because our genus has managed to adapt over millennia to slow shifts in past climate.

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Pecha Kucha Presentation Session 11, Saturday 14:40-15: 05

Locomotion in *Homo floresiensis*: reconstructing foot use from the internal bone structure of the metatarsals of LB1

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The enigmatic *Homo floresiensis* displays a unique combination of cranial and post-cranial morphology [1-3], distinguishing it from other species of the genus *Homo*. Although its skeletal anatomy shows clear adaptations for terrestrial bipedalism, it also retains a suite of features conducive to arboreal behaviours. Thus, exactly how the locomotor behaviours of *H. floresiensis* compare with those of other hominins remains an important research question. The foot of the holotype (LB1) is long relative to its femoral length, has a longer forefoot than hindfoot, long phalanges relative to the non-hallucial metatarsals (Mts), and a short Mt1 relative to the other Mts [3]. However, it also possesses a human-like Mt head morphology and relative robusticity pattern [2-3]. Here, we assess the internal morphology of the Mts of LB1 to further assess foot functional morphology and locomotor kinematics in *H. floresiensis*.

Using high resolution micro-CT scans of the Mts of LB1 and a comparative sample of *Homo sapiens* (N=10), *Pan troglodytes* (N=15), *Pan paniscus* (N=15), *Gorilla* spp. (N=10) and *Pongo* spp. (N=9), we conducted a cross-sectional geometric analysis at mid-shaft and analysis of trabecular bone distribution in the Mt head. As the head was only fully preserved for the right Mt5 of LB1, trabecular analysis was limited to this element.

Cross-sectional geometry of the Mts at mid-shaft distinguishes between ape-like and human-like biomechanics, with greater loading of the Mt2 and Mt3 in apes compared with more lateral loading in humans [4]. The Mts of LB1 are internally robust, having a high cross-sectional area relative to bone length. Results show that the relative strength of the Mts, based on the internal structure, differs from the previously reported human-like pattern, which was based on external measurements of midshaft circumference [2-3]. We find that, after scaling by total bone length, the robusticity pattern for the left Mts of LB1 is 1>2>5>3>4 for CSA and Z, and 1>5>2>4>3 for J. Although there is some variation among humans, in general the Mt3 and Mt2 have lower measures of robusticity than the Mt4 and Mt5 [4]. In LB1, the Mt2 is consistently more robust than is expected in humans, with the pattern being 1>2/5>3/4 compared to 1>4/5>2/3 in humans.

The distribution of trabecular bone in the Mt5 head distinguishes between locomotor groups. In *H. sapiens*, where the foot is loaded in dorsiflexion there is a dorsal concentration of bone, which is asymmetric in extending dorsomedially. In African apes, where the toes are positioned dorsally during knuckle-walking and disto-plantarly during climbing (depending on substrate size) the distribution of trabecular bone extends dorsally to plantarly on the metatarsal head. In *Pongo*, trabecular bone is distributed distally and plantarly reflecting a grasping foot. The distribution of trabecular bone in the Mt5 of LB1 is located dorsally and distally but does not extend plantarly. This distribution pattern differs from humans in being centrally located, rather than medially, and in extending further distally. This suggests that the metatarsophalangeal joint in LB1 was loaded in a more a neutral position than in humans.

Together, the results suggest that loading of the foot of *H. floresiensis* differed from modern humans. First, the distribution of load across the foot was likely higher in the Mt2, a feature that could relate to higher loading of the second ray in a foot with a relatively short first ray. Secondly, the trabecular pattern suggests loading of the Mt5 head more distally than in humans, and with less asymmetric loading. This differing position of the metatarsophalangeal joint could be related to the long, curved phalanges of LB1. Future research exploring whole-bone cortical and trabecular structure of the metatarsals will shed new light on the kinematics of locomotion in *H. floresiensis*.

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Poster Presentation Number 111, Session 2, Friday 18:15

The human cochlea: a test case for endocranial morphology comparisons on a small scale

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The last decades have seen a rapid increase in the availability of computed tomography (CT) and, more recently, of microCT scans of extinct and extant species, as well as in the number of digital repositories providing access to 3D meshes derived from these scans. This trend is allowing a broadening in the use of 3D geometric morphometrics methods, as well as the development of increasingly sophisticated analyses. However, little effort has been devoted in ascertaining if data acquired and processed with different methods are readily comparable. While this might not be relevant for large structures such as cranial endocasts, it could be critical at a smaller scale as in the case of the cochlea. Found inside the petrosal bone and housing the hearing organ, its morphology has been frequently used for inferring paleoecological factors and phylogenetic affinities in hominins [1-2]. Hence, assessing errors affecting its morphological variability could help clarifying previously inferred aspects of human evolution.

Here we investigated how scan type, image stack preprocessing (i.e., contrast enhancement, noise reduction, and image filtering), and inter-observer errors affect cochlear segmentation and quantified their influence on volume measurements. To do so we relied on a sample comprising 10 extant human petrosal bone CT and microCT scans, which were independently segmented by four different observers following the state-of-the-art protocol provided in the literature [3]. The segmentations were repeated in by each observer on different types of CT and microCT images (16 bits and 8 bits), with and without preprocessing [4], using Avizo and Mimics. The volumes were computed both directly from the raw labels and from the generated 3D meshes. Differences in the measured volumes were inspected by relying on percent differences computed for each specimen and considering all the possible pairs of observers and image types, which allowed computing the inter-observer error as well as the differences between volumes obtained by different image types.

The results highlighted significant differences (>%5) only between volumes measured by two pairs of observers (AU and FB vs. MCV and AQS) when microCT data were inspected, while in all other instances (CT vs. microCT; 16bits vs. 8bits; standard vs. preprocessed images) the mean differences were below the golden standard. However, it is important to notice that even if the mean difference never surpassed the 5% threshold, in a few cases the individual difference was ~10%. Eventually, we observed only minor and constant differences (<2%) between the volumes computed from the segmentation labels and the generated 3D meshes, if the latter was generated with constrained smoothing.

Based on the obtained results, a direct comparison between volume data derived from different scanning (CT vs. microCT) and image (16 bits vs. 8 bits) types and differently preprocessed image stacks is warranted. This also applies to 3D meshes when smoothing level and parameter are given. Notably, inter-observer difference appears as the main driver of uncertainties at the time of measuring cochlear volume. Differently trained users might reach quite different volume measures, depending on their definition of the threshold for the bone/lumen boundary (up to 15% of the total volume). Conversely, this difference drops to <5% when the users have been trained together. This is not surprising given the variability in bone density (modiolus vs. basal turn) found in the cochlear area, already highlighted by previous analyses [5], which complicates the identification of an unambiguous threshold for its segmentation. Hence, we advocate for an improvement of the currently available protocols for cochlea segmentation, which should rely on easily identifiable landmarks in order to guide the observer in defining threshold values.

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Pecha Kucha Presentation Session 2, Thursday 11:30-11:55

Multiple expansions and local extinctions characterized *Homo sapiens* expansion into Eurasia

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The population dynamics that followed the Out of Africa (OoA) expansion of *Homo sapiens* and the whereabouts of the early migrants before the differentiation that ultimately led to the formation of Oceanian, West and East Eurasian macro populations have long been debated. Most studies point to 70,000-60,000 years ago as the most likely time window for the OoA, however the population divergence between East and West Eurasian is inferred to have occurred not earlier than 45,000-40,000 years ago, thus indicating that until that time the ancestors of all modern Eurasians lived somewhere in the new continent as a single population which we name "Hub". The divergence between these macro-populations can be considered a mark of the broader colonization of Eurasia, that in the time interval between ~50.000 and ~35.000 years ago is additionally characterized by the appearance and turnover of several techno-complexes which we can divide into the macro categories of *Initial Upper Paleolithic* (IUP), *Upper Paleolithic* (UP) and *non_Mousterian and non-IUP* technologies.

Here [1] we analyze the available Eurasian Paleolithic aDNA to provide a comprehensive population model, primarily using admixturegraphs, and validate it in light of available material culture. Our results show that the that the genetic modeling of Paleolithic genomes largely matches the material culture evidence and suggests multiple waves of colonization of Eurasia. A major expansion, represented by the individuals from Bacho Kiro [2], Oase [3], Ust'Ishim and Tianyuan [3], is broadly associated with Initial Upper Paleolithic lithics and populated West and East Eurasia around 45.000 years ago; before getting largely extinct in Europe. Another expansion, which started before 38.000 years ago and is represented by individuals like Kostenki 14 [4] and Sunghir, is broadly associated with Upper Paleolithic industries and repopulated Europe with sporadic admixtures with the previous wave (Goyet Q116-1 [13]) and more systematic ones while moving through Siberia (Yana, Mal'ta). Prior to these events, we also confirm Zlatý Kůň [5] as the most basal human lineage sequenced to date OoA, representing an earlier wave of colonization from the Hub whose timing and extension are currently unknown, and putatively link it to non-Mousterian and non-IUP lithics documented in Europe 48.000-43.000 years ago.

Leveraging on our integrated approach we propose that, starting from a Eurasian population Hub, the broader colonization of the continent occurred through multiple events of expansion and local extinctions; with each expansion characterized by distinct chronologies, genetics and lithic technologies.

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Pecha Kucha Presentation Session 9, Saturday 10: 05-10:30

The rule of the Red Queen: did interspecific competition regulate hominin speciation?

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Background: In the metaphorical battle for evolutionary causality, the 'Court Jester' [1] is frequently pitted against the 'Red Queen' [2]. For the 'Court Jester', the primary causes of evolutionary change are external climatic and environmental factors, while that role is fulfilled by interspecific competition in 'Red Queen' models. Research interest in the relative importance of climate versus interspecific competition in shaping hominin speciation dynamics has been surprisingly asymmetrical: changing or variable climate is by far the most commonly-invoked driver of cladogenesis in our lineage (e.g. [3]). While the role of interspecific competition (hereafter 'competition') in hominin evolution has received some attention, there has been a distinct focus on linking specific adaptive traits to competition, rather than asking whether there was a general relationship between the intensity of hominin competition and macroevolutionary dynamics.

Such a relationship has played a major role in vertebrate diversification, however. In virtually all vertebrate clades in which the link between competition and diversification has been analysed, speciation has been shown to be diversity-dependent [4]. As a clade expands and species diversity increases over time, finite niche and/or biogeographical space becomes saturated, and future speciation is consequently restricted. As a rule of thumb, then, vertebrate speciation tends to be negatively diversity-dependent because of the speciation-limiting action of competition. Whether hominin speciation was regulated in a similar way is unknown. Here, we examine the relationship between species diversity, competition, and speciation in hominins.

Methods: First, we use generalised linear models (GLMs) to ask whether fossil first appearance dates (FADs) are predicted by previous diversity; under a negative diversity-dependent regime, FADs should cluster in times of lower previous diversity. FADs are the conventional proxy for speciation in palaeoanthropology, but they can be affected by processes such as sampling and preservation bias, and are a misleadingly binary proxy for speciation [5], and so we then directly calculate hominin speciation rates across two phylogenies to take into account phylogenetic uncertainty. Using these data, we perform phylogenetic GLMs to ask whether variation in speciation rates correlate with previous clade- and region-wide diversity. Finally, we examine temporal trends in the diversification of two ecologically relevant traits – body size and endocranial volume – using disparity through time (DTT) plots, as a proxy for the strength of competition between hominin species.

Results: The direction of the relationship between diversity and speciation rate is significantly different in *Homo* than in its predecessors, which followed the pattern seen in many vertebrate clades. In *Australopithecus* and *Paranthropus*, as in birds, reptiles, and other mammals [4], speciation rate slowed as a function of increasing diversity, meaning speciation was regulated by competition for ecological or geographical space. For *Homo*, in contrast, speciation rate is higher when there were more competing taxa. These results are echoed in those of the FAD-based analysis: *Australopithecus* FADs tend to occur when there were no competitors, while in *Homo* there is a shift towards speciation in the presence of other, presumably competing, taxa. It is likely *Homo* competed with *Australopithecus* and *Paranthropus* for niche/geographic space already saturated, and, although the data we present do not shed light on how *Homo* was able to outcompete other species or access new ecological niche space in saturated evolutionary environments, we make the case that either was possible through the use of technology for extractive foraging.

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Virtual Pecha Kucha Presentation Session 8, Friday 16:40 -15:05

Ulnar styloid reduction and the possible link with triquetral shape and wrist mobility across different primate taxa

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In the hominoid lineage, there is a reduction of the ulnar styloid process leading to a reduced or absent ulnocarpal articulation [1]. In addition to this separation of the ulna from the carpal joint, and to avoid joint collapse and preserve stability of the proximal carpal row, the reduction of the ulnocarpal articulation likely leads to changes in the morphology of the carpal bones as well. We expect that the ulnar reduction observed in hominoid primates has led to a reorganization of the carpus and that this signal will be most pronounced at the ulnar side. Moreover, it has been suggested that this reduced ulnocarpal articulation might be functionally linked to a greater overall wrist mobility, especially ulnar deviation and/or supination [2-3]. Across primates, we lack a full insight in the relation between wrist mobility and ulnar/carpal morphology. In a previous study we were able to show that the shape of the hamate and triquetrum of quadrupedal anthropoids, which mainly use their wrist under compressive conditions, differs from that of suspensory primates which wrist is mainly subjected to tensile and torsional forces. Within the hominids, differences in shape also distinguish more terrestrial from more arboreal species. Moreover, we demonstrated a significant covariation between the shape of these carpals [4]. The present study is divided in two parts: (1) quantification of distal ulnar shape and investigation of shape variation between different primate taxa, and (2) quantification of wrist mobility during radioulnar deviation (RD/UD) and pro-supination (PRO/SUP) across primate taxa and investigation of the link with distal ulnar morphology. For part one, the sample includes the ulna and triquetrum of 168 anthropoid primate specimens representing 13 different genera of four taxonomic clades, including plathyrrhines (genera: *Alouatta*, *Ateles*, *Cebus*), cercopithecoids (genera: *Macaca*, *Nasalis*, *Papio*), hylobatids (genera: *Hylobates*, *Nomascus*, *Symphalangus*), and hominids (genera: *Gorilla*, *Homo*, *Pan*, *Pongo*). To capture the overall shape, fixed landmarks are placed on the surface of the 3D meshes of the ulna and triquetrum obtained from CT or surface scanning of isolated skeletal elements. A principal component analysis on the aligned shape coordinates is used to explore major patterns of variation. The main differences between modern humans and hylobatids/macaques are the short ulnar styloid and broader ulnar head of humans. We note an increase in curvature of the ulnar head and a higher inclination of the styloid process on the radial side in hylobatids compared to macaques, morphologies that Sarmiento linked to a large range of motion of the wrist [5]. For the second part, we CT-scanned the forearm of 20 primate cadavers (8 hylobatids, 7 macaques, 3 chimpanzees, 1 bonobo, and 1 gorilla) in five standardized positions using a custom-designed rig (neutral, maximal RD/UD, and maximal PRO/SUP). For each specimen, we created 3D meshes of the carpal bones, third metacarpal (MC3), ulna and radius. The range of motion (ROM) of MC3 relative to the radius or ulna is calculated as a measure of maximal RD/UD and PRO/SUP, respectively, using an in-house developed Python code. The ROM is highest in hylobatids for both UD (41.3 ± 7.7°) and SUP (129.7 ± 10.4°). In macaques, UD (31.23 ± 5.6°) is higher compared to chimpanzees (20.19 ± 4.1°) while SUP is lower (66.13 ± 14.8° and 90.14 ± 5.6°). These results indicate that wrist mobility is not just a result of ulnar reduction, as hylobatids show the highest ROM in UD and SUP although their ulnar styloid is relatively longer compared to the other primates. Further research and a broader range of primate taxa are needed to elucidate the precise contribution of ulnar and carpal 3D geometry to overall wrist mobility.

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Poster Presentation Number 18, Session 1, Thursday 18:15

The effect of formation processes on Palaeolithic settlement patterns: insights from Kazakhstan and the Swabian Jura, Germany

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Palaeolithic archaeology often uses variations in settlement patterns to understand changes in human behavior [1]. Settlement patterns, however, can be biased by hominin choices regarding site use or site selection and by the natural processes that determine the visibility of the archaeological record. Human and natural biases control metrics like artifact density that are widely applied to model population size and occupation span [2-3]. Geoarchaeological approaches can help address these biases by investigating the processes that form archaeological sites [4]. However, regions or sites with a poor archaeological record and low artifact densities often remain unexplored. This study addresses these deficiencies by investigating the interplay between formation processes and settlement patterns on different analytical scales. First, we discuss the distribution of sites with low artifact density on a regional scale in the understudied region of Kazakhstan. Second, we present sites with low artifact density in the archaeologically rich valleys of the Swabian Jura, Germany. To achieve these research objectives, we employ a geoarchaeological approach combining field survey, test-pit excavations, micromorphology and landscape observations. Our results show that systematic biases influence site distribution in Kazakhstan, with caves, springs and loess settings being the most promising contexts for the formation of Palaeolithic sites. Natural processes tied to the regional semi-arid climate control the preservation of cave sediments and probably explain variations in the frequency of Palaeolithic sites among different regions of Central Asia. In contrast, the local scale analysis in the Swabian Jura demonstrated that human choices and not natural processes likely control the formation of low-density archaeological cave records. By understanding the processes that govern the distribution of archaeological sites or the formation of low-density sequences over a given area, we are able to assess the integrity of the archaeological record and construct more accurate interpretations regarding hominin dispersals and settlement patterns.

The PALAEOSILKROAD project conducted all field research 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). We would also like to thank the Senckenberg Centre for Human Evolution and Paleoenvironment (SHEP), the Verein für Eiszeitkunst im Lonetal, the Ministerium für Wissenschaft, Forschung und Kunst Baden-Württemberg and the University of Tübingen for their financial and logistical support.

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Podium Presentation Session 7, Friday 14:50-15:10

New insights into ochre features and their associated behaviours from the Howieson's Poort layers at Klipdrift Shelter

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The emergence of symbolism is a crucial aspect of investigating when, why and how ancient hominins adopted modern behaviour. Within this discussion, the use of mineral pigments is arguably one of the oldest mediums for abstract or symbolic communication. One mineral pigment that is frequently encountered at South African sites is an iron-rich material colloquially called ochre. The extensive collection and manipulation of ochre likely emerged during or before the African Middle Stone Age (MSA) and spread throughout Europe, the Levant, Asia, and Australia. Thus, exploring the emergence and spread of such behaviours can provide valuable insight into the beginnings and subsequent spread of complex behaviours such as resource trade, long-distance travel, social structures, articulated language, advanced cognition and personal expression.

Several sites in southern Africa are particularly situated to illuminate the emergence and intensification of ochre behaviours. Two of these sites, Blombos Cave and Klipdrift Rockshelter (KDS) lie on the southern coast of the Western Cape and provide a detailed temporal overview of the South African MSA. Specifically, the micro-laminated Howieson's Poort layers (ca. 65-50 ky BP) at KDS are characterized by superimposed hearth features, organic material and an abundance of bone, lithic fragments, and engraved ostrich eggshell. In addition, a considerable ochre assemblage, including anthropogenically modified ochre pieces, ochre processing tools, and ochre-stained lithic material, has been recovered. The currently published ochre assemblage includes more than 356 pieces (heavier than 0.1g) from the 2011-2013 excavation seasons as well as associated artefacts, which likely source from the Bokkeveld Shale deposits some 30km from the site. A continuous in-situ "ochre layer" from level PBE (ca. 64 ka BP) offers a rare type of ochre feature that has up until now not been extensively investigated or reported on before, and a similar ochre feature is also found at an even earlier context at Blombos Cave. Furthermore, though layer PBE didn't yield the highest number of ochre pieces, by mass, it contains the highest concentration of ochre in the form of highly fragmented pieces weighing less than 0.1g. The frequency of smaller ochre fragments likely relates to the ochre layer, which is characterized by a dense concentration of microscopic ochre, including both red and yellow varieties with different petrographies (visible in thin section) spread over several archaeological units. Here, we present an updated assessment of the KDS ochre assemblage, including new data from excavations in 2018, as well a detailed overview of the ochre layer from KDS and how these artefacts relate to similar features from Blombos Cave. Our study sets the groundwork for future diachronic analyses, such as types of ochre collected and how these change over time, their possible geological origins, and the nature of ochre residues on associated artefacts. Observing these patterns of ochre use, both diachronically and in-situ, as well as in comparison to other symbolically related practices (e.g., engraved ostrich eggshells) and to other geographically and temporally related sites, can inform us on the nature symbolic expression and expansion of *Homo sapiens* during and throughout the South African MSA.

Poster Presentation Number 48, Session 1, Thursday 18:15

How microartifacts provide the key for interpreting the Middle Pleistocene lifeways at Schöningen

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Chipped stone artifacts are a fundamental source of information for reconstructing human behavioral diversity in the past. Traditionally, archeologists have favored the study of large and diagnostic artifacts, at the expense of the small fraction of the stone industry. This is because for a long time researchers assumed that the smaller an artifact is, the less information it provided. This study illustrates the interpretative potential of lithic microartifacts in a case study from the 300,000-year-old locality of Schöningen, in northern Germany. In 2017, over an area of 64 m2, the team excavated an almost complete skeleton of an extinct Eurasian straight-tusked elephant at Schö 13 II-3. Here, we recovered several dozen small and microartifacts, most of them between 5 and 15 mm, along with 4 pieces of angular debris and 3 natural fragments. Hominin activity is also testified on the spot by three bone retouchers used for flint knapping, all from the immediate vicinity and in close association with the elephant bones. We applied a holistic approach including morpho-technological analysis, experimental archeology, use-wear analysis and optical coupled with spectroscopic residue analyses for: 1) characterizing the flaking attributes on the knapped products; 2) determining the use of the microflakes, 3) testing the potential of microartifacts for reconstructing site function; and 4) reconstructing technological and functional activities performed at the location of the elephant. Our comprehensive techno-functional analysis shows that small and microflakes at Schö 13 II-3 are resharpening flakes. Several resharpening flakes show traces of processing woody materials on their striking platforms, which correspond to the former working edges of tools. Microscopic residues compatible with vegetal tissues adhering on these platforms and sticking to the dorsal retouch scars corroborate this observation. Additionally, hominins used a sharp-edged, natural fragment of flint to process fresh animal tissues, which likely originates from butchering the elephant. These results provide evidence for curational behavior while documenting the production and/or maintenance of wooden tools. Moreover, they demonstrate the coexistence of curated and expedient technological behavior by the Schöningen hominins ca. 300,000 years ago. This study proves that use-wear and residue analyses of microartifacts provide valuable information concerning tool use and technological activities. This is especially important in contexts where no formal tools are recovered or at sites characterized by low numbers of lithic tools such as Schöningen. In this regard, our example opens new perspectives for reconstructing hominin behavior based significantly on the recovery of small and microartifacts.

Poster Presentation Number 90, Session 2, Friday 18:15

A CT-based comparison of 3D scapular morphology in hominids

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The aim of this study was to develop an image-based protocol for quantifying three-dimensional (3D) differences in scapular morphology of hominids with the purpose of identifying morphological traits that may be linked to the development of rotator cuff tears (RCT) in humans.

Although degenerative RCT in humans are frequent, and their occurrence has been found to correlate with scapular morphology, RCTs have not yet been reported in non-human great apes. We hypothesize that differences in scapular morphology between humans and great apes may be a reason why RCTs are not observed in great apes.

Using dedicated image processing software (Mimics, Materialise, Leuven) 3D reconstructions were made of CT and surface scans of a total of 69 scapulae from *Homo* (n=20), *Pongo* (n=13), *Gorilla* (n=16) and *Pan* (n=20). On these 3D bone meshes, the inferior glenoid plane was determined and subsequently a number of bony landmarks on the scapula, the coracoid, and the acromion were defined. These landmarks permit the measurement of seven angles that characterize the 3D morphology of the scapula, more specifically: the delto-fulcral triangle (DFT), comprising the alpha, beta, and delta angle, the acromion-glenoid angle (AGA), the coracoid-glenoid center-posterior acromial angle (CGA), the anterior and posterior tilt of the coracoacromial complex. The DFT characterizes the coracoacromial complex and thus subacromial space, while the AGA represents the acromial overhang. The CGA defines the width of the coracoacromial complex. The orientation of the coracoacromial complex was defined using the anterior and the posterior tilt of the CGA.

The main differences in DFT were found between humans and the great apes, with minor differences within the great apes. The DFT of humans is on average lower compared to that of the great apes ($p \leq 0.008$), with the smallest alpha (32.7° ±4.5°), smallest delta (45.7° ±3.9°), and highest beta angle (101.6° ±6.2°) of all hominid genera. The DFT of chimpanzees is on average higher compared to that of humans ($p \leq 0.008$), with a larger alpha (37.6°± 6.2°) and delta angle (54.5° ±3.9°), and smaller beta angle (87.9° ±5.0°). For the other angles, we found significant differences between humans and, respectively, gorillas (AGA) and orangutans (CGA), but also between the great apes. The mean AGA of humans (59.1° ±6.4°) is significantly smaller ($p<0.001$) than in gorillas (68.8° ±5.9°), and this angle is also significantly different between chimpanzees (61.5° ±7.7°) and gorillas ($p=0.008$). The mean CGA of orangutans (92.9° ±11.4°) is significantly lower than that of humans (110.1° ±8.3°), chimpanzees (117.1° ±8.3°) and gorilla (114.9° ±8.8°) ($p<0.001$). Humans and gorillas are characterized by a posterior tilt of their coracoacromial complex, while chimpanzees show mainly an anterior tilt. The coracoacromial complex of the orangutans was not tilted anteriorly or posteriorly.

Medical image-based methodology was used to quantify the 3D morphology of the scapula, allowing the identification of morphological features that differ significantly between humans and great apes, but also between great apes. We could demonstrate that modern humans are characterized by a lower subacromial space which, combined with other morphological features, could contribute to a high prevalence of degenerative RCT [1-2]. These findings create a window of opportunities for further investigation into the functional implications of differences in scapular morphology and the development of degenerative RCT.

The authors would like to express their appreciation to Jimmy Saunders for his authorisation to scan the nonhuman cadavers at the faculty of Veterinary Medicine, University of Ghent. In addition, we would like to thank the collaborating zoos (Dierenpark Amersfoort, the Netherlands; Royal Zoological Society Antwerp, Belgium; Pairi Daiza, Belgium; ZooParc de Beauval, France) for providing access to their deceased primates or to CT scan images of their primates. Particular thanks go to dr. Emmanuel Gilissen from the Royal Museum for Central Africa, Belgium, for providing access to the invaluable collection of primates of the institute.

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Poster Presentation Number 61, Session 2, Friday 18:15

Saint-Prest (northern France): further evidence of human presence in north-western Europe around 1 My?

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In the middle of the 19th century, numerous bones of large mammals (*Mammuthus meridionalis*, *Hippopotamus antiquus*, *Bison schoetensacki*, *Pachycrocuta brevirostris*...) were discovered at Saint-Prest, in a quarry in the Eure valley, north-east of Chartres. For palaeontologists, this site remains a reference as several types have been described there such as *Cervalces carnutorum* and *Trogontherium cuvieri boisvilletti* or *Mammuthus meridionalis depereti*. More recently, a geological and taxonomic revision has been carried out confirming the attribution of the faunal assemblage to the epi-Villafranchian, between 800 ky and 1.2 My [1].

However, one question remains unanswered: is there a human presence on the site? As no human remains have been found, they can only be attested by indirect evidences: artefacts and/or cut-marks on animal bones. The latter were described as early as 1863 by E. Desnoyers [2], giving rise to lively debates that led to mistrust of the site and ultimately to its being forgotten.

As part of a multi-disciplinary research program, we sought to locate the collections dispersed in various public and private institutions and conducted an archaeozoological analysis of the material identified [3]. Concerning the lithic material, only the 4 flint flakes published by the Abbey Bourgeois [4] and now preserved in the Musée d'archéologie nationale, could be discussed to assess human passages. Concerning the fauna, out of about 600 fossils examined, 5 to 10 traces could be considered as anthropic cut-marks.

The evidence is therefore scarce to attest a hominin presence in Saint-Prest around 1 Ma. However, in the pene-contemporaneous sites, particularly around the Mediterranean basin and in the Yunxian site in China, traces of cut-marks are often rare as well.

Thus, the Saint-Prest site, along with those of Happisburgh 3 and Pakefield in UK, could testify the earliest human occupations in Western Europe in their northernmost extension.

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Pecha Kucha Presentation Session 2, Thursday 11:30-11:55

An ecological driver factor caused the spatiotemporal patterns of Neanderthal disappearance in Iberia

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The replacement of *H. neanderthalensis* populations by Anatomical Modern Humans (AMH) is a turning point in human evolution. An increasing number of researchers point out that the abrupt climatic shifts during Marine Isotope Stage (MIS) 3 played a key role during the Middle to Upper Palaeolithic transition. Nevertheless, the underlying mechanisms linking climatic changes and the spatiotemporal patterns of Neanderthals' disappearance are still unknown. Due to its widely investigated and rich archaeological record, Iberia offers a suitable setting to assess this role. In this study, we quantified the effects of the stadial and interstadial conditions during the MIS 3 on the productivity of the ecosystems and analysed its association with the spatial and temporal replacement patterns of the Mousterian by the Aurignacian technocomplexes in Iberia. First, we used summed probability distribution to assess the evolution of the frequency of archaeological assemblages through time, optimal linear estimation models to estimate the first/last appearance of each culture, and Bayesian age modelling to reconstruct an updated timescale of the transition. Second, we validated a palaeoclimate general circulation model with pollen-based reconstructions and used it as input in a generalized dynamic vegetation model (LPJ-GUESS) to estimate the Net Primary Productivity between 55 and 30 ky BP in each archaeological and paleontological site. Lastly, we developed a macroecological model validated with present-day observations to calculate herbivore abundance. Results obtained indicate that, in Northern and hinterland Iberian areas, the end of the Mousterian was coeval with a significant drop in the available biomass for secondary consumers. However, the Mediterranean region had more stable conditions and, during the cold stadial moments, sustained higher biomass of medium and medium-large herbivores. Accordingly, we propose an ecological driver factor for the hiatus between the Mousterian and Aurignacian in Northern Iberia, and the longer persistence of Neanderthals in the Thermomediterranean region.

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Poster Presentation Number 26, Session 1, Thursday 18:15

New contributions from the spatial statistical analysis of archaeological remains to the formation history of Level 3 at the Neanderthal site Cueva Des-Cubierta Cave in Pinilla del Valle, Spain

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The Neanderthal site of Cueva Des-Cubierta Cave (CDC, Pinilla del Valle, Madrid, Spain) has yielded an anomalous archaeological assemblage in level 3, characterized by the presence of Mousterian industry, an anthropically modified faunal record dominated by cranial remains of large ungulates with defensive cranial appendages [1-2], and the existence of abundant remains affected by fire. The unusual characteristics of the site stress the need to investigate and evaluate the site's integrity. Spatial statistical analyses are proving to be of great use for interpreting site formation processes at archaeological sites. Cave contexts, such as the one presented here, represent a greater challenge than open-air sites given their sedimentary characteristics, however powerful tools exist that help expose hidden associations in the spatial distributions of archaeological remains. Here, we present an analysis of the spatial point pattern of CDC level 3 in its vertical section, which explores the spatial distribution, varying intensity, and the degree and type of spatial association of dolomitic clasts and different types of archaeological materials, including faunal remains -with particular attention to the cranial remains-, lithic industry, rubefacted limestones, and charcoals. We evaluate Complete Spatial Randomness (CSR), estimate the intensity of the spatial point pattern using kernel density maps, explore the presence of hot spots or areas of high intensity using scan tests, and examine interpoint interaction through the application of the inhomogeneous versions of the K, pair correlation and mark connection functions. All analyses take into consideration several features of the remains, e.g., size and type of the remains or whether they have been damaged by fire. The results suggest notable differences in the distribution of the different types of archaeological remains and natural clasts. The multimodal distribution of archaeological remains with several peaks along the z-axis shows variability depending on the type and size of materials. The spatial pattern of burnt remains presents several hot spots, especially in the case of rubefacted clasts. Interestingly, faunal and lithic remains present contrasting spatial patterns. These differences will be explored in more detail in future spatial analyses that take into consideration additional techno-typological data for the lithic industry and zooarchaeological variables for the faunal remains. Our results support the general stratigraphic integrity of the site and contribute to the interpretation of the formation history of Cueva Des-Cubierta Cave.

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Podium Presentation Session 1, Thursday 9:20-9:40

Genetic link between Aurignacian and Magdalenian in Ice Age western Europe

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Human populations in Europe underwent significant range contractions during the Last Glacial Maximum (LGM) and retreated to southern climatic refugia, which likely had lasting and dramatic effects on the genetic variation of Paleolithic peoples [1-2]. Pre-LGM Gravettian-associated group from central Europe differ genetically from post-LGM Magdalenian-associated groups, whereas the latter have been interpreted as a stemming from a genetic ancestry first found in an Aurignacian- associated individual from north-western Europe [2]. However, the genomic processes accompanying the cultural transition from the Gravettian to the Magdalenian across Europe remains poorly understood. For western and southwestern Europe, this is due to the lack of genomic data from the intermediate Solutrean period (~24-19 ka cal BP), which overlaps the LGM climatic event. Here we present genome-wide data from a Solutrean-associated individual from the Andalusian site Cueva del Malalmuerzo in southern Iberia, which was directly dated to ~23 ka cal BP.

The genetic results of Malalmuerzo (MLZ) individual reveal an ancestry that is different from pre-LGM Gravettian individuals, but that genetically connects an Aurignacian-associated genome (Goyet Q116-1) with post-LGM Magdalenian-related ancestry across Europe. Despite carrying Goyet Q116-1-related ancestry, MLZ is most closely related to subsequent Magdalenian-associated individuals, suggesting the presence of genetic continuity in Western Europe spanning the LGM. In addition, our results confirm the absence of excess shared drift between MLZ and pre-LGM Gravettian-associated individuals from central Europe. This scenario could either be interpreted as a replacement of the Gravettian-associated individuals by Solutrean-associated individuals who carried Goyet Q116-1-related ancestry, or as the absence of central European Gravettian ancestry in Iberia despite the presence of such techno-complex throughout Europe.

The Solutrean techno-complex remained geographically restricted to today's France and Iberia, which renders more plausible the role of southwestern Europe as a climatic refugium for Upper Paleolithic populations during the LGM.

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Poster Presentation Number 11, Session 1, Thursday 18:15

Multi-analytical approaches reveal new human fossils and occupation history of Vogelherd Cave

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Vogelherd Cave is one of the Swabian Jura caves in south-western Germany, known for the earliest evidence of figurative art in the Aurignacian around 43-35,000 years ago. The cave was initially excavated in 1931 and was completely dug out in just twelve weeks. The discovery of ivory figurines from two Aurignacian layers highlighted the importance of the site, and the Swabian Jura more general, in the dispersal of modern humans across Europe. To improve our knowledge of the site, the University of Tübingen excavated from 2005 to 2012 the spoilheap of the old excavations using modern archaeological techniques. Using water screening of all sediment, hundreds of Aurignacian ivory beads were discovered, alongside flute fragments, dozens of new fragments of figurines and many unidentifiable bone fragments.

In this study, we use ZooMS (Zooarchaeology by Mass Spectrometry) to determine taxonomically bone fragments that were water-screened alongside the Aurignacian-type beads. ZooMS is now an established method applied to unidentifiable bone assemblages with the aim of discovering hominin fossils and specimens from other taxa. Although several human remains were unearthed previously from Vogelherd, none of them predated the Holocene.

We analysed 287 non-diagnostic and randomly-selected bone fragments using ZooMS and identified three new hominin fossils. Direct radiocarbon dating and ancient DNA analysis suggests they belonged to three individuals that lived at different times, the oldest one comes from a Magdalenian individual (~16 ka cal BP) while the remaining two fall in the Neolithic period. The former is also the oldest human fossil identified at Vogelherd so far.

Given the limited number of sites in Northern Europe falling between 23-18 ka, the consensus among archaeologists is that of large-scale depopulation of parts of the continent during the Last Glacial Maximum, an interpretation also supported by recent genetic data. While the new fossil lacks precise context, its radiometric age and the identification of two coeval archaeological layers at the site, indicate Magdalenian repopulation of Vogelherd just after the Last Glacial Maximum. Finally, the age of two remaining humans were confirmed by direct radiocarbon dating (~5 ka cal BP) and ancient DNA analysis (Neolithic farmer-related genomic ancestry and mitochondrial DNA haplogroup), respectively.

We compared the dataset from ZooMS (n=243) with the morphologically identified mammal datasets from the first excavations (n=7717) and the backdirt (n=1945). A high success rate on the taxonomic identification was achieved through ZooMS (84.67%) including the identification of higher proportion of hares and woolly rhinos than in the other samples. The overall composition of the ZooMS dataset shares more similarities with that of the first excavation rather than the backdirt one. The results verified ZooMS as an efficient taxonomical method.

This work received support from European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program, the Ministry of Science of Baden-Württemberg, the Senckenberg Centre for Human Evolution and Paleoenvironment and the Archaeological Heritage Office of Baden-Württemberg. We are grateful to Dr. He Yu and Prof. Dr. Johannes Krause of Max Planck Institute for Evolutionary Anthropology for supporting this study.

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Poster Presentation Number 77, Session 2, Friday 18:15

Technological production in the Howiesons Poort: Preliminary results from Nelson Bay Cave

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The HP technocomplex has been central to discussions of the cultural and cognitive capabilities of modern humans and the behavioral evolution of our species during the late Pleistocene [1-3]. Backed artifacts, bladelets, and geometric forms are characteristic of Howiesons Poort assemblages across southern Africa and are argued to encompass early composite tool technology, and may represent some of the earliest projectiles known to date [2,4]. However, we still don't know much about how they were produced or their role in the technological repertoire of people living during this time.

The site of Nelson Bay Cave (NBC), located on the southern coast of South Africa, is a long sequence site with extensive deposits extending from the Holocene into the late Pleistocene. Descriptions of the lithics from NBC were foundational to the first comprehensive descriptions of the MSA [1]. Although NBC is a well-known site, the lithic assemblages have only been studied in detail once to date [1]. Given the bulk of new research work produced in the intervening time, it is necessary to revisit the materials from NBC so that data from the site are comparable to the current body of literature. Because of the large size of the lithic assemblages from the site, we can recognize and quantify technological features and trends related to production methods.

Here, we discuss preliminary results from a sample that is part of a larger study. We provide technological descriptions of production methods used in the Level 6, the oldest unmixed Howiesons Poort layer from NBC and address several questions related to technological decision making. Preliminary results from this study demonstrate two notable features. First, the presence of cores on flakes indicates independent, intentional production of small blades and bladelets separate from sequences used to produce large blanks. Second, evidence in the assemblage suggests large blades were intentional fragmented to produce truncated forms and the characteristic Howiesons Poort segments and geometrics. When these preliminary results are considered, we can establish that raw material constraints do not explain the production of small blanks and tools within the assemblage, and that the observed characteristics likely reflect intentional selection for small blanks and other aspects of technological decision making.

Dr. Teresa Steele, Jamie Kelly, Julia Kennedy, Thomas Volman

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Podium Presentation Session 1, Thursday 9:40-10:00

What the Venus from Willendorf tells us about the dispersal of Gravettian populations

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The Venus I figurine was found on the left bank of the Danube in Willendorf II/Lower Austria in 1908. It evidently comes from an archaeological horizon 25cm below Layer 9 [1], possibly equivalent with Layer 8a (<30.8-29.2 ka cal BP) [2]. The statuette represents a symbolized faceless adult female with exaggerated genitalia, pronounced haunches, heavy breasts, and is made of oolitic limestone which is completely absent in and around Willendorf. The availability of micro-computed tomography (µCT) provided the first chance to investigate the figurine in 3D in a resolution close to thin-sections and microscopy (scans performed at the Vienna Micro-CT Lab, spatial resolution 53µm and 11.5µm).

The analyses revealed that the rock represents an oomouldic limestone, consisting of calcitized ooids with layered, micritic cortex. The leaching of the ooid-nuclei is a result of post-sedimentary meteoric leaching of originally aragonitic ooids. The resulting porous structure is potentially the major reason why the raw material was selected, as it would have facilitated the production process. Six sub-spherical iron-oxide concretions are randomly distributed within the volume of the figurine and correspond in size with hemispherical cavities on the surface. The cavities appear to have resulted from broken-off limonite concretions during the carving process. Scattered shell-fragments of bivalves appear in the scan, one being identified as *Oxytomidae*, suggesting a Jurassic age for the Venus oolite.

Samples from 33 oolite localities from France to the Ukraine and from Germany to Sicily were collected. Some localities could be excluded as possible origin of the Venus raw material based on age, texture, and fossil content. Concordance of grain size distribution of the remaining samples was analyzed using thin sections and Hellinger distances. One locality, Sega di Ala (near Lake Garda, Italy), was indistinguishable from the six samples of the Venus, which all clustered together. In contrast, all localities within a radius of 200km from Willendorf as well as those from Swabia near the Danube displayed either very different grain size distributions, sedimentary composition, or represented Miocene oolites. The second likely locality was found at Isjum in the eastern Ukraine. Russian sites with younger Venus figurines are in its vicinity.

Sega di Ala is located only 16km away from Grotta di Fumane, an important prehistoric karstic cave. Willendorf is very close to Austrian paleolithic sites at Krems-Wachtberg and Krems-Hundssteig. GIS-based simulations [3] have suggested one possible optimal-path route for the migration of Gravettian people between these two clusters bypassing the Alps in the south and moving into the Pannonian Basin. However, a hunter-gatherer group could have possibly crossed the Alps relatively quickly following the major river valleys of the Etsch, Inn, and the Danube. Along this roughly 730km long route, the altitude is constantly below 1000m a.s.l., except for a short distance of ~35km at Reschensee (max. 1530m a.s.l.). Such a crossing of the Alps remains a hypothesis at the moment but should be investigated further.

Long distance travel of artefacts during the Gravettian could already be demonstrated in several cases (e.g. [4]). The Venus I from Willendorf was possibly transported from south of the alpine edge to Willendorf at the Danube, suggesting a dispersal of human groups bypassing, or even crossing, the Alps in the times before the Last Glacial Maximum. While this is the most likely result from our analysis, it cannot be ruled out that the material could originate from the eastern Ukraine, which would indicate a long-term and long-distance diffusion of cultural artefacts from the East to the West. In any event, our results suggest considerable mobility of Gravettian people in the time around 30,000 years ago.

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Poster Presentation Number 49, Session 1, Thursday 18:15

Recovering 300,000-year-old faunal DNA from the Middle Pleistocene open-air site of Schöningen

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Although the Middle Pleistocene represents a pivotal period in the evolution of hominin and animal species, the challenges presented by DNA preservation on this timescale have limited the number of ancient genomes available to study. These have originated almost exclusively from permafrost or cave settings, whereas reports of retrieval of ancient DNA (aDNA) from open-air sites have been extremely sparse.

One such site which has substantially impacted our understanding of hominin evolution is Schöningen (Lower Saxony, Germany). This open-air site is well known for its exceptional preservation, in particular the discovery of wooden spears dated to ~300,000 years ago. The site's late Middle Pleistocene faunal assemblage consists of over 20,000 large mammal remains accumulated from both anthropogenic and natural origins. This large assemblage provides insight into the behaviors and paleoenvironment of archaic hominins, as well as represents an excellent biostratigraphic reference site for the Central European faunal record [1]. Advancements in sampling methods and laboratory protocols justify new attempts of retrieving aDNA from Middle Pleistocene sites, especially at Schöningen considering its excellent bone preservation. Targeted sampling of the petrous portion of the temporal bone has demonstrated to yield higher amounts of endogenous DNA than other skeletal elements, and cutting-edge DNA extraction [2-3] and library protocols have made it possible to retrieve ultrashort (≥25 bp) DNA fragments [4-5].

Here, we present aDNA analyses of ten ~300,000-year-old faunal petrous bones from Schöningen. Initially, specimens were morphologically analyzed and CT scanned. The dense petrous region around the bony labyrinth was targeted for sampling while DNA extraction and single-stranded library preparation were performed according to recently optimized laboratory methods [5]. Shotgun sequencing and subsequent comparison of DNA sequences against modern-day faunal reference genomes revealed that the majority of specimens contain endogenous aDNA preservation, including indications of high damage patterns and short fragment lengths for the aligned sequences. Moreover, the retrieved genomic data allows for taxon confirmation as well as taxon determination, which could be applied to complement and extend morphology-based identifications in the future. Our results demonstrate that animal specimens from Schöningen can be used as source material in aDNA analyses. Moreover, these results push back the known age limitations for aDNA retrieval from Middle Pleistocene open-air sites and potentiate further analyses of other contemporaneous sites.

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Pecha Kucha Presentation Session 11, Saturday 14:40-15: 05

Rethinking the Middle to Later Stone Age transition in southern Africa - new data and perspectives from Eswatini

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The dawn of the Later Stone Age (LSA) and the concomitant end of the Middle Stone Age (MSA) is commonly seen as a major transition in prehistory, though one that remains heavily debated within the archaeological community. Open questions and current discussions focus on principally all aspects of this transition, including basic issues on when, where, why, how and even if it happened. What is not debated is the general relevance of this shift for human evolution: in contrast to the transition between the Middle to Upper Paleolithic period in Europe, the changes in behaviors and cultural innovations seen between the MSA and LSA took place without a replacement of one human species by another, raising important questions on the causes and trajectories of cultural evolution within *Homo sapiens*.

In southern Africa, most archaeological sites suggest an origin of LSA technology after about 30,000 years BP. The single exception is Border Cave situated at the border between South Africa and Eswatini, with surprisingly old dates of ~43,000 BP associated with an LSA-like bipolar quartz assemblage [1-2]. While many researchers now consider Border Cave to represent the early origin of the LSA in southern Africa, these findings lack proper contextualization with regional lithic and chronometric data. Here we pursue the question whether Border Cave provides firm evidence for the source of LSA technology that later spread to the rest of southern Africa which is the currently dominating hypothesis in the field. We also propose an alternative hypothesis in which Border Cave constitutes an isolated case of an early invention of a set of technological traits similar to the later LSA which, however, failed to succeed and did not spread to other parts of southern Africa.

To test between these two hypotheses, we provide new chronometric and lithic data from the site of Sibebe, situated in the highveld of Eswatini only 100 km distant to Border Cave and contextualize these results with nearby localities. Eswatini represents an ideal study area as it features many excavated sites (e.g. [3-4]) but remains understudied and underappreciated, rarely appearing in comparative discussions of the African MSA/LSA. In total we studied 6787 lithics from 20 archaeological levels at Sibebe spanning its MSA and LSA occupations, obtained three new AMS C14 dates and re-calibrated a further six previous radiocarbon ages.

Our analyses at Sibebe identify two distinct groups of MSA lithic assemblages dated to between 43,000-27,000 cal BP by C14, directly overlain by a late Holocene LSA industry dated to 2,000 cal BP. The latest MSA expression at Sibebe dating to ~27,000 cal BP features finely shaped unifacial and bifacial points with abundant shaping flakes and facetted platforms but without any trends towards LSA technology such as more frequent expedient technology, quartz use or microlithization. A comparative review of archaeological sites in Eswatini, South Africa, and Mozambique confirms similar MSA industries post-dating 30,000 BP but finds no evidence for LSA technologies before ~27,000 BP. The findings from both Sibebe and an exhaustive review of relevant sites in the wider area suggest that Border Cave cannot mark the origin of the much later LSA in southern Africa, but rather signifies an early set of locally specific behavioral innovations that was quickly abandoned and only caught on in much later times. These findings have important implications for the origin, spread and maintenance of new technologies and our understanding of cultural evolutionary trajectories in southern Africa and beyond.

We express our gratitude to Hlobsile Sikhosana and the members of the Eswatini National Trust Commission for kindly providing us with access to the SARA collection and workspace at the National Museum Lobamba. We are especially grateful to Ayanda Mabuza, Temahlubi Nkambule, Rosemary Andrade, Celiwe Dlamini and Nomsa Dlamini for their constant scientific and logistic support. Special thanks are due to Bob Forrester for his tireless effort to study and protect the rich cultural heritage of Eswatini and for introducing us to a multitude of sites in the country. We are also grateful to Jörg Linstädter and the German Archaeological Institute for the good partnership over the last couple of years and financial support. This research was funded by the project BA 6479/2-1 of the Deutsche Forschungsgemeinschaft.

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Podium Presentation Session 7, Friday 15:50-16:10

Digital 3D soft tissue reconstruction of the *Australopithecus afarensis* pelvis and leg alongside predictions of muscular leverage

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Soft tissues do not preserve in the fossil record, rather we are left looking at just the skeletal material. Yet, muscles animate the body. They allow an animal to move, walk and run. To understand how an extinct species may have moved, we first need to reconstruct the missing soft tissues of the skeleton with an understanding of volume and the composition within the body. The Australopithecus afarensis specimen AL 288-1 is one of the most complete early hominin skeletons of which has been well-studied since its discovery in the 1970s. Here, soft tissues of the entire pelvis and leg were reconstructed for the first time using a digital polygonal muscle modelling approach [1]. These reconstructed muscle volumes and configurations guided biomechanical modelling of the leg in comparison to that of a modern human. Each muscle's moment arms were computed to ascertain the leverage of the AL 288-1 leg in comparison to that of a human, thus addressing questions regarding the ability and efficiency to move in certain ways. To do so, the freely available Brassey et al. [2] AL 288-1 reconstruction was used. Modifications were first made to the reconstruction of the pelvis, in which the sacroiliac and pubic joints were rearticulated. Specifically, the distance between the ischiopubic ramus was reduced and both os coxae were internally rotated, thus improving sacroiliac articulation. A composite Au. afarensis foot model was created. A 3D polygonal muscle modelling approach was used [1], guided by muscle scarring and by cross sections of Magnetic Resonance Imaging (MRI) scans of a modern human [3]. The latter guided muscular configuration and volume within the body based upon estimates of the size of each muscle's origin and insertion [1]. For muscles in which no scarring on the bone was visible, muscle attachment was estimated based upon published dissection data from Pan troglodytes and Homo sapiens. In total, 37 muscles were created per leg – this total does not differentiate between muscles composed of multiple heads (i.e., the M. extensor digitorum longus). Intrinsic muscles of the foot were not modelled; rather, only 'foot' muscles which crossed the ankle joint were included due to the sparsity of preserved foot material. The polygonal muscles guided each muscle's line of action which was 'threaded' through each muscle's centroid [1], and then fed into an OpenSim biomechanical model. Muscle volume was calculated assuming a tissue density of 1060 kg/m3. The moment arms of each muscle group throughout each joint's range of motion (flexion-extension, abduction-adduction, rotation) were computed, following [4]. These were then compared to that of a human model, in which muscle parameters were collected from published MRI/diffusion tensor imaging scans (n=10 individuals) [3] and used here to generate a subject-specific human model in OpenSim (n=1). This talk will present (1) the muscle modelling approach, (2) a complete soft tissue reconstruction of the Au. afarensis foot pelvis and leg, and (3) the leverage estimates of each lower limb muscle group in comparison to that of a human (i.e., how does peak moment-generating capacity differ between a human and AL 288-1 during hip adduction?). This research was supported by a Leverhulme Trust Early Career Fellowship (grant number: ECF-2021-054) and by the Isaac Newton Trust, University of Cambridge.

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Poster Presentation Number 17, Session 1, Thursday 18:15

More than art and music: mammoth ivory tools from the Swabian Aurignacian

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Within the Aurignacian mammoth ivory played a minor role in most regions. Aurignacian groups mainly used this material for carving personal ornaments. Here we present a case in which ivory represents the preferred material for a wide range of tools. The Swabian Aurignacian is so renowned for its vast assemblages of symbolic artifacts made from mammoth ivory like figurative artworks (e.g., [1-3]) that the wide array of tools made of this material is often overlooked. Recent excavations in the Ach and Lone Valleys of southwestern Germany have documented a rich and varied record of ivory artifacts within a well-stratified context. At Hohle Fels, for example, important finds originate from each of the archaeological horizons (AH) IIe to Vb dating radiocarbon to ca. 35,000 – 42,000 cal. BP. In 2019, the excavation team recovered three massive, elongated ivory tools in AH IV from a single feature, which all show similar modifications to their proximal and distal ends. The excavators interpreted these tools ranging in length between 10 and 23 cm as chisels [4]. The ends of these artifacts preserve heavily battered surfaces with clear parallels described on many other ivory tools from the Swabian Aurignacian [3]. The range of ivory tools is varied and testifies to high technical skills of the Aurignacian people. We have examined other classes of artifacts including points, perforated batons and other tools like scrapers or smoothers to document the wide range of technological applications of mammoth ivory. We also know these tools from Geißenklösterle and Vogelherd. This underlines the common culture in this region during the Aurignacian. Here we present results from experimental archaeology in comparison with macro- and microscopic observations from the Aurignacian artifacts. These results allow us to demonstrate how Aurginacian people used these tools and in doing so, we gain important new insights into the technological repertoire of the early modern humans who initially settled the Upper Danube region.

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Poster Presentation Number 7, Session 1, Thursday 18:15

A new look at the lithic technology of Trou de la Mère Clochette (Rochefort-sur-Nenon)

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First excavated by Julien Feuvrier from 1905 to 1909, Trou de la Mère Clochette is an important site for the Aurignacian of Eastern France, lying along the route to southwestern France along the extension of the hypothesized Danube-corridor and being thus of special interest to the question of the arrival of Anatomically Modern Humans in Europe. It is one of only few Aurignacian sites in this region of Bourgogne-Franche-Comté and contains a rich lithic industry as well as organic artefacts, such as split-based points, two of which were dated to 33,750 ±350 and 35,460 ±250 14C BP respectively [1].

Unfortunately, although the excavation method of J. Feuvrier was advanced for his time, he only distinguished three different layers, consisting of *couche blanche* ("white layer"), *couche jaune* ("yellow layer") and *couche meuble, noirâtre* ("loose, blackish layer"), of which only the *couche jaune* contained palaeolithic artefacts [2]. While the artefacts identified as Aurignacian stem from a *couche ferrugineuse* ("red layer"), which is the lowest part of the couche jaune, no other differentiation of the artefact-bearing layer has been reported. Due to this lack of stratigraphical data, the lithic artefacts must be analyzed based solely on their typo-technology and sometimes on residual sediment on their surface. This has led to a series of different interpretations of the artefact assemblage, especially concerning the backed pieces. Most prominently, they have been identified as Châtelperronian artefacts by Desbrosse [3], or as markers for a Gravettian by Bachellerie and Brou [4].

In the course of a project revisiting possible Châtelperronian sites, taking also into account other possible Châtelperronian points stemming from the Haute-Saône region [5], the artefacts of the Trou de la Mère Clochette have been reanalyzed and studied from a technological point of view. The results of these technological analyses will be presented in this poster, with a special focus on the core technology.

We would like to express our gratitude to Samuel Monier and the Musée des beaux-arts de Dole for giving us access to the Trou de la Mère Clochette collection and for the friendly assistance. This research is part of the DFG project FL 244/7-1.

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Podium Presentation Session 6, Friday 12:20-12:40

Nesher Ramla Unit III: An aurochs mass hunting site in the Levant?

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Large-scale accumulations of bovine (bison or aurochs) remains exist in several open-air, seemingly short-lived deposits in the European Middle Paleolithic, and these are sometimes portrayed as mass hunting sites [1]. Simultaneous killing, and even more so, processing of a sizeable number of large animals may testify to cooperation and communication at a higher scale from what is usually envisaged for the Middle Paleolithic. It could serve as proxy of aggregation events, involving a relatively high number of people from different bands who work together for at least several days. This in turn could lead to inter-group interaction, exchange of knowledge and dissemination of innovations, thus being an important factor in human cultural evolution. However, the identification of mass hunting is not straightforward, typically employing criteria of depositional context, bovine age and sex profiles, and seasonality markers (e.g., [2,3]).

The Levant region, with its rich Paleolithic record, has nonetheless lacked evidence of such large-scale bovine accumulations up to now. Unit III is a distinct ~30 cm-thick layer within the eight-m-thick Middle Paleolithic deposits of the Nesher Ramla sinkhole (ca. 130k BP) in central Israel [4]. Numerous faunal and lithic remains, as well as manuports and combustion features, have been retrieved in this unit in much greater densities compared to the overlying or underlying deposits. The faunal assemblage was created and primarily modified by human activities and is dominated by aurochs and tortoise bones [5]. To test the hypothesis that the aurochs assemblage in Unit III represents a mass hunting event or a few such events, we examined their age, sex, and taphonomy, in conjunction with dental micro- and mesowear and dental stable isotope analysis. We also present and discuss a unique find, a flint chip stuck in an aurochs tibia, with evidence to show that it resulted from a failed hunting attempt.

The sinkhole contains selective body parts, biased in favor of meat- and especially fat-rich elements, and therefore represents transport (presumably from a very short distance) and processing. The classic natural herd demographic profile was not attained, as the Unit III assemblage is heavily dominated by prime-age cows. This could correspond with stampeding a herd column led by these individuals, or with selective transport and processing aimed at the adult individuals. Dental microwear shows low variability, likely representing a single season, but the dental isotope results point at high inter-specimen variability in $\delta 18O$ values, which point to different water sources and unrelated life histories of the hunted animals.

We conclude that Nesher Ramla Unit III is a special activity campsite, likely dedicated to the seasonal hunting and processing of aurochs. Demography and seasonality indicators accord with a mass hunting scenario but do not prove it. Furthermore, recapture evidence and dental isotopic variability cast doubt on the mass hunting hypothesis. We conclude that Unit III evidence seems to accord better with a series of repeated hunting/butchery episodes close in time, performed by small bands of hominins who probably lived in low population density in the MIS 5 Levant.

This research was supported by the Israel Science Foundation (Grant No. 1258/17).

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Podium Presentation Session 6, Friday 12:00-12:20

Nesher Ramla site, late Middle Pleistocene *Homo* technological organization and mobility, and the question of modern and archaic *Homo* interactions in the Middle Paleolithic

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The open-air Middle Paleolithic site of Nesher Ramla, Israel, contains an 8-m-thick archaeological sequence consisting of six stratigraphic units (Units I to VI). All units demonstrate evidence for in situ human activities containing large lithic, faunal, and ground stone tool assemblages, along with hearths and other well-defined spatial features all dated to Marine Isotope Stage (MIS) 5. The stone tool assemblages show similar technological features throughout the site stratigraphy suggesting that the entire Middle Paleolithic sequence represents a single techno-complex. Nonetheless, an array of studies on lithic raw material exploitation, lithic technology and tool use, fauna and use of fire suggest that the function and the importance of the site fluctuated throughout the sequence, but was mainly focused on hunting and exploitation of animal resources. The discovery of late Middle Pleistocene Homo fossils in Unit VI dated to MIS 5e suggests that this archaic Homo chronologically overlapped with H. sapiens in western Asia, found at Qafzeh and Skhul caves.

Lithic analysis reveals that late Middle Pleistocene Homo at Nesher Ramla mastered stone-tool production technologies, previously known in the region only among H. sapiens. The Levallois knapping methods used by Nesher Ramla hominins are indistinguishable from that of concurrent H. sapiens in western Asia. The lithic assemblage of Nesher Ramla is dominated by the centripetal Levallois method, which represents the major technology used in the Levant during MIS 5, and which was traditionally associated with H. sapiens in the region. In addition, the Levallois point production centered on preferential convergent method represents an auxiliary reduction sequence at Nesher Ramla and other MIS 5 sites in the region. Other technologies common in East Africa and Arabia such as discoidal, bifacial and Nubian, are absent at Nesher Ramla and other MIS 5 sites in the Mediterranean Levant. These observations suggest that MIS 5 lithic assemblages in the region represent a single techno-complex that was produced by both, Neanderthal-like archaic Homo and H. sapiens. The most parsimonious explanation for such a close similarity is the socio-cultural interactions between these two Homo populations.

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Podium Presentation Session 4, Thursday 17:10-17:20

The Late Pleistocene human dental remains from Mandrin Cave, France

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Mandrin Cave, located in the southeast of France, near the town of Malataverne, overlooks the eastern bank of the middle Rhône River Valley at an elevation of 225 m. Since 1990, excavations have revealed a 3-m deep stratigraphic sequence containing 12 archeological layers (layers J to B) ranging from marine isotope stage (MIS) 5 to the very end of the Middle Paleolithic, and the emergence of the Upper Paleolithic [1-2]. In nearly all of these layers, except H and J, dentognathic specimens (mostly isolated teeth) belonging to *Homo* were identified so far. Layers I, G and F, dating from ~80 to 60 ka, yielded Mousterian industries and three fragmentary deciduous and permanent tooth crowns (Man15 G 2851, Man15 G 2852, Man21 F 1139), as well as one LLdm2 (Man19 I 948) and one LLM1 (Man98 F 811). Layer E, dated to ~54 ka, marks a radical transition in the archeological sequence, with blades, bladelets and small points belonging to the Neronian culture, which shows manifest similarities with Initial Upper Paleolithic industries from western Asia. Within the well-constrained Neronian Layer E, an URdm2 was found (Man12 E 1300) [2]. The three overlying archeological levels contain Mousterian industries, together with two isolated URdm2 (Man04 D 395, Man04 D 679) in layer D (dated to ~53 ka), a LLdm2 and a LLM3 (Man02 C 983, Man11 C 204) in layer C (dated to ~51 ka), and portions of a mandible and maxilla with 31 permanent teeth belonging to a single individual nicknamed Thorin in layer B (dated to ~50 ka). This nearly complete dentition lacks the ULC, URP3 and URP4, but includes two supernumerary lower molars (LLM4 and LRM4). In total, 41 human dental elements spanning the stratigraphic sequence of Mandrin Cave were studied, representing a minimum of nine individuals, five juvenile Neanderthals, a modern human child and three adult Neanderthals. We analyzed the microCT record of the human teeth and investigated the external and internal structure, including the enamel-dentine junction (EDJ) that is a reliable taxonomic proxy [2], and compared these data with those available for Neanderthals, Late Pleistocene modern humans, and Holocene humans. Among the layer I–F teeth, the better preserved LLdm2 and LLM1 exhibit a complete mid-trigonid crest at the EDJ level and geometric morphometrics indicate that they both have a typical Neanderthal shape [2]. Geometric morphometric analyses of the EDJ shape and talon outline of the Layer E URdm2 unambiguously attribute it to an Upper Paleolithic modern human. Shape analyses of the crown outline of the isolated URdm2s from layer D and of the LLdm2 of layer C show that they belong to Neanderthal children. The morphology of the sub-complete dentition of Thorin from layer B exhibits typical Neanderthal features, with shovel-shaped maxillary central incisors, marked labial convexity on the maxillary lateral incisors that also show a large tuberculum dentale on the lingual aspect of the crown, a well-developed hypocone projected lingually in the maxillary molars, and high root stem/branches ratio (i.e., taurodontism). The presence of the two distomolars is outstanding as they are extremely rare in living humans (around 0.02%) and, to the best of our knowledge, have not been reported in Pleistocene *Homo* so far, though a few occurrences of other kinds of supernumerary teeth have been described in Neanderthal and Paleolithic modern humans [3]. Studies of odontoskeletal anomalies found in early-generation hybrids of living primates display a relatively high incidence of distomolars [4]. Considering that an early incursion of modern humans is recorded at Mandrin Cave ~54 ka and that dispersals are recorded around 48–45 ka [5], it is possible that interbreeding occurred in the region ~50 ka. The site of Mandrin Cave is remarkable as it documents the first alternating occupation of Neanderthals and modern humans, as well as a unique record of various Neanderthal groups during most of the Late Pleistocene.

We deeply acknowledge the Service Régional de l'Archéologie Auvergne Rhône-Alpes and the city of Malataverne that supported the 30 years of continuous field researches in Grotte Mandrin. We thank the many curators and colleagues who granted access to the comparative fossil and recent hominin specimens for scanning, as well as the online sharing platforms of the Nespos Society and ESRF Paleontological database (http://paleo.esrf.eu). We thank Harvard University's Peabody Museum of Archaeology and Ethnology for allowing access to the Ksar Akil collections by L.M. and L.S. For analytical support and microtomographic scanning and sharing of the material, we acknowledge B. Duployer and C. Tenailleau (University of Toulouse); A. Mazurier and R. Macchiarelli (University of Poitiers); M. Honegger (University of Neuchâtel); F. Bon and J. Cauliez (University of Toulouse J. Jaurès); S. Hérouin (Archeological Service of Chartres); R. Lebrun (University of Montpellier); A. Bravin, C. Nemoz, and P. Tafforeau (ESRF Synchrotron); P. Bayle, I. Crevecoeur, R. Ledevin, M. Matu, S. Rottier, and F. Santos (University of Bordeaux); and M. Le Luyer (University of Kent).

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Poster Presentation Number 99, Session 2, Friday 18:15

An integrated approach to the study of long bone morphology and cortical thickness distribution

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Past human populations have been characterized by high levels of mobility in contrast with recent populations. From the literature, the reconstruction of mobility and physical activity levels are performed by measuring the biomechanical performance of long at the mid-shaft [1-2]. Over recent decades it has become increasingly clear how complex is the mechanism of bone modelling and remodelling, and that several factors are involved [1,3]. However, it is still unclear what effect do body proportions, physical activity and sexual dimorphism and age have on long bone morphology. Here, we used geometric morphometrics and morphometric maps of cortical thickness to analyse the morphology and the diaphyseal shape of the tibia and femur from a sample of recently deceased modern humans [4]. The dataset includes information on each individual in relation to sex, age, weight, stature, biomechanical length and occupational level. Despite traditional methods of investigation (analysis limited to a few cross-sections) we extensively analysed variations along the diaphysis by applying *morphomap* R methods [5] which allow to study the entire diaphysis of the bone with a high degree of details. On each of the long bones we extracted 61 cross-sections along the diaphysis from the 20% to the 80% of the total biomechanical length. Each cross-section is defined by 40 pairs of equiangular semilandmarks on the periosteal and on the endosteal contour. The set of 61 cross-sections was used to build a dataset of shape variables and matrices of cortical thickness. A significant correlation by Procrustes ANOVA was observed in both femurs and tibiae with the sex variable ($p=0.026$ for femurs and $p=0.001$ for tibiae). Partial Least Squares analysis shows a statistically significant correlation between age and biomechanical length in the femur. In females we found a strong correlation with age in femurs, but the same result is not observed in males. The different results between the sexes may be related to the occurrence of osteoporosis in women which has a marked impact on the femurs. This suggests that the tibia might be more reliable than the femur in the study of mobility because it is less influenced by age. In this communication, we show the potential of using an integrated approach to the extensive study of the diaphysis combining morphometry and biomechanics. This approach is reliable for assessing diaphysis bone morphology not only in modern humans or archaeological remains but has a great potential interest in paleoanthropological and primate studies in reconstructing past loading history.

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Pecha Kucha Presentation Session 9, Saturday 9:15-9:40

Mapping the spread of blade assemblages from the Altai to the Tibetan Plateau using ecological niche modeling

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The Initial Upper Paleolithic blade assemblages from Kazakhstan, Siberia, and North Mongolia, mostly dated between 48-40 ka cal BP, offer possible evidence for a northern dispersal route for modern humans into eastern Eurasia [1-2]. The blade site of Nwya Devu was recently discovered in the interior Tibetan Plateau and dated as early as 40 ka [3], suggesting a plausible highland extension of the blade technology from the Steppe. Consistent with the dispersal scenario, local antecedents for blade technology in the highland are absent, and laminar technology is rare between the two regions during the Marine Isotope Stage 3. Except for the Shuidonggou site in North China, contemporaneous stone tool assemblages of the neighboring lowlands around the Tibetan Plateau are vastly dominated by the basic core-and-flake technology [4-5]. However, given the adaptive challenges of peopling the harsh environment of the high-altitude Tibetan Plateau, how and why past hunter-gatherers moved up to the region remain unexplained. We note that the environments between the Steppe and the Plateau have many similarities, such as low temperature and humidity, long winters with strong seasonality, and open grassland landscapes. In this study, we consider the hypothesis that hunter-gatherers from the Steppe zone who experienced a set of comparable ecological pressures had more adaptive advantages in the highland over those from neighboring lowlands under the East Asia summer monsoon regime with a temperate climate. To test this hypothesis, we use ecological niche modeling to evaluate the role of basic environmental factors on the geographic distribution of blade-based and flake-based assemblages. Our results show that the temperature and precipitation of Nwya Devu site fall within the range of variations observed among the blade sites from the Steppe. The ecological conditions and lithic tradition of Nwya Devu contrast with the sites in adjacent lowlands. The environmental similarities indeed play a critical role in the expansion of human groups equipped with the blade technology into the Tibetan Plateau. Among the environmental factors tested, temperature turns out to be the strongest predictor for the geographic distribution of the blade technology in these regions. It suggests that the subsistence strategies associated with blades were closely linked to cold adaptation, such as the production of effective hunting tools and hide clothing, which were likely part of the adaptative repertoire that predisposed hunter-gatherer populations from the Steppe to the extreme highland environment.

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