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## 40 kyr old association of Mousterian lithic industry with 20 antler sagaie and two Neandertal milk teeth at Cueva del Conde (Asturias, Northern Spain)

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The Cueva del Conde (or Cueva del Forno) is located in the Trubia valley in northern Spain. An extensive area of the archaeological deposits was excavated by the Count of La Vega del Sella in 1915, but two intact portions of the deposits remained untouched (Galería A y Plataforma). Roughly half of one of them (Galería A) was excavated by L.G. Freeman, who reported Mousterian levels sandwiched between sterile clays (underneath) and Upper Palaeolithic levels (above).

In 2001, new excavations were initiated by our team in Galería A and Plataforma, as well as in the cave entrance, never previously excavated. In these three areas Mousterian occupations were found above the sterile clays deposited on the cave floor (Adán, et al., 2008; Arbizu et al., 2005, 2009; López-García, et al., 2011). To date, the best studied assemblages correspond to levels 10 and 20a in Plataforma (located in the middle of the cave). The lithic assemblage of level 20a is composed of 13,840 items, 9,364 of which are knapping debris and micro debris. Quartzite is the predominant raw material (98%), and there is residual presence of flint and other rocks. All of the raw materials can be found in the immediate surroundings of the site. The techno-typological characteristics of the assemblage allow us to define it as Mousterian. The flake reduction shows a predominance of centripetal reduction schemes, with both Levallois and discoid techniques, although a secondary production of blades, generated through a Levallois-like method, is also present. Formal tool-types are scarce, with straight and convex sidescrapers being the best represented ones.

The level 10 and level 20a together have produced 7,930 macrofaunal remains suggesting a mild climate, with red deer as a dominant species (67%) and, in a lesser amount, chamois, ibex, auroch, roe deer, horse, bear and fox in decreasing order. The presence of 20 deer antler points stands out from levels 10 and 20a. They are short (microsagaie) in most cases, and show a perfectly rounded base. Two human milk teeth were recovered in level 20a, an upper first right incisor (Conde 1) and a lower right canine (Conde 2), that could have belonged to a single individual aged 4-6 years old.

There are three radiocarbon dates for level 20a. Two were obtained by Beta Analytic: one on bone (38,250 +/- 390 yr B.P.) and another on charcoal (37,710 ± 470 yr B.P.). The third date was obtained by the Oxford laboratory (ORAU) on bone, yielding an age of 47,600 ± 3100 yr BP, although the collagen content was lower than ideally required.

The Conde incisor morphology is similar to that observed at Roc de Marsal and Arcy-sur-Cure. It exhibits marked labial convexity, slight lingual shoveling, and some expression of a lingual tubercle. In addition, Conde 1 is larger than all the Upper Paleolithic modern human teeth to which it was compared. Although the morphology of the dci is not particularly diagnostic in Neanderthals, the Conde 2 canine differs from those of Upper Paleolithic modern humans in its marked labial convexity and in the degree of marginal ridge development. The mesiodistal and, particularly, the buccolingual breadths, are within the range of variation in Neanderthals, very close to the Neandertal mean but slightly larger than the Upper Paleolithic mean. The association of antler sagaie, Mousterian lithics and Neandertal fossils at the Cueva del Conde has not been documented elsewhere in Spain.

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*Homo floresiensis*, *Homo erectus* and *Homo sapiens* — a comparison of morphological characters

Debbie Argue &amp; Colin Groves

There are three hypotheses for *Homo floresiensis*. The first is that it is directly descended from an early member of *Homo*; the second, that the remains represent a morphological response to the “Island Rule”, the assumed ancestral population being *H. erectus*, the only known early hominin candidate in South East Asia; the third hypothesis, that *Homo floresiensis* is a modern human with pathology.

We discuss each of these hypotheses; and examine the characteristics that differ between *H. floresiensis* and *H. erectus*, and between *H. floresiensis* and *H. sapiens*. The results of our analyses lead us to favour the hypothesis that *H. floresiensis* is a very early *Homo*. We nevertheless consider the ‘Island Rule’ hypothesis extant, and anticipate further research will shed light on the question. We propose that *Homo floresiensis* is not *H. sapiens*.

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## Micro-CT analysis of the occipital bone of La Ferrassie 8: new data on the internal structure of the suprainiac fossa of a Neandertal child

Antoine Balzeau & H el ene Rougier

In a recent study (Balzeau and Rougier, 2010), we have ascertained the autapomorphic status of the Neandertal suprainiac fossa as a depression showing external bone specificities together with a thinning of the diploic layer with no substantial remodeling nor variation in the external table thickness in this area. A suprainiac fossa with these characteristics is systematically present on Neandertals from the earliest developmental stages on, and since the beginning of the differentiation of the Neandertal lineage. However, our previous study was limited in that we were unable to analyse imaging datasets with a sufficient resolution to detail the structural bone composition in the area of the suprainiac fossa of a young Neandertal specimen.

Here, we present the detailed analysis of the micro-CT dataset (with a resolution of 50 microns) of the occipital bone of the La Ferrassie 8 Neandertal child, who is proposed to be slightly younger than 2 years. The whole extent of the suprainiac fossa, as well as its local irregularities, mainly affect the diploic layer where the three layers of bone are individualised. This new study supports our previous work and illustrates that the internal particularities that make the suprainiac fossa a Neandertal autapomorphy are evident early during ontogeny.

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## Evaluating a possible adaptive shift between the Proto- and Early Aurignacian via Eco-cultural niche modeling.

William E. Banks, Francesco d'Errico, Joao Zilhao & Masa Kageyama

The Aurignacian technocomplex is characterized by temporally and culturally distinct phases. Between its first two such subdivisions, the Proto-Aurignacian and the Early Aurignacian, we see a shift from the use of a single reduction sequence to that of two distinct reduction sequences for the production of blades and bladelets, the appearance of split-based antler points, and a number of changes in stone tool typology and technology as well as in the symbolic material culture.

Radiocarbon ages indicate that the Proto-Aurignacian is situated within a period marked by the presence of two Greenland Interstadials (GI 10 and 9), and the Early Aurignacian falls within the rigorous climatic episode known as Heinrich Event 4.

In an effort to better understand the potential factors behind these cultural changes, we used eco-cultural niche modeling to quantitatively evaluate the relationships between these shifts in material culture and environmental variability.

We employed genetic algorithm (GARP) and maximum entropy (Maxent) techniques to estimate the ecological niches exploited by populations (i.e., eco-cultural niches) during these two phases of the Aurignacian. Eco-cultural niche modeling has been shown to be effective in evaluating whether links exist between an adaptive system and ecological constraints, and identifying cases in which the geographic distribution of a given archaeological population was influenced more by non-ecological factors. This approach has been used to reconstruct eco-cultural niches, identify potential human ranges (Banks et al. 2008a), and explore the environmental influences on material culture and cultural geography during the Last Glacial Maximum in Europe (Banks et al. 2009, 2011), as well as Neanderthal/modern human interactions during the later part of MIS 3 (Banks et al. 2008b).

For data inputs, GARP and Maxent require the geographic coordinates where the archaeological populations of interest have been observed, and a set of raster GIS data layers summarizing environmental dimensions potentially relevant to shaping the geographic distribution of the human populations.

Our occurrence data consist of sites with archaeological remains culturally recognized as either Proto-Aurignacian or Early Aurignacian. Our GIS data layers consist of topographic/landscape attributes (elevation, slope, etc.) and two high-resolution paleoclimatic simulations: a) one used as a proxy for the period that includes Greenland Interstadials 10 and 9, and b) one representing conditions during Heinrich Event 4.

The present study's initial results, which are currently undergoing additional evaluation, appear to indicate that the changes in material culture between the Proto-Aurignacian and the Early Aurignacian are associated with an expansion of the ecological niche exploited by human populations of the latter phase. This eco-cultural niche shift appears to be an adaptive response to the relative deterioration in environmental conditions during Heinrich Event 4.

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## Acheulian lithic variability and its behavioral implications at the site of Revadim, Israel

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Lower Paleolithic lithic assemblages serve as a major source of information reflecting on the behaviour and capabilities of Early and Middle Pleistocene hominins. However, the available data on the Acheulian is still ambiguous, viewed by some as demonstrating a long period of cultural stagnation and technological stasis while others view it as more flexible and innovative than previously conceived (e.g. Hosfield, 2008; Nowell & White, 2010; Stout, 2011).

The multi-layered Late Acheulian site of Revadim provides a rare opportunity to study patterns of continuity and change within the lithic assemblages of the Late Lower Paleolithic period in the Levant. This open-air site was excavated to a large extent (ca. 250 sq.m.) and yielded a wealth of lithic and faunal remains (Marder et al., 2011). The rich lithic assemblages are typical of the Late Acheulian in the Levant, including Handaxes but mostly dominated by flake-production and flake-tools.

Our recent analysis indicated the innovative use of the Levallois technology at the site, supporting claims that prepared core technologies and the production of predetermined flakes were practiced already at the end of the Lower Paleolithic period, alongside handaxe and simple flake production.

Area B at the site is generally characterized by an abundance of Elephant remains and handaxes. Its lithic assemblages includes 27,591 items that were recovered from a 94 m<sup>2</sup> area (total volume excavated is 50.17 m<sup>3</sup>, with an average density of 550 items per m<sup>3</sup>).

In this presentation we will be dealing with a detailed study of specific archaeological contexts from Area B. These contexts are distinct concentrations of finds identified during field work and appear to better represent episodes of human behaviour within the general archaeological palimpsest characterizing the site. We will show that notwithstanding the fact that similar technological procedures were practiced throughout the synchronic and diachronic human occupation, considerable differences in the rate of appearance of specific technologies and artefact-types as well as artefact densities reflect variation in human behavior across time and space. Our claims are supported not only by quantitative data and the presence/absence of specific phenomenon, but are based mainly on comparisons of artefact densities per excavated volume. Following recent claims regarding spatial organization of hominin activities in the Acheulian (e.g. Alperson-Afil et al., 2009) and recent advances in the understanding of Mousterian lithic variability (Delagnes and Rendu, 2011) we will discuss the implication of our results regarding cultural diversity and flexible human behavior at late Acheulian Revadim.

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## Ontogeny of humeral torsion in humans and African apes: is humeral torsion a homology or a homoplasy?

Anna Barros

**Background:** Hominoid primates share a number of features of shoulder morphology (i.e., dorsally placed scapulae, humeral torsion, and cranially directed glenoid fossae) that have generally been associated with use of the upper limb in overhead postural and locomotor activities (Larson, 1988.) Humeral torsion, which refers to the medial displacement of the head of the humerus in relation to the shaft and distal epiphyses, is therefore viewed as a significant diagnostic characteristic in the interpretation of locomotor abilities in fossil primates (Begun 1992, 1994.)

The high degrees of humeral torsion in African apes and humans is considered by some to be a shared derived character and therefore evidence for a knuckle-walking stage in human evolution (Washburn 1971; Richmond et al. 2001; Begun 2004.) Others, however, consider that humeral torsion in humans is an independently acquired characteristic that reflects upper limbs used for manipulation and the need to maintain the hands in front of the body (Larson, 1998 and 2007a.)

**Aims:** In order to investigate whether humeral torsion in African apes and humans is a shared derived character (homology) or, on the contrary, an independently acquired trait (homoplasy) this study compares humeral torsion in *Pan troglodytes*, *Gorilla gorilla* and *Homo sapiens* from an ontogenetic perspective. The assumption being that characters that are homologous will arise through similar developmental processes, while characters that are homoplastic will arise through different developmental processes.

**Methods:** Humeri of infant, juvenile and adult individuals of all species were measured. Human populations of known age were used (Spitalfields collection and Lisbon collection); the ape sample was composed of individuals for which Approximate Relative Dental Aging scores (ARDA) exist, collected from the Powell Cotton Museum (Kent) (Dean and Wood, 1981.) Humeral torsion was measured using 3D surface scans of individual humeri obtained using a Handyscan 3D EXAscan. A method for measuring humeral torsion from 3D scans was devised using Amira software. Statistical analyses were conducted using R.

**Results:** Humeral torsion was found to increase with age in all African ape species and in humans. In chimpanzees and gorillas, humeral torsion was found to adopt adult average after M1 eruption, while in humans, humeral torsion was found to adopt adult average around M3 eruption. Before M1 eruption (before 4 years in apes and before 7 years in humans), there were no significant differences in humeral torsion values between the three species ( $p > 0.1$ .) There were however, significant differences between humeral torsion values of juveniles in all three species ( $p < 0.05$ ) and subadults/adults of all three species ( $p < 0.05$ .) The results seem to suggest that humeral torsion in African apes and humans is phylogenetically conserved and that differences in torsion values arise subsequently to infancy, and are therefore a product of activity during development.

The results suggest that humeral torsion is more likely to be inherited from a common ancestor and that it is therefore a shared derived character (i.e., a homology) between African apes and humans.

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## The sagittal posture of the Kebara 2 Neandertal

Ella Been, Alon Barash, Asier Gómez-Olivencia & Patricia Kramer

A complete hominin spine is very rarely preserved in the fossil record. One remarkable exception is the Kebara 2 skeleton from Israel, representing an almost complete in-situ burial. The skeleton of Kebara 2 poses a complete pelvis, lumbar and thoracic spine, and therefore, it enables us to fully reconstruct its spinal curvatures.

Spinal posture has crucial functional implications for bipedal walking and weight bearing. The curvatures are determined by pelvic morphology and by vertebral and intervertebral disk morphology. The main challenge in reconstructing spinal curvatures in extinct hominins solely from osseous material is deciding how to overcome the absence of intervertebral disks and what reference frame is correct for pelvic orientation.

This paper presents, therefore, a new reconstruction of the sagittal spinal posture of Kebara 2. Recently few studies offered a reliable method for measuring and calculating spinal posture based on osteological material. Peleg et al (2007) demonstrated how to establish sacral orientation within the pelvic girdle. Been et al (2007, 2010) established a method for calculating the lordotic curvature of the lumbar spine and Goh et al (1999) offered a way to reconstruct thoracic kyphosis. Based on these methods, we measured the pelvis and the vertebrae of Kebara 2 and reconstructed its sagittal spinal posture. Using visualization software, we aligned a 3D reconstruction of the original bones onto the spinal curvature.

Our reconstruction is the first nearly full sagittal spinal reconstruction (lacking only the cervical part) of Kebara 2. This reconstruction clearly demonstrates some postural differences between the Kebara 2 spinal curvature and the sagittal curvatures of modern humans: Sacral orientation of Kebara 2 is more vertical compared with that of modern humans; the lordotic curvature of Kebara 2 is clearly less pronounced than that of modern humans; and on the other hand, the thoracic kyphosis of Kebara 2 is similar to that of modern humans.

The Kebara 2 Neandertal skeleton demonstrates an upright erect hominin with a different vertebral morphology and spinal orientation than the modern human shape. This implies that during hominin evolution upright erect posture was achieved through different spinal postures. It also suggests locomotive and weight bearing differences between Neandertals and modern humans.

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## Comparison of dental measurement systems for taxonomic assignment of Neanderthal and modern human lower second deciduous molars

Stefano Benazzi, Cinzia Fornai, Priscilla Bayle, Michael Coquerelle, Ottmar Kullmer, Francesco Mallegni & Gerhard W. Weber

Morphometric approaches for taxonomic discrimination of Neanderthal and modern human dental remains have usually considered the permanent teeth, in particular the molars, neglecting the deciduous dentition. Moreover, as teeth are usually worn, the challenge is to include worn deciduous teeth for which the cusp tips are obscured, the occlusal grooves may no longer be visible, and only the lateral wall of the crown is available.

The present contribution evaluates various parameters gathered from the lateral aspects of the crown for taxonomic assignment of Neanderthal and modern human lower second deciduous molar (dm<sub>2</sub>). These parameters include the crown diameters, the height of the lateral wall of the crown (lateral crown height = LCH), the lateral enamel thickness, and the dentine volume of the lateral wall including the volume of the coronal pulp chamber (lateral dentine plus pulp volume = LDPV) in a 3D digital sample of Neanderthal and modern human dm<sub>2</sub>s.

The LDPV and the LCH allow us to discriminate between Neanderthals and modern humans with 88.5% and 92.3% accuracy, respectively. Only 70% of the specimens were correctly classified on the basis of the RET index. Moreover, we also emphasize that results of the lateral enamel thickness method depend on the magnitude of the interproximal wear.

Accordingly, we suggest using the LCH or the LDPV to discriminate between Neanderthal and modern human dm<sub>2</sub>s. These parameters are more independent of interproximal wear and loss of lateral enamel.

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## Early Upper Paleolithic ecodynamics in southern Iberia

Nuno Bicho, Joãoascalheira, João Marreiros & Telmo Pereira

Iberian Early Upper Paleolithic ecology is known mainly from a few relatively confined areas: Portuguese Estremadura (Zilhão 1997), Cantabria (Straus 2002), Catalonia (Mangado et al. 2010), Valencia (Roman et al. 2010) and Eastern Andalusia (Aura et al. 2010, Cortés 2010). The cultural traits from each area seem to stand in isolation and very little research has been done in the intervening lands that would allow linking the early cultural dynamics on the Iberian Peninsula as a whole. The area between Gibraltar and Lisbon was represented by a particularly large gap in Upper Paleolithic occupation. This gap has been filled with the discovery of the rock-shelter of Vale Boi, the first of its kind in the Algarve (southern Portugal) (Bicho et al. 2003, 2010a, 2010b, in press).

This multicomponent site presents a long chronological sequence with Mousterian, Early and Late Gravettian (Marreiros et al. in press), Proto-Solutrean, Solutrean (Casalheira 2010), Magdalenian (Cortés et al. in press, Mendonça 2009), and Early Neolithic (Carvalho 2010). It is very rich in well preserved faunal remains (bone and marine shell). In addition it is marked by a wide array of artifacts including chipped and ground stone, bone tools, and body ornaments (Bicho et al. 2004).

Data analyses indicate a striking combination of cultural traits, including the presence of art, from the Mediterranean and Atlantic areas during the Gravettian and Solutrean phases. This suggests that Vale Boi, located at the western end of the Gulf of Cadiz, lay at the cross-roads of two rather different ecological and cultural worlds – the Atlantic shore known only from Portuguese Estremadura; and the Mediterranean coast well documented from the Valencia and Malaga Spanish districts. Both these areas are at a distance, as the crow flies, of over 300 km. Faunal remains indicate a trend of resource intensification in the forms of expanding dietary breadth and rendering bone grease from the carcasses of large game animals and in the use of marine resources starting in the early Gravettian (Manne et al. 2003, Manne & Bicho 2009), perhaps even earlier in the region (Bicho and Haws, 2008).

Modern theoretical biases in archaeology have led to a marginalization of marine resources and a dismissal of their use by Paleolithic hunter-gatherers (Clark and Milner, 2001). However, Vale Boi as well as other sites have shown that marine resources were likely very important, both for dietary and social reasons (Manne et al. in press). This paper, thus, focuses on the importance of coastal environments and aquatic resources in the economy, subsistence, and social strategies in southern Iberia during the early Upper Paleolithic.

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## Tool use and cumulative cultural evolution in humans and chimpanzees

**Christophe Boesch**

Louis Leakey highlighted the importance of tools to define humans by giving the name “*Homo habilis*” to the first of our ancestors clearly associated with tools. However, since the observation in the early 60s of spontaneous tool use in wild chimpanzees, the debate has shifted towards establishing what in the tool using skills distinguished the two species.

Recently, new observations of large tool sets and complex sequential tool uses in new chimpanzee populations from Central Africa have multiplied and expanded our knowledge of the tool using skills in that species.

Detailed comparisons of different chimpanzee populations reveal a pattern of accumulation of changes in tool techniques that strongly suggest that cumulative cultural evolution has been taking place in that species. Since recently cumulative cultural evolution has been proposed to distinguish human tool use from other animal species,

I present an operational definition of cumulative evolution that allows identifying this process in the field and from tool samples. I will discuss the challenges of identifying and comparing cumulative cultural evolution from human archeological remains with chimpanzee behavioral observations.

## It's possible to find a mathematical algorithm in the morphology of the Mesolithic cores? Algorithms as a tool for a morphological analysis of Mesolithic cores.

Andrzej Boguszewski & Pawel Hitczenko

A core, what is it? Despite of being a refuse of flint-knapping process, cores are in fact among the most interesting and important lithic artefacts. While formal lithic tools were subjects to many kinds of temporary stresses: function, mode, seasonality, use, mending, etc, the production of cores was controlled primarily by only two main factors: the knapping tradition and the parameters of raw materials. In consequence, cores preserve and transmit the basic cultural knapping tradition much better than tools which are subject to rapid morphological changes and modifications. If lithic tools can be used to identify a culture or its chronology, cores carry in their morphology more fundamental information about flint-knapping traditions of their makers. Therefore, it is very important for an archaeologist to decode and to understand this disguised information.

How do we describe cores? When we examine cores we intuitively assume that some of them are similar while others are different. When we try to rationalise this observation, we use different and often incoherent criteria. Here are some examples. A typological description of cores includes: the number of platforms, changes of direction of percussion, type of raw material, flint-knapping techniques, overall shape, etc – some of these criteria (but usually not the same) are frequently employed at the same time by the same author in the same work. This method, or maybe better to say lack of a method makes in many cases a designation "Cores" useless.

The key questions in core analysis are: what is significant and important in core morphology? What kind of objective and easily observable criteria should we identify as common typological features shared in the production of cores? So, what to do? I think that mathematics may offer an answer. The diversity of morphological forms of cores is repetitive, so we can try to find what sort of factors (steps in the core reduction process) contributes to the similarity of forms.

The promising approach in pursuit of such factors, in my opinion, is to search for algorithms in their measurements and proportions. Until now, I have measured over 400 Mesolithic cores from the sites in northern Italy, Belgium and Poland. Every core has been described by 14 distinctive features including 6 metrical measurements, 1 measurement in degrees, 1 qualitative criterion (presence/absence) and 6 coefficients of proportions. All the quantitative features depend on the last knapping direction. When we observe simple cumulative diagrams of each of these features, the peaks and the depressions are – best or worse – present. So, the metrical algorithms do exist! It's a time to find them.

## Integrative analysis of the hip joint: the three-dimensional orientation of the acetabulum and its relation with the orientation of the femoral neck

Noémie Bonneau, July Bouhallier, Caroline Simonis, Michel Baylac, Olivier Gagey & Christine Tardieu

Although numerous primates use bipedal locomotion to some degree, humans are characterized by a permanent bipedalism resulting in strong mechanical constraints on the coxo-femoral joint, especially during one-legged stance. Both stability and mobility are required to ensure a functional interface supporting and transmitting forces between pelvis and lower limbs.

A precise knowledge of this joint has important clinical implications in advancing hip surgery and functional rehabilitation, as well as for physical anthropology to improve our biomechanical understanding from evolutionary perspective. An appropriate 3D orientation of the coxo-femoral joint, composed of the acetabulum and the proximal femur, is fundamental to ensure an efficient bipedal gait and posture. The structure of this joint was explored in our study by analysing the 3D orientation of the acetabulum and its relation with the orientation of the femoral neck. The 3D orientation of the acetabulum is defined in the literature as the perpendicular to the plane that passes along the acetabular rim (Calandruccio, 1987). However, the acetabular rim is not regular (Vandenbussche et al., 2008), suggesting a methodological problem.

An innovative cadaver study of the labrum was developed to shed light on the questions surrounding the proper quantification of the 3D orientation of the acetabulum. Digitalisations on 20 cadavers using a MicroScribe system were performed and data were analysed using a custom-designed library in R.

Our results suggest that the anterior and posterior rims of the acetabulum form an angle of 156.2° on average, rather than being in a same plane. The value and the orientation of this angle allow us to predict ( $p < 0.001$ ) the orientation of the labrum, a fibrocartilage not present in fossil material.

Moreover, biomechanical explanations of the irregularity in the acetabular rim were investigated (article in prep.). An accurate determination of the 3D orientation of the femoral neck requires a consideration of its complex architecture reflecting the biomechanical constraints induced by bipedal locomotion. The neck morphology results from 1) the medial and arcuate trabecular systems of the trabecular bone (Skuban et al., 2009) and 2) the strong asymmetry of the cortical bone (Lovejoy, 2005).

Given these considerations, we suggest to model the femoral neck using two cylinders. Sixteen paired femora were used to evaluate this method. The surface geometry of the femoral neck was acquired and was subsequently used to fit one or two cylinders. The model based on two cylinders provided a significantly smaller standard deviation than the one based on a single cylinder ( $p < 0.001$ ) and reduced the intraobserver measurement error. Based on these results, a mathematic tool has been developed to propose a semi-automatic determination of the 3D orientation of the femoral neck (article in prep.).

The co-variations of the 3D orientations of the acetabulum and the femoral neck were described based on geometric morphometric techniques using a large sample of modern human skeletons. Currently, we are expanding our study on a sample of juvenile human and adult great apes skeletons.

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## Deciduous molar morphology of living hominids and South African fossil hominins

Silvia Bortoluzzi, Silvia Boccone & Jacopo Moggi Cecchi

The analysis of the morphological details of the dentition is useful when identifying fossil remains, and it also allows to delve into the phyletic relationships among extinct and extant species. The morphological variation of the deciduous teeth in living and fossil hominids is still relatively poorly known and, moreover, there are very few published comparisons among species.

In this paper we present a first study of deciduous molar crown morphology (maxillary and mandibular) of South African fossil hominins. South African fossil hominin sites are very rich in dental remains and deciduous dentition is well represented. We examined juvenile specimens of *A. africanus*, *P. robustus* and South African early *Homo*. A large sample of great apes and modern humans has also been studied as a comparative group. The total sample studied consists of 1324 teeth; we examined 7 dm1, 23 dm2, 7 dm1 and 17 dm2 of South African fossil hominins (*A. africanus*, *P. robustus* and early *Homo*); as a comparative sample we analyzed 225 dm1, 220 dm2, 273 dm1 and 429 dm2 of great apes (*Pongo pygmaeus*, *Pongo abelii*, *Gorilla gorilla*, *Gorilla beringei*, *Pan troglodytes* and *Pan paniscus*) and 23 dm1, 27 dm2, 34 dm1 and 40 dm2 of humans (Europeans and South Americans).

We analyzed 2D digital images of occlusal molar surface, measuring different metrical variables such as diameters, cusp areas and occlusal polygon areas. Moreover, with the intent to describe the overall morphology of the crown we also scored some nonmetrical features. Metric and non-metric variables have been studied to evaluate and quantify inter- and intraspecific differences of the tooth crown morphology. All the species considered are dimensionally distinguishable. Furthermore, statistical analysis of metrical and discrete variables allow in many case to differentiate among groups, for example, is possible to separate the African apes from the Asian species.

Differences in molars shape allow to discriminate fossil from living species, and also species within the same genus and populations within modern humans. In particular, morphology of first deciduous molars is very variable among the examined taxa. The crown of first deciduous lower molar is completely molariform in hominins whereas in apes more than three cusps are never present. First upper deciduous molar crown morphology is molariform in fossil hominins, with four main cusps well developed, whereas in humans and apes the crown is divisible in two main parts, variably developed in the different species. Second molars, upper and lower, present a more conservative shape in all the species. The main cusps are always well developed and accessory cusps are more frequent in hominins. Shape of the occlusal polygon varies markedly between examined genera.

## The Sungir' - Strelecka techno-complex, representing the oldest stage of Eastern European Upper Palaeolithic

**Gerhard Bosinski**

The finds of Sungir' are placed in the upper part of a humic soil largely affected by solifluction and cryoturbation. The burials were well under this soil and undisturbed. The lithic industry is characterized by triangular Sungir' points, short endscrapers, burins on broken blades, leafpoints, sidescrapers, and splintered pieces. Other sites of the Sungir'-Strelecka group are Kostenki I, 5 (Poljakov), Kostenki VI (Strelecka), Kostenki XI, 5 (Anosovka 2), Kostenki XII, 3 (Volkov), Garči in the Perm region, and Birjuč'ja Balka near Rostov. The stone artefacts of these sites are identically and could also be classified as the final stage of Eastern European Middle Palaeolithic.

The 14-C dates from Sungir' and the other sites are very heterogeneous, at Sungir' between 14000 and 28000 B.P. Chronologically more reliable are ashes from a volcanic eruption (Campanian Ignimbrite/Y5) in the Naples region 38000 – 41000 years ago. At Kostenki VI (Strelecka) and Kostenki XII (Volkov), apparently also at Kostenki I (Poljakov) these ashes are younger than the Sungir'-Strelecka group, at Kostenki XI (Anosovka 2) they seem older. At Kostenki I (Poljakov) the Aurignacian overlies the Sungir'-Strelecka level. At Kostenki XIV (Markina Gora) the Aurignacian is contemporary with the volcanic ashes. The Sungir'-Strelecka techno-complex is very homogeneous and due to stratigraphy older than the Aurignacian. The ivory statuettes with their vague outlines represent the precursors of the Aurignacian statuettes. From Sungir' are also small flat pebbles with a perforation which often is placed aside the axe of symmetry. Likely these pebbles were originally painted and used as pendants, as well as the two "horses" of ivory which are perforated at their hind legs. Indeed the statuettes from Sungir' seem to illustrate the decisive step from a selection of natural objects (pebbles) to the creation of sculptures in ivory.

## Modeling the impact of climate on the pattern of human population expansion in Iberia during the Last Glacial Maximum

Ariane Burke, Colin David Wren, Andre Costopoulos & Guillaume Levvasseur

The “Groupe d’Etude des Dispersions d’Hominidés” was formed in 2008 to investigate hominin dispersals. Here we present recent research designed to assess the impact of environmental change on the pattern of population expansion after a period of initial colonisation, using the archaeological record of the Iberian Peninsula as a test case.

In this research, we use agent-based modelling and a high-resolution climate simulation to test the impact of climate change on (i) regional environments and (ii) the rate of expansion of human populations during the Late Glacial Maximum.

The effects of climate change on regional environments during the onset of full glacial conditions in the Iberian Peninsula is a hotly debated topic (d’Errico and Sánchez Goñi, 2003; d’Errico and Sanchez Goni, 2004; Carrión 2004; Finlayson and Carrión, 2007; Sepulchre et al. 2007). Our research helps shed light on this debate, and on the relationship between environmental change and early human settlement patterns and population dynamics.

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## Does anterior tooth root size correlate with symphyseal size in Neanderthals and modern humans?

Adeline Le Cabec, Kornelius Kupczik, Philipp Gunz, José Braga & Jean-Jacques Hublin

Anterior tooth root length has been shown to taxonomically distinguish Neanderthals from anatomically modern humans (AMH) (Bailey, 2005). Nonetheless, this could be an allometric effect due to jaw size, Neanderthals being more robust than modern humans. Both groups are known to differ in symphyseal shape in that Neanderthals have a receding symphysis while modern humans present a fully developed chin (e.g. Nicholson and Harvati, 2006; Mounier et al., 2009). Whereas tooth development is complete once the root apex is closed, the jaw bone is still subject to growth processes involving both bone resorption and deposition, and later to remodeling, especially through ageing.

Whether tooth size and jaw size are significantly correlated has not yet been thoroughly investigated in modern humans, and root size in anterior teeth remains largely unexplored. Most of the previous studies have revealed a very low or non-existent correlation between tooth size and jaw size in recent modern humans (e.g. Filipsson and Goldson, 1963; Henderson and Corruccini, 1976).

In the present study, we investigate whether root size of the mandibular permanent incisors and canines is correlated with symphyseal size in the Mauer mandible, Neanderthals (N=13), late Pleistocene AMH (N=4) and recent AMH specimens (N=22). High resolution micro-computed tomography ( $\mu$ -CT) allows for a fine and non-destructive quantification of the dental root and mandibular dimensions (linear, surface and volumetric measurements). In addition, and to complete the understanding of our findings, the cross-sectional symphyseal shape is analyzed using geometric morphometric techniques.

Our results confirm previous studies which suggest that Neanderthals have overall larger roots than recent and Pleistocene AMH, not only in terms of root length but also in root surface area and volume. In contrast, in terms of jaw size, AMH and Neanderthals do not differ significantly in symphyseal height and width. However, Neanderthals have a significantly larger symphyseal cross-sectional area than AMH. Importantly, no significant correlation was found between root size and jaw size in AMH. The same applies for Neanderthals, except in regard to their mandibular canine, for which root size correlates with jaw size.

In addition, the shape analysis of the cross-sectional symphyseal contour further explains the difference in cross-sectional area between Neanderthals and AMH by ruling out any isometric scaling.

As previously shown (e.g. Mounier et al., 2009), the symphyseal morphology of these two groups displays differences in shape attributed to the lack of a chin in Neanderthals, and to an unevenly thick symphysis (strongly developed *incurvatio mandibularis* and chin) in AMH. A number of Neanderthals present some traits which are present in the modern human chin, but without meeting the fully modern symphyseal morphology. Therefore Neanderthals are much more widespread in terms of variability of their symphyseal cross-sectional shape than recent modern humans.

Our study lends support to previous works which show that root length proves to be a meaningful taxonomical tool in distinguishing Neanderthals from AMH. However, further studies including both isolated and in situ teeth are required to better understand the yet non-exhaustively known variability of the Neanderthal anterior tooth root dimensions.

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## Evolving brains, evolving minds

Denise Cappadonia, Serena Trapani & Michele Erlandes

Kluge, i. e. “a clumsy or inelegant – yet surprisingly effective solution – to a problem.” In this way Marcus (2008) has termed human brain, as a product of evolution, because of the coexistence in it of ancient phylogenetic structures with new ones. MacLean (1990) described primate’s brain as formed by three principal phylogenetic structures that have been integrated during evolution. He called these basic types Protoreptilian (R-complex), Old mammalian (Limbic System), and Neomammalian brains.

The heuristic value of this model, for a long time underappreciated, has been revalued by many scholars (Cory & Gardner 2002). The counterpart of the Protoreptilian brain in Mammals is fundamental for genetically constituted forms of behavior as hunting, mating, and forming social hierarchies. The Limbic System is the main seat of emotive behaviors, and it may also be seen as a regulator (mostly inhibitory) of the R-complex, while the Neomammalian brain is the main seat of cognitive and conscious capabilities. Considering the global functioning of the Brain (i. e. the Mind), d’Aquili and Newberg (1999) have considered its primary functional components, which they have referred to as cognitive operators, which have specific functions that are localized in specific regions of the brain and perform activities that underlie the capacities of the mind. Newberg and d’Aquili (2001) have described eight cognitive operators: the holistic, the reductionist, the causal, the abstractive, the binary, the quantitative, the emotional, and the existential ones. As these authors noticed (2001), the cognitive operator concept is clearly “similar to the concept of cognitive modules in that both are functions and are localizable to one or more specific areas of the brain.” ... However, cognitive operators differ from cognitive modules, because cognitive modules represent more specific functions that are localized to particular brain structures, whereas cognitive operators refer to more generalized functions of many areas of the brain: modules are concerned more the anatomy of the brain, operators more the physiology of the brain (or of the encephalon). However brain functions also produce behaviors and unconscious knowledge.

In this paper we extend the operator concept from cognitive ones to encephalic ones. Encephalic operators may be defined as behavioral, emotive or cognitive operators that are specific functions performed by specific parts of the encephalon. In this paper we sketch the distribution of encephalic operators among brain structures and in a phylogenetic view, also comparing these operators with Primary Emotional Systems identified by Panksepp (1998).

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## Dating the Early Upper Paleolithic of Southwestern Iberia: the case of Vale Boi.

João Cascalheira, Nuno Bicho, João Marreiros & Telmo Pereira

Despite the regional long tradition in Paleolithic research, the Early Upper Paleolithic (EUP) record in Southern Iberia is still very unclear. This fact seems to result from three main reasons: most materials come from old excavations, carried out before 1980; very few long stratigraphical sequences in situ with organic preservation; and thence, just a few archaeological deposits securely radiocarbon dated (Peña, 2009; Villaverde et al., 1998). In this context, the Paleolithic site of Vale Boi (southern Portugal) provided, over the last decade, relevant data for the development of a controlled cultural and absolute chronology and a refined regional model for the first Anatomically Modern Humans (AMH) occupations in Southwestern Iberia.

Combining an open-air and a rockshelter component, Vale Boi presents a fairly complete diachronic record, with important levels of Late Mousterian, Gravettian, Proto-Solutrean, Solutrean and Magdalenian, most of them containing very rich and well preserved assemblages of lithic and bone tools, faunal remains (bone and marine shells), body ornaments, charcoal, and mobile art (Bicho et al., in press; 2010). In fact, the unique organic richness and preservation of the site, together with the relatively pristine state of the deposits, allowed the AMS dating of a set of more than twenty samples on charcoal, shell and bone.

Among these results there is the earliest Gravettian dated occupation in Southern Iberia, c. 28ka BP, marked by the presence of a particular type of projectile: a bipointed and doubled backed bladelet (Marreiros et al., in press). This poster, thus, will focus on the radiocarbon sequence for the Early Upper Paleolithic of Vale Boi, and its contribution on the discussion of the Middle to Upper Paleolithic transition in Southern Iberia.

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## The Bifacial Shaping Strategies during the Acheulean at Melka Kunture (Upper Awash, Ethiopia): the Early Middle Pleistocene sites of Simbiro III, Garba XIII and Gombore II

**Carmine Collina**

The Melka Kunture archaeological complex has been uncovered since the 1970s and is located in a demi-graben depression that belongs to the Upper Awash Basin on the Ethiopian Plateau. This area provides evidence of a human occupation of this part of the Upper Awash Valley between the end of Olduvai Polarity Subzone and the BMR at least. In this paper we will present the new archaeological data from the excavations and the surveys carried out by the Italian Archaeological Mission all over the last five years in the Acheulean sites of Simbiro III, Garba XIII and Gombore II.

A technological study, based on the concepts of chaîne opératoire and raw material economy, has been carried out in order to identify the bifacial shaping strategies in the lithic complexes of these sites.

The selected sets of artefacts show the variability and complexity of the technical behaviors associated to the productions of bifacial artefacts. The study reveals new data about the bifacial shaping strategies adopted at the beginning of the Middle Pleistocene in Ethiopia.

## Excavations at the MSA shell midden of Hoedjiespunt, South Africa: testing models for early coastal adaptations

Nicholas J. Conard, Andrew W. Kandel, K. Kyriacou, M. Will & J.E. Parkington

New excavations at the Middle Stone Age (MSA) shell midden of Hoedjiespunt 1 (HDP1) on the West Coast of South Africa are shedding light on the evolution of coastal adaptations and MSA innovations. HDP1 dates to the last interglacial and provides a good case study for testing models about the importance of marine resources with regard to human evolution. Our analysis documents three main phases of occupation, each containing abundant lithic artifacts, shellfish, terrestrial fauna, ostrich eggshell and ochre. Some of these materials are burnt. While these deposits are not shell middens in the strictest sense, they do contain significant amounts of shellfish.

The details of each archaeological horizon vary, but the basic cultural signature remains constant throughout the deposits. The lithic assemblage is characterized by about 80% chipped quartz and roughly 20% silcrete and other raw materials. The lithic assemblage shows complete, bipolar and hard hammer, reduction sequences for the locally available quartz, but highly truncated reduction sequences with many isolated end-products for silcrete and the other raw materials which are clearly non-local. Shellfish exploitation is focused on the acquisition of granite limpets (*Cymbula granatina*) and black mussels (*Choromytilus meridionalis*) with other species present in far fewer numbers. While ostrich eggshell is plentiful, engraved or perforated pieces have not been observed. However, many pieces of ochre show clear signs of utilization. This robust analysis of lithic technology and the exploitation of marine resources by MSA hunter-gatherers of the West Coast of South Africa facilitates the comparison with other early MSA coastal sites such as Ysterfontein 1 and Pinnacle Point Cave 13A.

## Mandibular morphology in humans and chimpanzees: developmental effect of the teeth, the tongue and suprahyoid muscles on the mental region

Michael Coquerelle, Stefano Benazzi, Fred L. Bookstein, Sascha Senck, Philipp Mitteroecker & Gerhard W. Weber

The protruding mental (chin) region we observe in modern humans is unclear in its evolutionary meaning. During human evolution, the mandible shortened, teeth reduced in size, and the mental region became more prominent as the face repositioned beneath the anterior braincase and the vocal tract decreased anteroposteriorly. In contrast, the human tongue is not relatively smaller at birth it is as long and flat as a chimpanzee's, occupying almost the entire mouth.

Our 3D study aims to provide new insights about the evolution and development of the mental region by combining information from the vocal tract musculature (tongue, suprahyoid muscles), the jaws, and the teeth in humans and chimpanzees.

Our sample consists of CT scans of 166 humans and 14 chimpanzees, ranging from fetuses to adults. We use geometric morphometric methods and conjoint measurement to analyze mandibular shape, muscle insertions, and tooth mineralization and position as if over ontogeny.

Our results show that from early fetal stages to birth, the chimpanzee mandible maintains its V-shape, whereas the reshaping of the human mandible involves apposing a shallow U-shaped alveolar process to a V-shaped basilar bone. In the fetal chimpanzee, by contrast with the fetal human, the  $d_{12}$  develop behind the central ones that occupy the most anterior part of the symphysis. The species share a complex combination of phenotypic changes at the symphysis, but at different developmental stages. These include the reorientation of the anterior teeth before their vertical emergence and the forward shift of the basal symphysis, which is associated with the emergence of a symphyseal tuber in chimpanzees during fetal life and a prominent chin in humans early in postnatal life. The inclination of the chimpanzee symphysis is coordinated with the emergence of the  $d_c$ . In humans, mandibular growth and tooth mineralization are tightly associated only prior to  $M_1$  emergence, while the sexual dimorphism of the mental region (a prominence more advanced in males) is not correlated with dentition.

Integrating the muscular insertion into the geometric framework, we show that the reorientation of the anterior teeth and the prominence the mental region are tightly associated with the downward and forward relocation of the tongue and suprahyoid muscle insertions. In both humans and chimpanzees, the forward positioning of the mental region may be necessary for the development of supralaryngeal muscles. In humans, the mental region develops labially from inward to outward, in association with the muscle insertion relocations, contributing to the projection of the mental region and likely contributing to reorientation of the anterior teeth before emergence.

Because of the anatomical and temporal relationships, we interpret the muscle insertion displacements as a result of the tongue shape changes and the lowering of the hyo-laryngeal structures. Initial differences in tooth sizes and positions would be related to the earlier appearance of the U-shaped alveolar process during human ontogeny and the inclination of the symphysis in chimpanzees.

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## Human Adaptations to the Late Last Glacial in Western and Central Europe: The Magdalenian landscape of El Mirón Cave (Cantabria, North Spain)

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Based on the study of the fossils of small mammals biostratigraphically recovered in the Magdalenian sequence of El Mirón cave, in the Asón Valley, Cantabria (Cuenca-Bescós et al., 2009), we reconstruct the landscape of the region during the Magdalenian. This study shows that the beginning of the expansion of the forests began during the Middle Magdalenian, and in the Late Last Glacial, between 15 and 10 kyr BP, there is an important increase in the number of species of forest habitats, with the appearance of new taxa in the sequence. It is remarkable that the increasing in forest taxa does not match a dismissal in open, water or generalist small mammals. Also noteworthy is that our study documents an earlier expansion of the forests, at least in this region, than the one known as the Holocene Optimum.

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## Alternative strategies in Neandertal mobility

Anne Delagnes & William Rendu

We propose a reassessment of Neandertal mobility based on zooarchaeological and technological combined approach, compiled in a database which encompasses all Middle Paleolithic assemblages from south-western France that have been recently analyzed and dated. Our results evidence that the Levallois and laminar technologies, which prevailed during the early stages of the Middle Paleolithic, prior to OIS4, were related to a forager-related mobility system with no selective hunting strategies. By contrast, they relied on a demanding raw material supply, both in terms of size and quality of the knapped nodules. The long and complex reduction sequences that characterize these technologies resulted in single purpose end-products with a short use-life.

At the end of the Middle Paleolithic, the development of selective and seasonally scheduled hunting strategies focused on migratory preys (reindeer and bison) is correlated with the emergence of adapted technologies, specifically the Quina and discoidal-denticulate systems. They both rely on flexible and easily segmentable reduction sequences designed for the production of multi-purpose blanks, which may have been alternately used as tools or cores.

While the Quina system produces multi-purpose and long-lasting blanks that require sizeable nodules of fine-grained rock, the discoidal-denticulate system is characterized by multi-purpose blanks with a less pronounced durability and a greater adaptability to low-quality materials, such as quartz. Thus, they provide alternate responses (durability versus adaptability) to mobility strategies focused on hunting.

In between the Quina and discoidal-denticulate systems, the MTA system combines a long-lasting and highly mobile shaped component, i.e. the MTA bifaces. These essentially were designed for butchery and required high quality raw materials, while the flaked component of this technology was more expedient, less mobile and associated with a non-selective hunting economy.

The alternative strategies developed by late Neandertals do not fit within a linear and gradual evolutionary trend, as is shown by the temporal development of the MTA technological system in between the Quina and discoidal-denticulate systems. Each system reflects an innovative and distinct response to the dietary needs of Neandertal groups and forms a time-limited occurrence. Similar sporadic innovations, whether technological or symbolic, have already been observed throughout the Middle Paleolithic. These innovations do not directly foreshadow the behaviors developed by the first Upper Paleolithic populations. The lack of direct filiation between both complexes is also expressed by the smaller extent of the Mousterian subsistence territories and by the scarcity of lithic or bone weaponry up to the end of this period while they constitute major focus of the Upper Paleolithic production. Nevertheless, the existence of complex subsistence systems as early as the Middle Paleolithic, along with the determining role played by hunting activities in the organization of some late Mousterian groups, echoes a prevailing phenomenon in Upper Paleolithic societies.

## North Black Sea region Archaic Aurignacian complexes with different microliths and their role for Western Eurasia Aurignacian variability and origin studies

Yuri E. Demidenko

A “new breath” for Aurignacian studies in Eastern Europe was brought by new 1990s excavations at Siuren I rock-shelter in Crimea (Demidenko et al. 1998; Demidenko & Otte 2000-2001; 2007). Regarding the site’s Aurignacian content, there were established two Aurignacian industries at Siuren I: an Early Aurignacian of Krems-Dufour type, or, in other terminologies, Aurignacian 0 / Proto-Aurignacian / Archaic Aurignacian with Dufour bladelets for 1920s excavation Lower layer / 1990s excavation Units H and G and a Late Aurignacian of Krems-Dufour type or Aurignacian II – IV / Late / Evolved Aurignacian with Roc de Combe microblades for 1920s excavation Middle layer / 1990s excavation Unit F. Now Siuren I is a key Aurignacian site in Eastern Europe. Moreover, Siuren I is the only site for both Eastern and Central Europe with two different Aurignacian industries having Dufour bladelets and Roc de Combe microblades. Accordingly, there were developed many urgent Aurignacian subjects for East European Upper Paleolithic with support of the Siuren I Aurignacian materials (Demidenko 2003; 2004; 2009).

Now one of the studying Aurignacian aspects is an industrial variability of North Black Sea region Archaic Aurignacian assemblages with different microliths. After re-studies of Archaic Aurignacian assemblages in Russian part of the region (Chulek I site in Lower Don river area; Kamennomostskaya cave, lower layer and Shyrokiy Mys site in North-Western Caucasus), there were established two-fold industrial connections for the region’s Archaic Aurignacian complexes (Demidenko 2000-2001; 2008; 2009).

The Siuren I and Chulek I Archaic Aurignacian complexes have analogies in the West, in European Proto-Aurignacian, while Kamennomostskaya and Shyrokiy Mys Archaic Aurignacian complexes find comparisons in the South, in Levantine Aurignacian A and B, and Zagros Early Aurignacian. Such differently directed comparisons might indeed indicate Archaic Aurignacian *Homo sapiens* migrations to the south of Eastern Europe from western and southern territories. Additional studies of Levantine Early Upper Paleolithic allowed the present author to propose a new hypothesis on local Aurignacian origin in Near East. This is the only region in Western Eurasia with an Upper Paleolithic industry preceding Aurignacian and having some definite Aurignacian features. Accordingly, it is possible to see smooth industrial transitions from such the industry, a facies of Early Ahmarian with some carinated burins (e.g. Erq el-Ahmar, layers E – D; Lagama V, VII, XII; Yabrud II, layers 5 – 4) to Levantine Aurignacian A industry with a share of carinated burins among all burins up to 75% (e.g. Ksar Akil, the 1930s levels XII – XI; Yabrud II, layer 3; Umm el Tlel, secteur 2, locus Sud-Ouest, couche 14'b; secteur 2, locus Nord, couche II2b; secteur 5, couche P1c) and then to Levantine Aurignacian B industry (Ksar Akil, the 1930s level X; Antelias, level IV; Abu Halka, level IVc). The latter industry is proposed to be viewed as a possible initial “industrial source” of Archaic Aurignacian complexes throughout various regions of Western Eurasia.

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## New Excavations at the Grotte des Contrebandiers, Morocco

Harold Dibble, Vera Aldeias, Jean-Jacques Hublin, Zenobia Jacobs, Daniel Richter, Kaye Reed, Denné Reed, Robert Roberts, Dennis Sandgathe, Teresa Steele & Mohamed A. el Hajraoui

In 2007 new excavations began at the site of Contrebandiers, located on the Atlantic coast near the town of Témara, which is one of three sites in the nearby area (the others being El Mnasra and El Harhoura) that overlap in their sequences and that share similar methods of recovery and analysis. Building on the earlier work of J. Roche, the recent work has obtained samples from most of the stratigraphic sequence, from the so-called Moroccan Mousterian to Aterian to Iberomaurusian.

This paper will discuss the earlier industries, which along with the hominin fossils recovered from the site by Roche and the current team, are especially relevant to the origins of modern *Homo sapiens* in North Africa.

## Microanatomical investigation of juvenile remains of South Siberian Neanderthals

Maria Dobrovolskaya & Maria Mednikova

Microstructural studies of fossil remains are rarely conducted, because of their labor-consuming and intrusive patterns. The goal of our study was to describe histological patterns of juvenile bones from Okladnikov Cave (Altai, Russia). It seemed to be necessary for biological age identification and comparison of bone fragments separated in different layers of the cave. It was also important to estimate features of compact bone formation peculiar for this Neanderthal group.

Microscopic sections from juvenile right humerus, right and left femurs were prepared. According to macromorphological estimation, the bones belonged to individuals about 8 years at death (or even to one individual) [Mednikova, 2011]. Samples were taken from shifts at places of muscle attachments with joining medial and distal part of the shaft. Bone samples were put in special rubber and then polished using a Laborol-5 Struers polishing machine and Dia-Pro polishing suspensions with 1 µ diamond grains, and with an OP-U silicon suspension. Firstly, sections were examined in reflected light using an Olympus BX-41 light microscope and were photographed with a Colour View digital camera. The diameters of osteons and Haversian canals were measured with Olympus Cell software (image size 144 µ by 107 µ). The histological patterns in place of muscle insertion were compared with areas far from attachment points. Then investigation was provided by the raster double-ray electronic microscope “Quanta 3D FEG” with electron beam resolution 1.2 nm and 7nm FIB (Ion beam resolution) at 30 kV at beam coincident point, with chamber vacuum 2600 Pa. This step of investigation had pilot character. Standard sputtering of gold by magnetron way for the right femur sample as well as standard thermal sputtering of carbon for the left femur sample was done. Light microscopic examination of samples of humerus and right femur of Okladnikov Cave juveniles estimated some osteon parameters. Three parts of cortical layer were investigated (external, perimedullar and middle). Maximal diameters of osteons were measured as well as osteon number and percent of non-remodeled subperiosteal area of circumferential lamellar bone tissue. Using electronic microscope we focused on femoral samples for both sides. Specifically, we measured concentric lamellar breadth around Haversian canal with magnification 3000 and observed common picture.

Features of Haversian system were determined in limits of modern variations [Martin, Burr, 1998]. Osteon numbers both for humerus and for femur seem to be larger than it was earlier described for adult Middle Pleistocene archaic forms like Boxgrove 1 and Shanidar 2 [Streeter et al., 2001]. The method of the age at death prediction was devised by G. Maat, M. Aarents and Nagelkerke [2005] on the base of remodeling of circumferential lamellar bone tissue in the anterior cortex of the femoral shaft. The main distinguished pattern of Altai juvenile samples is reduction of non-remodeled circumferential lamellar zone.

From our point of view, this is a result of original pathway of the growth. There are clear histological indicators of the faster aging of Neanderthal juveniles in Altai in comparison with modern humans.

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## New associated hominin remains from BK (Upper Bed II, Olduvai Gorge, Tanzania)

Manuel Domínguez-Rodrigo, Enrique Baquedano, Travis R. Pickering, Audax Mabulla, Henry T. Bunn, Charles Musiba, Fernando Diez-Martin, Manuel Santonja, David Uribelarrea, Rebeca Barba, José Yravedra & Agness Gidna

Excavations at the c. 1.2 Ma BK site (uppermost Bed II, Olduvai Gorge) were resumed in 2006. They have resulted in the discovery of a sequence of hominin occupation floors, comprising eight archaeological levels. Some of them provide the earliest evidence of the systematic exploitation of megafauna by hominin foragers. Further, BK preserves the largest samples of hominin-butchered bones from the Early Pleistocene. These large samples allow detailed taphonomic reconstructions of the carcass-processing behaviors of the early hominins who generated them.

In 2010-2011, excavations in BK archaeological Level 4 yielded six hominin teeth, a distal humerus fragment, much of a proximal radius with its shaft and a femur shaft (cataloged collectively as OH 80). Those elements (currently under study) identified more specifically than to simply *Hominidae* gen. et sp. indet are attributed to the genus *Paranthropus*.

To date, incontrovertible *P. boisei* partial skeletons, in which postcranial remains occur in association with taxonomically diagnostic craniodental remains, are unknown in the hominin fossil record. KNMER 1500 is argued to be a female of *P. boisei*, on the grounds on the morphology of its mandibular body (thickness and presence of marginal crest), but this claim is challenged since the same morphology also occurs in *Homo rudolfensis* (Wood, 1991). Thus, OH 80 is the first unambiguous dentally associated paranthropine partial skeleton in East Africa. The morphology and size of its constituent parts suggest the fossils derived from a large individual (significantly larger than KNMER 1500), one who represents one of the most recent occurrences of *Paranthropus* before its extinction in East Africa.

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## Recent advances in the radiocarbon dating of Paleolithic remains

Katerina Douka, Rachel Wood, Fiona Brock & Tom F.G. Higham

The advantages of the radiocarbon method in dating archaeological remains of our recent evolutionary past are well known, as are its caveats; the latter mainly centre on the need for effective decontamination of the samples prior to dating and calibration of the dates to calendar time. These issues become all the more important around the effective limit of the method ( 55 ka BP), a period of particular significance in human evolution. The issue of calibration has been tentatively solved with the publication of IntCal09, an internationally-agreed calibration curve spanning 0-55 ka BP. Pretreatment chemistry, on the other hand, is continuously upgraded. Over the last decade, a suite of methodological advances have improved the chemical and physical cleaning of bone (ultrafiltration), charcoal (ABOx) and shell (CarDS) prior to AMS measurement.

All three methods have been successfully applied in the Oxford Radiocarbon Accelerator Unit in the dating of Palaeolithic material from Europe and the Levant. In this presentation, we will discuss the nature of the technical improvements and present examples where the application of these new pretreatment methods has transformed our views on the chronology of particular Palaeolithic contexts.

## Fauna and habitats in Plio Pleistocene eastern Africa: a multi-species ecomorphological approach

Sarah Elton, Carlo Meloro, Julien Louys, Peter Ditchfield & Laura Bishop

Palaeoenvironmental reconstruction for hominin sites is accomplished on a range of scales (global, regional, local) using a variety of different methods based on both biotic and abiotic evidence. Here, we use postcranial ecomorphological data from several large mammal taxa (primates, carnivorans, and artiodactyls) at the Plio-Pleistocene hominin site of Koobi Fora to characterise regional palaeoenvironments.

Our ecomorphological analysis uses scaled linear measurements in discriminant function analysis to determine habitat preferences in extinct mammals, based on a comparative ‘training set’ of extant animals of known behaviour and ecology. The ‘training set’ comprises multiple species from a family or superfamily, so these analyses can be performed on specimens that are not or cannot be assigned to a species. This method thus gives us the opportunity to assess availability of habitats without having to obtain detailed taxonomic identification from specimens.

Results indicate that even fragmented fossil material holds sufficient functional morphological signals to illuminate habitat preferences and locomotion in primates, carnivorans and artiodactyls. In primates and carnivorans, the humerus (as a whole bone, as well as the epiphyses separately) is especially informative, with relatively small numbers of linear measurements allowing the specimen to be assigned to ‘closed’, ‘open’ or ‘mixed’ habitat. The same is true for the femur in primates and suids.

On the basis of this, we aim to develop ‘in field’ ecomorphic methods that allow rapid assessment of locomotion and habitat preference on key indicator elements from a range of mammalian groups. Using a more extensive dataset comprising multiple postcranial elements, the Plio-Pleistocene data from Koobi Fora indicate that mammals adapted to a range of habitats were present throughout the stratigraphic sequence. For primates, wholly arboreal taxa were much less well represented than open or mixed-habitat species, especially after 2 Ma, although they remained part of the community. Few of the primate species found at Koobi Fora during the Plio-Pleistocene are extant, but the general regional community structure is similar, with arboreal and terrestrial species found in East Africa today. In suids, ecomorphic analysis indicates that open, mixed and closed forms were also found throughout the sequence, and this diversity is again reflected in the modern East African pig fauna, despite species turnover.

Our data support strongly the presence of diverse habitats at Koobi Fora during the Plio-Pleistocene, consistent with a speciose hominin fauna that survived over an extended period of geological time. Nonetheless, the hominins are represented today by a single species. Examining the general trends among several synchronous and probably sympatric mammalian groups will allow the construction of a more detailed picture of the evolution of modern East African mammal communities and will help to pinpoint how, when and why the ecology and behaviour of *Homo* diverged so dramatically.

## Variability of the number of roots in a single biological population of *Pan troglodytes verus*

Edouard-Georges Emonet & Ottmar Kullmer

Dental roots are often preserved in the fossil record, either in isolated teeth or in jaw fragments (Hartwig, 2002). The development of X-ray tomography and micro-tomography during the past decades led to a growing number of studies imaging and describing the dental roots morphology of fossil hominoids (e. g. Kupczik et al., 2005, Brunet et al., 2002 ; Brunet et al., 2005, Kupczik and Dean, 2008; Suwa et al., 2009, Berger et al., 2010). The evolution of the dental morphology was observed and discussed, mainly in terms of the number of roots pro tooth (Kovacs, 1971 ; Wood et al., 1988 ; Kupczik et al., 2005). However, the variability of the number of roots in a species is only known in modern humans, which display an autapomorphic morphology. This lack of data concerning the variability of the number of roots in a biological population of non-human hominoids greatly hinders the interpretation of the observation made on fossils.

The Senckenberg chimpanzee sample offers a unique opportunity to explore the morphological variability in a single biological population and chimpanzees. It is the re-uniting of the Frankfurt University and the Giessen University samples, and contains 403 skulls and 82 mandibles of *Pan troglodytes verus* from Liberia. Since the collection area is surrounded by rivers on three sides, it is assumed that the collection derives from one specific natural population. It includes individuals of all ages, from newborn to late matures. It comprises at least four generations and its sex-ratio is balanced. The variability of this population in terms of root number was measured and compared to other data concerning modern apes. The count of the number of roots was achieved with both external observations, when available, and CT-tomography data analysis.

The resulting variability is very low for each roots, the predominant number of roots for a tooth position being observed in more than 97% of the specimens, except for P/4 (94%), M/1 (89%) and P4/ (57%). No variability at all was observed for lacteal teeth, whether the first molar was yet erupted or not. Furthermore, male and female samples are statistically identical, and no difference linked to size or age (evaluated by the wear pattern) was observed nor statistically significant.

Differences in the number of roots between this sample and other genera of extant hominoids (*Gorilla*, *Pongo*, *Hylobates* and *Homo*) are significant, and the variability of the Senckenberg chimpanzee sample is lower than the variability of any other taxa.

These results support the phylogenetic signal observed in the progressive reduction of the number of roots from early hominins to modern humans.

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## Supernatural agents in human minds: brain mechanisms and triggering stimuli

Michele Erlandes, Denise Cappadonia & Serena Trapani

According to Darwinian Evolution, all human behaviors or thoughts are products of neural (or neuroendocrine) functions in conjunction with inputs that trigger these functions: No function, no behavior or thought; no input, no behavior or thought (adapted from Buss & Shackelford 1997).

Most scholars think that religion, in the basic form we here consider, i. e. belief in supernatural agents, arose, in early humans, from the functions of cognitive “devices” such as the Hyperactive Agent Detection Device (HADD, Barrett, 2000), and the Hyperactive Understanding of Intentionality (HUI) and the Hyperactive Teleofunctional Reasoning (HTR) ones (Pyysiäinen, 2009).

Dunbar (2004) has pointed up that if religion needs a fifth level of intentionality and a grammatical language it could arise only in anatomically modern humans (less than 200,000 years ago), and Rossano (2010) suggests that religion arose in the “African Interregnum” (from 100,000 to 70,000 years ago). From an ethological point of view, religion is a system of rank, implying dependence, subordination and submission to unseen superiors (Burkert, 1996). About the genesis of the ideas of such beings, Morris (1967), updating Freud, has proposed that divine beings resulted from the projection of the figure of the dominant male of a “Single Male” primate group.

However, inferring social behaviour from the sexual dimorphism noticed in fossils, most scholars think that in ancient groups of *Hominini* endowed with low sexual dimorphism (as from *Homo habilis* or *Homo erectus* on), there was not any individual, i. e. dominant male of a SM group, that could act as realistic example of a “Immense Powerful Being/Agent”. How could a projection in a super-human world of such a being have happened? A possible answer is that the human brain preserved (and still preserves) hierarchy forming structures, but they were (up to pre-religious *Homo sapiens*) inhibited or not stimulated. Consequently we can deduce that at some time (presumably in the African Interregnum) hierarchy forming structures has been set free from the inhibitory action of other brain structures, or were triggered to act, as a consequence of a strong stimulus. As this stimulus gave rise to a concept of an unseen agent, it had to be a phenomenon with no empirical cause. We may presume that this “input” consisted in the awareness of being mortal: *Homo sapiens* realized he could die even if no visible agent killed him. In this paper we schematize how this input triggered the action of above mentioned brain “devices” to develop a “Immense Power Agent” concept, and then religions according to ecological, cultural and social environments.

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## The reality of Neandertal symbolic behavior at the Grotte du Renne, Arcy-sur-Cure

Francesco d'Errico, João Zilhão, François Caron, Pierre Del Moral, Frédéric Santos, Hélène Salomon, Michèle Julien, Annie Roblin-Jouve & Francine David

The question of whether symbolically mediated behavior is exclusive to modern humans or shared with anatomically archaic populations such as the Neandertals is hotly debated. At the Grotte du Renne, Arcy-sur-Cure, France, the Châtelperronian levels contain Neandertal remains and personal ornaments, decorated bone tools and colorants, but it has been suggested that this association reflects intrusion of the symbolic artifacts from the overlying Protoaurignacian and/or of the Neandertal remains from the underlying Mousterian.

On the basis of these concerns, three alternatives to the stratigraphic integrity of the Châtelperronian levels of the Grotte du Renne are conceivable: (a) the personal ornaments, bone tools and colorants are Protoaurignacian or later and the Neandertal remains are Mousterian, so the site's Châtelperronian lacked symbolic artifacts and is of unknown authorship, (b) the personal ornaments are Protoaurignacian or later, so the site's Châtelperronian, although made by Neandertals, lacked symbolic artifacts, as the colorants and bone tools may be regarded as functional; and (c) the personal ornaments, bone tools and colorants are Châtelperronian, but the Neandertal remains are Mousterian, so the Châtelperronian may well have been made by modern humans.

We tested these hypotheses against the horizontal and vertical distributions of the various categories of finds (human remains, personal ornaments, bone tools, colorants, colorant processing tools, Levallois flakes, Châtelperron points, racloirs châtelperroniens, Dufour bladelets and their unretouched blanks), and statistically assessed the probability that the Châtelperronian levels are of mixed composition. To test such a probability we estimated, for each hypothesis, the rate parameter that best fitted, according to the Pearson chi square statistic, the transformation between the initial and final conditions. This rate parameter provides the best trade-off regarding objects that have not moved and objects that have moved under the different hypotheses. We then conducted a goodness of fit test to assess the likelihood that the final distribution was generated from the hypothesized initial distributions via the model.

Using the best fitted rate parameter for each hypothesis, we obtained expected final distributions for each find category and probabilities that any given item moved from any given level to another. These distributions were compared with the observed final distributions to assess the goodness of fit of the model associated with each hypothesis. This goodness of fit is measured by the Pearson chi square statistic, which provides a positive measure of discrepancy between the expected and true final distributions of objects.

Having concluded that small scale, generalized displacement failed to account for significant movement in some find categories and none in others, we then calculated, using the Bayes theorem, the probability that items from the key find categories had moved into the Châtelperronian from the overlying Protoaurignacian or the underlying Mousterian under the constraints posed by the distribution of diagnostic stone tools.

Our results reject that the associations result from large or small scale, localized or generalized post-depositional displacement, and they imply that incomplete sample decontamination is the parsimonious explanation for the stratigraphic anomalies seen in the radiocarbon dating of the sequence. The symbolic artifacts in the Châtelperronian of the Grotte du Renne are indeed Neandertal material culture.

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## New insights on Neanderthal demise and its determinants by the way of mathematical modelling

Virginie Fabre, Anna Degioanni & Silvana Condemi

The Neanderthal population is a well distinguished European population which lived and thrive in Europe from MOIS<sub>7</sub> to MOIS<sub>3</sub>. The disappearance of this population about 30,000 years ago is often associated with a demographical crisis whose the causes are strongly debated. Among the current hypotheses, climate, competition with modern humans, demographic differences between these two populations or epidemic diseases have been evoked.

Indeed, the climate deteriorations could have been so strong during MOIS<sub>4</sub> and MOIS<sub>3</sub> that the population confined in refugia never could have expanded again under viable condition, namely with a sufficient population size and a moderate population fragmentation. The competition with expanding Modern humans could be another cause of Neanderthal demise, this competition could have unsettle the smaller and less adapted population. The demographic difference between Neanderthals and Modern humans could be the effect of different fecundities or different timings of maturation which would have favoured Modern humans. Finally, epidemic diseases could have been spread in Europe during MOIS<sub>3</sub> by the way of Modern humans expansion, or with an independent way, causing the Neanderthal disappearance.

In this work I have reconsidered these assumptions and their determinants by using classical mathematical models and by creating new deterministic models more specified to this fossil population. Models are used here because reality is too complex and not enough well known to understand the phenomenon of demographic fluctuation and population extinction. These models are based on predation and competition and the growth rate of human populations depending on the metabolic rate and the hunting and gathering products. For each demise assumptions, new parameters are added for testing the potential likelihood of each one in the issue of Neanderthals extinction. The aim of this work was to check the information given by modelling, in terms of importance of such or such parameters in the extinction process, with the information supplied by classical paleoanthropological, zooarchaeological and prehistorical studies.

The first results allowed us to exclude the assumption of an epidemic disease or a resource competition as a cause of Neanderthal extinction whereas climate, competition in a broad sense, or demographic differences could have led, under specific conditions, to Neanderthal demise. These specific conditions will be discussed during the presentation.

## Preliminary results of recent fieldwork at the Lower Palaeolithic site Happisburgh Site 1, East Anglia, UK

Michael Field, Monika Knul & Wil Roebroeks

Recent discoveries on the North Sea coast in East Anglia, UK have raised questions regarding the strength of former theories on the earliest occupation of the middle and northern latitudes of Europe. Flint artefacts from the Cromer Forest-bed Formation at Pakefield and Happisburgh Site 3 demonstrate that hominins were already present in north-west Europe before 0.5 Ma (Parfitt et al. 2010; Parfitt et al. 2005). These artefacts are associated with a *Miomys* micromammal fauna. The conditions at Pakefield were temperate while those experienced at Happisburgh Site 3 were relatively cool. The sites are located in the deposits of rivers that flowed across a coastal plain into the western side of the southern North Sea basin.

The current Leiden fieldwork at Happisburgh Site 1 consists of a multidisciplinary study of a pre-Anglian (MIS 12) river channel infill, possibly younger than the one at Happisburgh Site 3. At Happisburgh Site 1 the fine grained fluvial deposits contain primary context archaeology and well preserved plant remains. The paper gives a short overview of the preliminary results of the Leiden fieldwork situated within in the wider context of the earliest occupation of this part of Europe.

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## Enamel thickness and dental tissue proportions in modern human upper first deciduous molars

Cinzia Fornai, Catherine Bauer, Stefano Benazzi, Katerina Harvati & Gerhard W. Weber

The morphometric analysis of human teeth for taxonomical purposes is focused mainly on the intensive investigation of permanent teeth, whereas considerably fewer data are available on deciduous dentitions. Only recently, more attention has been drawn to deciduous teeth. However, these studies focused on deciduous teeth are mostly based on traditional morphometric measurements such as mesio-distal and bucco-lingual diameters which do not sufficiently capture tooth morphology to discriminate taxa (Toussaint et al., 2010).

To overcome this problem, three-dimensional enamel thickness and dental tissue proportions have been suggested as useful measurements allowing at differentiating even among closely related species such as Neanderthals and modern humans on the basis of permanent teeth (e.g., Olejniczak, 2008; Smith et al., 2007; 2010).

In fact, even though Neanderthal dentitions show a similar absolute enamel volume as modern humans, it is deposited over a larger volume of dentine, resulting in a lower average and relative enamel thickness (e.g., Macchiarelli et al., 2006). Nonetheless, the intra-specific range of variability for these parameters in milk teeth is currently not known, since only few studies have been published on the subject (e.g., Bayle et al., 2009, 2010; Zanolli et al., 2010).

In this contribution, we undertake a preliminary exploration of the variability of the enamel thickness and dental tissue proportions in the upper first deciduous molars (dm1). The dental sample for the results reported below consists of a total of 15 modern human specimens from European archaeological sites. Only unworn and slightly worn teeth (degree of wear not superior to level 2 according to Smith, 1984) were included in the sample. We aim to enlarge the sample size up to at least 20 individuals.

The specimens were scanned by means of micro-CT (voxel size ranging between 22 and 35  $\mu\text{m}^3$ ) and the volumes of the dental tissues were measured after semiautomatic segmentation of the images. The enamel volume, the dentine volume (including the coronal pulp chamber), and the surface area of the enamel dentine junction (EDJ) were measured following the protocol provided by Olejniczak et al. (2008). These measurements were used to calculate the average enamel thickness (AET: the enamel volume divided by the EDJ surface area; this index is in millimetres) and the relative enamel thickness (RET: the average enamel thickness divided by the cube root of the dentine volume multiplied by 100; this index is scale free).

Based on the primary measurements from human dm1, (enamel volume ( $56.26 \text{ mm}^3 \pm 6.32 \text{ SD}$ ), lateral dentine and pulp chamber volume ( $110.36 \text{ mm}^3 \pm 9.37 \text{ SD}$ ), EDJ surface ( $105.57 \text{ mm}^2 \pm 6.56 \text{ SD}$ )), the average enamel thickness was calculated as  $0.53 \pm 0.06 \text{ mm}$  and the relative enamel thickness as  $11.14 \pm 1.27$ .

These results will serve to build up a data base of subadult specimens for studies of functional anatomy and taxonomy. This data can be further used to evaluate the differences of dental tissue proportions between deciduous and permanent teeth or to distinguish between anatomical modern humans and Neanderthals.

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## Re-Evaluating the Grandmother Hypothesis

Molly Fox

We have re-modeled the predictions of the grandmother hypothesis by examining the genetic relatedness between grandmothers and grandchildren. Boys and girls differ in the percent of genes they share with maternal versus paternal grandmothers because of differences in X-chromosome inheritance.

We have demonstrated a relationship between X-chromosome inheritance and grandchild mortality in the presence of a grandmother. This approach yields more consistent support for the grandmother hypothesis. Additionally, paternal grandmothers may have a detrimental effect on grandsons, according to a wide a cross-cultural analysis.

We show how sexually antagonistic zygotic drive could encourage individuals to help those with whom they are more likely to share genetic material at the expense of other relatives. This new idea has stimulated considerable controversy, and here I respond to this controversy with theoretical frameworks that could explain this phenomenon in light of reproductive strategy and adaptive incentives. These modifications to the traditional grandmother hypothesis provide some evidence that our species' unique post-menopausal longevity may be an X-linked trait.

The analysis may encourage other researchers to include the variation in relatedness beyond Hamiltonian coefficients, especially when considering sex-specific adaptations.

## Middle Pleistocene human facial morphology in an evolutionary and developmental context

Sarah Freidline, Philipp Gunz, Katerina Harvati & Jean-Jacques Hublin

Neanderthals and anatomically modern humans exhibit distinct facial architectures. The patterning of facial morphology of their predecessors, the middle Pleistocene humans, however is more mosaic-like variously aligning them to *Homo erectus sensu lato*, *H. neanderthalensis* and *H. sapiens*.

Facial features that foreshadow the “classic” Neanderthal morphology have been equivocally identified in the European middle Pleistocene humans (e.g., Arago 21, Sima de los Huesos 5, Petralona) but are absent in their African and Asian counterparts. If verifiable, the presence of these “incipient” Neanderthal facial features in European middle Pleistocene humans provides compelling evidence for their inclusion in the Neanderthal lineage and an accretionary model of Neanderthal origins. However, many of these facial features are discrete and not easily quantifiable using linear morphometrics or even traditional landmark-based geometric morphometrics. Additionally, significant changes in facial size and robusticity occurred throughout Pleistocene human evolution resulting in temporal trends in both facial reduction and enlargement. However, it is unclear how size affects facial features. Typical Neanderthal facial features, like maxillary inflation, may simply be a result of their overall larger facial size.

The goals of this study are to evaluate the middle Pleistocene human face in a broad evolutionary and developmental context. More specifically we 1) test to see how well facial morphology separates Pleistocene human groups; 2) seek to identify temporal trends that are potentially informative about ancestral or derived features; and 3) assess the effects of ontogenetic, static and evolutionary allometry on the Pleistocene human face.

The modern human sample (N=259) comprises cross-sectional growth series of four morphologically distinct human populations; their ages range from two years to adulthood. The fossil sample covers human specimens from the early Pleistocene to the Upper Paleolithic, and includes several sub-adult fossil humans.

We digitized landmarks and semilandmarks on surface scans and computed tomography scans and analyzed the Procrustes shape coordinates in shape-space and form-space (i.e. shape and size). One of the major advantages of 3-D geometric morphometrics, and specifically curve and surface semilandmarks, is that it allows researchers to quantify traits otherwise difficult to measure using traditional linear or even landmark-based geometric morphometrics. Complex features can thus be quantified as continuous variables, rather than discrete scores, and included in multivariate statistical analyses.

We show that species and population specific facial features develop before two years of age. Facial features can be used to separate Pleistocene humans into temporal clusters. Some aspects of the early Pleistocene human face are more similar to anatomically modern humans than to the middle and late Pleistocene humans.

Our results indicate the large-scale facial differences between Neanderthals and middle Pleistocene humans are mostly due to allometric scaling along a shared allometric trajectory and that certain features in the European middle Pleistocene human face are more similar to the “classic” Neanderthals than the African or Asian representatives.

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## Human occupation and palaeoecology during late Lower Pleistocene in north-eastern Spain: the key sites of Vallparadís (Barcelona) and Bòbila Ordis (Girona)

Joan Garcia Garriga, Kenneth Martínez Molina & Eudald Carbonell Roura

Research at the Vallparadís site (Barcelona) has demonstrated that Europe was continually populated by humans from 1.4-1.3 Ma to 0.78 Ma and has shown that there was a stable occupation of the site during this period. This is evidenced by the presence of lithic and faunal remains in most levels of a 20 metre stretch of alluvial/colluvial stratigraphy.

The dating of horse molars and quartz grains has established a weighted mean age of 0.83±0.13 Ma (ESR/U-series) for the richest level (level 10). This agrees with the palaeomagnetic analyses, which situate the Jaramillo sub-chron (0.99-1.07 Ma) just below this level. The biostratigraphic studies coincide in that the association of macromammals is Epivillafranchian. Certain large mammals stand out: *Elephas antiquus*, *Hippopotamus antiquus* and *Stephanorhinus hundsheimensis*, some of which have cut-marks. The microfaunal analysis shows that lower molars belonging to *Iberomys huescarensis* are similar to those found at Sima del Elefante (Atapuerca, Burgos) and lend further weight to the dating of the site.

Level 10 has provided a large quantity of Mode 1 tools, particularly in quartz, but also in flint, lydite and quartzite. Small tools were predominantly made by bipolar knapping on an anvil with very little centripetal exploitation and abundant retouched artefacts. They include denticulates that are fairly non-standard and irregularly retouched, and morphotypes such as becs and abrupt retouched tools.

The hominid's primary access to carcasses, the efficacy of their tools and their important social cohesion guaranteed their survival during the end of the Lower Pleistocene. This supports the hypothesis that hominid communities were able to overcome changing environmental conditions and the presence of large carnivores such as *Panthera gombaszoegensis*, *Pachycrocuta brevirostris* and a large indeterminate *Felidae* in Vallparadís, and *Homotherium latidens* in the neighbouring site of Cal Guardiola.

The Bòbila Ordis site (Girona) is known for the extraction of clay from an old quarry and has revealed an important deposit made up of three palaeolakes separated by normal faults with 52 metres of stratigraphic potential, of which the first 17 metres (lake 3) correspond to the end of the Lower Pleistocene. Palaeomagnetic analysis at the contiguous palaeolake (lake 1) dates the site's chronology from the Matuyama-Brunhes reversal (0.78 Ma) and the Cobb-Mountain subchron (1.19 Ma) to the early Matuyama chron, until 2.6 Ma. The site's abundant fossil record has been known since the 1960s and is located in the sections exposed by the quarry (lake 3). Particular important finds are *Hippopotamus amphibius*, *Cervus philisi* and *Equus stenonis*. The microfauna in lake 3 includes *Allophaiomys burgondiae* and in lake 1 *Allophaiomys pliocaenicus*, which suggests that the site is Late Biharian and between 0.7 and 2 Ma.

The pollen record in lake 3 suggests a warm temperature deciduous forest dominated by *Carpinus*, *Quercus* and *Ulmus-Zelkova*. The upper part of the sequence would have been dominated by a mixture of forest and steppe vegetation rich in *Asteraceae Cichorioideae*. Carrying out the first systematic excavations at the site within the frame of our project will enrich current knowledge regarding the continental palaeoecology during the Lower Pleistocene and hopefully add to the still scant archaeological information regarding the first human migrations to Europe.

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## A complete neck from Sima de los Huesos and the evolution of the cervical spine in Neandertal lineage

Asier Gómez-Olivencia, Juan Luis Arsuaga Ferreras, José Miguel Carretero, Ana Gracia & Ignacio Martínez

Traditionally, the cervical remains of Neandertals have been suggested to display “little indication of a form fundamentally different from that of modern human” (Stewart, 1962: 152; see also Trinkaus, 1983; Arensburg, 1991). According to these authors, only a few features, such as the length of the spinous processes of the C5 and the lesser inclination of the spinous processes of C5-C7, seem to be more common in Neandertals than in modern humans.

In order to test the proposed lack of differences between modern humans and Neandertals, we have compared a sample of eight Neandertal males to a sample of 70 modern human males. This study has shown that there are significant metric and morphological differences within the cervical region of the spine of *Homo neanderthalensis* from that of our own species.

We present a complete neck associated with Cranium 5 from the Middle Pleistocene site of Sima de los Huesos (SH) (Sierra de Atapuerca, Burgos). Cranium 5 currently represents the most complete cranium within the fossil record, and all the cervical elements are preserved in a complete or nearly complete fashion. This neck, together with other vertebral remains from SH, provides an opportunity to test whether Neandertal-specific features represent primitive or derived morphologies from their Middle Pleistocene ancestors.

When compared to modern humans, both Neandertals and the individuals from SH share a pattern of marginally significant short necks, with mediolaterally large atlanto-axial junctions, antero-posteriorly long vertebrae at the C4, C5 and C6 level, among other features. The SH specimens stand out for their moderately horizontal and hyper-robust spinous process at the C6 and C7 level. Neandertals exhibit longer, more slender and more horizontally oriented spinous processes in these two vertebrae and as well as wider neural arches.

The lengthening of the spinous processes at C6 and C7 and the wider neural arches could be related to biomechanical changes due to the more encephalized skull of Neandertals. However, more research is necessary to ascertain if the pattern of antero-posteriorly longer cervical vertebrae is related to differences in the curvature of the neck that would parallel the less lordotic lumbar spine found in Neandertals (Been et al., submitted).

The differences in the cervical region between Neandertals, their Middle Pleistocene ancestors from SH and modern humans, are consistent with those found in the lumbar region. Thus, the vertebral column, derived into disparate morphologies within Neandertal and modern human lineages from a primitive pattern different from the former. Finally, Cranium 5 belonged to one of the eldest individuals recovered from Sima de los Huesos (Bermúdez de Castro et al., 2004). Thus, it is not surprising to find evidence of osteophytosis suggesting osteoarthritis at the C5-T1 level.

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## Morphological integration in the hominin dentition: Evolutionary, functional and developmental factors

Aida Gómez-Robles

As the most common and best-preserved remains in the fossil record, teeth are central to our understanding of evolution (Tucker and Sharpe, 2004), including that of hominin species. However, many evolutionary analyses based on dental traits seem to overlook the constraints that limit dental evolution. These constraints are diverse, ranging from developmental interactions between the individual elements of a homologous series (the whole dentition) to functional constraints related to occlusion.

Morphological integration, analysed in this study as covariation in shape between teeth, is the result of these interactions. The relationship between morphological integration and evolution is discussed using an extensive sample of hominin fossils, representing the majority of the spatiotemporal distribution of Plio- and Pleistocene hominin species.

The European fossil record, which is continuous along the whole Pleistocene and includes up to four different species, accounts for a high proportion of the whole morphological hominin variation. Hence, the analysis of a broad sample of original European fossils is fundamental in this study because it aims to explain the variability observed in the complete hominin phylogeny.

Geometric morphometric techniques (rev. in Adams et al., 2004) provide a natural framework to study integration and the covariation among structures. Complementarily, phylogenetic comparative methods (Felsenstein, 1985) allow for the study of integration while accounting for non-independence among samples owing to their common evolutionary history.

This study combines geometric morphometrics with comparative methods (Arnqvist and Rowe, 2002; Drake and Klingenberg, 2010) in order to evaluate both the patterns of integration and the mode of evolution of the complete hominin postcanine dentition.

Classic morphogenetic field theory (Butler, 1939) holds that dental classes are determined by partially independent developmental programs. Nevertheless, the results of this study demonstrate that the claim for independence is not met, as teeth belonging to different classes display significant levels of covariation. These results also show how integration impacts the evolution of the different hominin teeth by generating stasis in elements with strong functional and/or developmental interactions (Polly, 2004; Wood et al., 2007; Piras et al., 2009). Alternatively, directional evolution occurs in the elements with marginal roles in occlusion and mastication (Lockwood et al., 2000), probably in response to other selective pressures.

This study highlights the need to reevaluate hypotheses about hominin evolution based on dental characters, given the complex evolutionary and developmental scenarios in which they have evolved.

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## Evolution of the *Homo sapiens* brain

Dominique Grimaud-Hervé, Antoine Balzeau, Florent Detroit, Benoît Combes, Sylvain Prima & Ralph Holloway

Paleoneurology is a major field of research in paleoanthropology. Evolution of the hominin brain is well documented and a very rich literature has been produced about this topic. However, if we have a rather good overview of the evolution and variation of endocranial anatomy between the different hominin species all along the 7 Ma of human history, extant knowledge on the diversity and modification of the brain among anatomically modern *Homo sapiens* in the last 200 000 years is particularly scarce. Indeed, we only have little information about variations in endocranial anatomy, dimensions and shape in fossil anatomically modern *Homo sapiens*. Evolution of the *Homo sapiens* brain since the emergence of our species until today is poorly documented.

The aim of this study is to document the variation in form, size and shape of the endocast between fossil anatomically modern *Homo sapiens* and extant modern humans. Comparative samples consist in several fossil anatomically modern *Homo sapiens* (Skhul V, Qafzeh 6, Cro-Magnon 1, 2, 3, Mladec 1, Pataud 1, Predmostí 3, 4, 9 and 10, Brno 3, Dolni Vestonice 1 and 2) and 102 endocasts of extant modern humans. This sample includes physical endocasts of the collections of the Musée de l'Homme, Paris, France, or virtual endocasts obtained from imaging methodologies.

Classic metric measures were acquired with callipers, cephalometers on the physical endocasts or on drawings for dimensions quantified in projections. 3D coordinates of landmarks for geometric morphometric analyses were registered with a microscribe on the physical endocasts or virtually on the 3D models.

A decrease in absolute endocranial size since the Upper Palaeolithic was noticeable. We also found that both modern and older endocrania have the same anatomical layout, but nonetheless show differences in the size and organization of different parts of the brain.

These results illustrate that our brain is very plastic, with some areas (frontal and occipital lobes) being more adaptative than others (parietal or cerebellar lobes). That may be due to constraints to maintain an optimal performance while reducing in size and changing in shape.

## Pathological conditions in LB1, the type specimen of *Homo floresiensis*: what difference do they make?

**Colin Groves**

Shortly after the original description of *Homo floresiensis*, claims began to be made that the specimens (the type specimen, LB1, in particular) show significant pathology, and that this even accounts for the described differences from *Homo sapiens*. Claims of this nature – that LB1 is a microcephalic, or more recently, a cretin – have been made persistently up to the present day. In this presentation, I show that LB1 exhibits many pathological conditions, but that these do not by any means alter the morphology in such a way as to mimic a non-sapiens condition; moreover, the other specimens of the species do not show these pathologies, yet their morphology is consistent in all significant ways with that of LB1. There is no doubt that *Homo floresiensis* is a valid species. Its true affinities are the subject of ongoing research.

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## Initial Upper Paleolithic human dental remains From Ucagizli Cave (Hatay, Turkey)

Erksin Güleç, Ismail Baykara, Ismail Özer, Mehmet Sağır & Cem Erkman

The Initial Upper Paleolithic is considered a technocomplex transitional between Middle and Upper Paleolithic. Chronologically, it seemed to occupy a comparatively interval between Mousterian and Upper Paleolithic industries such as the Ahmarian and Aurignacian.

The lithic assemblages combine Middle Paleolithic technological elements with essentially Upper Paleolithic typological inventories. Typologically, the Initial Upper Paleolithic seems to be more typical of the Upper Paleolithic, such as endscrapers and burins dominate most assemblages. Lately excavated Initial Upper Paleolithic site of Üçağızlı Cave is located on the Mediterranean coast in the Hatay province of south-central Turkey. Paleolithic deposits preserved within Üçağızlı Cave span a period of approximately 12,000 years.

AMS radiocarbon dates indicate that the sequence of layers in Üçağızlı Cave represents the temporal interval between roughly 41,000 and 29,000 uncalibrated radiocarbon years BP. Two principal cultural components are represented in Üçağızlı Cave. The first, more recent component closely resembles the Ahmarian complex known from other sites in the Levant. The second, earliest of these, corresponds to the so-called Initial Upper Paleolithic phase.

In this study, five human teeth from Üçağızlı cave Initial Upper Paleolithic layers are described. As a result, non-metric characters and the deciduous and adult teeth morphologies from Initial Upper Paleolithic layers show that Üçağızlı Cave inhabitants of this period were modern humans who had some archaic characters.

## Addressing the challenges of dating archaeological sites: A luminescence assessment of sediments at Jonzac, southwest France

Anja Gumprich & Kathryn E. Fitzsimmons

A key aspect of archaeological excavations is establishing the antiquity of the sites being investigated, particularly when they address significant questions such as the timing of transitional stone tool industries which relate to migration and innovation in human populations. Unfortunately, however, archaeological sites rarely contain sediments ideal for optically stimulated luminescence dating (OSL), and researchers are not in a position to choose the most suitable material with which to produce a geochronologic framework. In this respect the Paleolithic site of Chez-Pinaud (Jonzac) in southwest France is a prime example.

Jonzac is an open-air site adjacent a limestone cliff, containing a rich assemblage of multiple stone tool industries, combined with faunal remains, which correspond technologically to the period of transition from Neanderthals to anatomically modern humans in Europe. However, the sediments in which the archaeological material is found comprise both coarse- and fine-grained periglacial, colluvial, fluvial and aeolian facies, as well as sediments containing mixtures of all of these. Consequently, obtaining age estimates for these units must take into account issues of incomplete bleaching, post-depositional bioturbation and mixing, sediment inhomogeneity, and the difficulty of making reliable dosimetric calculations.

This project addresses the challenges of dating such sediments by undertaking a comprehensive study of the mineralogical characteristics of sedimentary quartz and feldspar from the site, in addition to micromorphological observations of the stratigraphic units sampled. This information was combined with characterization of the OSL signals from single coarse grains and single aliquot fine grains, to systematically differentiate sediment types and their suitability for luminescence dating. Dosimetry was assessed both in situ using a portable LaBr<sub>3</sub>(Ce) gamma spectrometer and in the laboratory using high resolution germanium gamma spectrometry.

The resulting age estimates therefore represent the most reliable data possible using the OSL technique for this site, and provide a potential blueprint for comparable studies at other archaeological sites. In addition, the independent geochronological techniques of AMS radiocarbon and TL dating of burnt flint material were applied to provide alternative age control for the site, and reinforce confidence in the approach adopted here.

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## The bony labyrinth reconsidered, introducing a new geometric morphometric approach

Philipp Gunz, Marissa Ramsier, Melanie Kuhrig, Jean-Jacques Hublin & Fred Spoor

The bony labyrinth in the temporal bone houses the sensory systems of balance and hearing. While the overall structure of the semicircular canals and cochlea is similar across mammals, their detailed morphology varies even among closely related groups. As such the shape of the labyrinth carries valuable functional and phylogenetic information.

Here we introduce a new, three-dimensional geometric morphometric approach to shape analysis of the labyrinth based on computed tomographic (CT) scans, as a major improvement upon previous studies based on linear measurements and angles. We first test our approach using a geographically diverse sample of 50 recent modern humans, and 30 chimpanzee specimens belonging to *Pan troglodytes troglodytes* and *P. t. verus*. We then explore the shape differences between the bony labyrinths of modern humans and Neandertals.

Our measurement protocol can be applied to CT scans of different spatial resolutions because it primarily quantifies the midline skeleton of the bony labyrinth. Accurately locating the lumen centre of the semicircular canals and the cochlea is not affected by the partial volume and thresholding effects that can make the comparison of the outer border problematic. After virtually extracting the bony labyrinth from CT scans of the temporal bone we compute its midline-skeleton by thinning the encased volume in the software Avizo. On the resulting medial axes of the semicircular canals and cochlea we place a sequence of semilandmarks. After Procrustes superimposition the shape coordinates are analyzed using principal component analysis and linear discriminant analysis. We use permutation tests on Procrustes distance, to test for significant shape differences between group-means.

We find highly significant shape differences between modern humans, Neandertals, and chimpanzees. Our results corroborate previously described shape differences between their bony labyrinths, but with an improved ability to discriminate between groups. As the geometric relationship among the semilandmark coordinates is preserved throughout the analysis we are able to quantify and visualize even small-scale shape differences. Notably, our approach makes it possible to detect and visualize subtle, yet statistically significant ( $P=0.009$ ), differences between two chimpanzee subspecies in the shape of their semicircular canals. Moreover, our method makes it possible to obtain complete separation of modern humans and Neandertals based on the shape of their semicircular canal system.

## New perspective on climatic background and chronology of the Middle Pleniglacial (MIS 3 stage) in Central and Eastern Europe

Paul Haesaerts, Freddy Damblon, Stephane Pirson, Christa Frank, Carolina Mallol, Vasile Chirica, Larissa Kulakovska, Philip R. Nigst & Jean-Jacques Hublin

Recent studies on Palaeolithic open-air sites related to long loess records from Central and Eastern Europe have provided an integrated high-resolution climatic sequence for the Middle Pleniglacial (MIS 3 stage). It concerns mainly the sites of Willendorf II and Schwallenbach in the Central Danube Basin (Nigst et al., 2008), and Molodova V and Mitoc-Malu Galben in the East Carpathian Area (Haesaerts et al., 2010). Each group constitutes the core of a renewed regional palaeoclimatic sequence based on pedosedimentary, malacological, and soil micromorphological data. Among others, we present new malacological data and radiocarbon dates between 55 and 40 ka uncal BP for the lower sequence of Willendorf II.

The conjunction of these complementary sequences provides an almost complete palaeoclimatic record for the Middle Pleniglacial encompassing about 15 interstadial events with a strong chronological frame based on large series of consistent radiocarbon dates on high-quality charcoal ranging from 55 to 25 ka uncal BP achieved in Groningen and Oxford. In this way, the integrated palaeoclimatic loess sequence could be compared by proxy-correlation with the climatic signal of the Greenland ice cores, allowing the atmospheric radiocarbon ages of the loess to be compared with the Greenland calendar chronology (Haesaerts et al., 2009).

This approach confirms the predominance of highly unstable environmental conditions during the Middle Pleniglacial on the scale of the European continent. Our results provide a new perspective on the chronostratigraphy of the Middle to Upper Palaeolithic transition period in Europe from Late Mousterian to Gravettian, including Early Upper Palaeolithic, Bohunician, Szeletian, and Aurignacian. Further, this data allows placing early modern human dispersal into Europe in a climatic context and to assess and discuss current models of early modern human expansion into Europe.

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## Revisiting the Origins and Phylogenetic Relationships of *Australopithecus africanus*: New Perspectives from the Woranso-Mille, Ethiopia

Yohannes Haile-Selassie

The origins and phylogenetic relationships of *Australopithecus africanus* Dart 1925 have remained elusive particularly since the 1960s, when a number of new hominid taxa started to appear in the Plio-Pleistocene fossil record of eastern Africa. Previous studies have alternatively recognized *Au. africanus* as a descendant of *Au. afarensis*, a sister of the “robust” clade, or a sister to a group including the genus *Homo* and the “robust” clade, among many others. The latter has been considered as the most parsimonious based on numerous cladistic analyses (For example, Strait et al., 1997; Kimbel et al., 2004). The conspicuous paraphyly of the genus *Australopithecus* has remained a major hurdle in the study of early hominid evolutionary history, although recent fossil discoveries from new paleontological areas have started shedding light on some of the most important issues related to phylogenetic relationships among the species of *Australopithecus* (for example, Haile-Selassie, 2010).

The Woranso-Mille study area, a relatively new paleoanthropological site located in the central Afar region of Ethiopia, has started yielding early hominid fossils dated to between <3.4 and 3.82 million years ago (Ma) in addition to more than 5,000 fossil specimens representing numerous vertebrate taxa (Haile-Selassie et al., 2007; Deino et al., 2010). The new hominid fossils not only shed light on the phylogenetic relationships of early *Australopithecus* in general, but also on the origin and phylogenetic relationships of *Au. africanus*. Cranial and postcranial specimens recovered during the 2010 field season from sediments that are dated to between 3.4 and 3.6 Ma are of particular interest as they do not seem to morphologically fit to either the contemporaneous *Au. afarensis* or other younger or older early hominid species known from eastern Africa.

Preliminary observations of the new Woranso-Mille specimens indicate that the dental, mandibular, and pedal specimens recovered from the 3.4 – 3.6 Ma are more similar to *Australopithecus africanus*, particularly in their lack of the “classic” mandibular lateral corpus contour hollow, the more anterior origin of the ascending ramus, and the larger breadth of the extramolar sulcus. Moreover, the pedal elements recovered from the Woranso-Mille lack significant metatarsal characters documented for *Australopithecus afarensis* (for example, “doming” of the first metatarsal head, Latimer and Lovejoy, 1982), and are more similar to Sterkfontein specimens described by Clarke and Tobias (1995) and Deloison (2003) and the 4.4 Ma *Ardipithecus ramidus* (Lovejoy et al., 2009).

This is the first occurrence of both cranial and postcranial fossil specimens from eastern Africa apparently showing greater affinity with a South African taxon, rather than with the spatially and temporally contemporaneous species, *Au. afarensis*. While this may have significant impact on our understanding of early hominid evolution, particularly in relation to what taxa should be included in *Australopithecus*, additional fossils and a detailed description and analyses of the Woranso-Mille hominids are necessary to understand the meaning of the proposed similarity and subsequent phylogenetic implications.

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## A reconsideration of the Apidima 2 cranium, S. Greece

Katerina Harvati, Chris Stringer & Panagiotis Karkanas

The Apidima fossil human crania were discovered in 1978 in a karstic cave complex (Apidima A-E) in the Mani peninsula, Southern Greece. Two individuals, Apidima 1 and 2, recovered from a breccia block in Cave A, have been considered as pre-Neanderthals of likely Middle Pleistocene age. Together with the Petralona cranium, the two Apidima specimens are among the most significant human fossil discoveries in South-East Europe. Despite their importance, however, little information exists about them in the international literature and a detailed comprehensive description is lacking.

The more complete Apidima 2 cranium has been reported as showing an elongated, low vault with a pronounced supra-orbital torus, a wide interorbital breadth, large rounded orbits, no canine fossa, a large nasal aperture and a prognathic face. Neanderthal affinities have been noted. Because it is relatively gracile, Apidima 2 has been considered a female, possibly belonging to the same taxon as the Petralona cranium.

Here we re-examine the taxonomic position of Apidima 2 using nine osteometric measurements published in the literature (Koutselinis et al. 1995), as well as an extensive comparative fossil human sample. We tested these measurements for possible error associated with distortion using row standardization in order to control for outlier values. This procedure resulted in the removal of two variables affected by distortion and/or breakage. We adjusted the remaining variables for size by subtracting the log geometric mean of each variable for each individual from each log-transformed measurement. We then conducted principal components (PCA), canonical variates (CVA) and discriminant analyses (DA) in order to shed light on the specimen's classification. Furthermore, we estimated the specimen's cranial capacity on the basis of these external measurements following the formula developed by Olivier and Tissier (1975).

The results of the PCA, CVA and DA suggest close affinities with Neanderthals. Contrary to our expectations, we did not find a strong relationship either with our Middle Pleistocene sample in general or with the Petralona specimen in particular. The Apidima 2 cranial capacity also falls within the Neanderthal range of variation and is larger than that reported for most Middle Pleistocene crania.

Since attempts at radiometric dating have not produced results, the chronology of the Apidima site must be assessed on the basis of geomorphology. A review of the site's geological setting suggests a large chronological bracket (400-105 ka) within which the deposition of the two Apidima specimens could have occurred.

Our findings suggest that the latter part of this period fits better with the observed morphology. If our interpretation is correct, it places the Apidima site and specimens among the Middle Paleolithic localities, such as Lakonis and Kalamakia, known from the immediate geographic vicinity in the Mani.

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## Immunogenetics of archaic humans

John Hawks & Aaron Sams

With genetic information from ancient specimens we can uncover details of their biology that might never be discovered from the skeleton. The immune system has been a major target of selection in human populations during the last 10,000 years, so that direct information from ancient specimens is of incomparable value in understanding our recent evolution. Immunity is modulated by a very diverse array of genes, notably the HLA cluster on chromosome 6, and many gene-phenotype associations are known relevant to immune response to pathogens.

We provide preliminary HLA types for Neandertal and Denisova genomes and additionally survey a broader suite of genetic variants that show associations with pathogen resistance in living human populations. The resulting catalog provides insights about the possible susceptibilities of archaic humans and the coevolution of pathogens and immunity prior to the agricultural revolution.

## 'Punctuated' Cultural Evolution & Climate Change: An update on the latest excavations at the southern African sites Blombos Cave and Klipdrift Shelter (100–60 ka)

Christopher Henshilwood, Karen van Niekerk & Francesco d'Errico

A major research challenge in archaeology is identifying when and how symbols were used for the first time to mediate hominin behaviour. Once in place this innovation provided an ability to share, store, and transmit coded information and played a crucial role in creating the social conventions and identities that now characterise human societies. Recent archaeological discoveries in some regions of Africa suggest symbols were part of *Homo sapiens* behaviour by at least 100 ka but the application of high resolution dating techniques to the archaeological data suggests that symbolic material culture occurs only sporadically after 100 ka and is a regular feature only after 25 ka. This evidence contradicts the idea that symbolic behaviour, once acquired, became a regular feature of human culture. This punctuated pattern has been attributed to the relatively small number of excavated sites in Africa. Another possibility is that the variable climates that characterised the Late Pleistocene had a major effect on the continuity of key cultural innovations. Highly variable environments can be one driver behind a rapid expansion of social learning and swift changes in environment in southern Africa during MIS 6 – 3 may have accelerated individual and general purpose social learning mechanisms that currently characterize humans. However, the adaptive responses of *Homo* to changing climates are poorly understood and researching the role of climate in shaping the cognitive evolution of *H. sapiens* is a priority.

One way of testing these models in southern Africa is by carrying out excavations at new MSA sites and by integrating the results with those from a variety of disciplines including palaeoclimatology, marine geology, dating and climate modeling. A major component of our TRACSYMBOLS project is the excavation of existing Middle Stone Age sites and the discovery and excavation of new sites in the southern Cape. Closely linked is the question of how and when key behavioural innovations emerged among *Homo sapiens* in this region and to explore whether environmental variability may have influenced this development. Here we report on our latest results from the 100 – 75 ka levels at Blombos Cave and on the preliminary results from a newly discovered and excavated site Klipdrift Shelter.

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## Radiocarbon dating the dispersal of the first anatomically modern humans into western Europe

Tom Higham, Rachel Wood, Katerina Douka, Roger Jacobi, Laura Basell & Christopher Bronk Ramsey

A reliable chronology is one of the keys to understanding the nature of the transition from the Middle to Upper Palaeolithic in western Eurasia. The transition describes the period during which anatomically modern humans (AMHs) replaced Neanderthals—who ultimately became extinct. The period over which this took place and the length of the temporal overlap between the two groups is a central question concerning researchers in this field with wide ranging implications in a number of areas; for example, the cognitive abilities of Neanderthals and whether there was any genetic exchange between the two populations.

Within a large project funded by the NERC in the UK, we have been dating over 400 samples of bone, shell and charcoal from more than 50 key Palaeolithic sites in over 10 countries. The main focus has been on sites with a succession of contexts containing lithic industries attributed to the Mousterian, Uluzzian, Châtelperronian, Aurignacian and Gravettian.

Work undertaken in Oxford over the last decade has been aimed at improving the dating of material between 25—55 ka BP which covers the Middle–Upper Palaeolithic transition. We have developed aspects of our pre-treatment chemistry, particularly the purification of bone collagen using ultrafiltration. When comparing the ultrafiltered results with previously determined samples of the same bone from our laboratory, and other laboratories, the results in many cases are quite different. When ultrafiltration is used, the dates are often older, and we consider, more accurate. We are also applying ABOx-SC methods to samples of charcoal, which shows similar improvements in many cases. In tandem, work has been undertaken on improving the applicability of our background correction for bone (Wood et al., 2010). In addition, we have been refining the detection of trace calcite in samples of marine shell for radiocarbon dating (Douka et al., 2010).

In this paper we will discuss the emerging chronology for the dispersal of the earliest anatomically modern humans into Europe by presenting results from some of the key sites in France, Germany, Italy, Spain and Belgium.

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## Lowered larynx in humans: speech or male sexual attractiveness?

Jean-Marie Hombert

Since the 70's, human speech abilities have been associated with a lowered larynx position. It was generally assumed that this lowered position gave the human vocal tract a shape (inverted L shape) and size (lengthening of the vocal tract), allowing for the production of a wide variety of sounds (vowels and consonants). It was then considered that the inability of non-human primates to produce "human" speech sounds was linked to this (peripheral) anatomical difference.

It should be mentioned that larynx lowering is not limited to *Homo sapiens* and can be used by males to produce calls in reproduction periods (e.g. in red deer). Body size is correlated to the length of the vocal tract. Frequency characteristics of these calls are determined by the size of the vocal tract. Calls produced with a lowered larynx will be associated with lower acoustic frequencies (because of an elongated vocal tract) and can be interpreted as being produced by a male with a larger body size (and consequently a more attractive male for reproduction).

In our species larynx displacement takes place at two different periods. At birth, human babies have a larynx position similar to non-human primates. There is a first laryngeal movement downwards soon after birth in males and females and a more drastic movement for males at puberty. This second lowering has an important acoustic effect on voice quality (lowered frequencies both for the pitch of the voice and for the formant frequencies of the speech signal).

Several experimental studies have shown that women are very sensitive to male voice quality. Lowered frequencies are considered more attractive and their judgments are even affected by the time at which they make these judgments during their menstrual cycle. In this sense, the lowered position found in human males plays the same function as it does in other species, making males sounds bigger (sexually more attractive?) than they really are.

In this paper we will show that this evolution associated with sexual attractiveness happened chronologically before the emergence of human language and was only later used for linguistic purposes.

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## Complex hunter-gatherers – monkeys interactions in Southeast Asian archipelagos

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Relationships between human and non-human primates have for long fascinated scholars in prehistory, social anthropology and ecology. Our research aims at deciphering the complex significance of the abundant fossil Cercopithecidae occurrences during the Holocene in Javanese prehistoric sites.

In the Southern Mountains (East Java, Indonesia), several cave sites excavated since the 1990' yielded significant amounts of Holocene primate remains. Among them, human skeletons found in burial contexts are probably the most striking discoveries. Besides documenting the morphological variability of the local Holocene hunter-gatherers, those funerary structures highlight a conspicuous diversity of mortuary practices for a restricted geographical and chronological interval. Several thousands of non-human primate remains were also recovered, accounting for more than 70% of mammalian fauna (number of determined remains). We determined that *Trachypithecus auratus* and *Macaca fascicularis* respectively account for 97% and 3% of the monkey remains in Song Terus. The present day biogeography and ecological niches of those two species are identical. Those proportions of monkeys clearly indicate a specialization of human groups for those preys. The homogeneous representation of the different anatomical parts does not point out any particular treatment of those monkeys. Nevertheless, a rich industry and especially pointed tools, has been produced from monkey long bones.

The question of human/non-human primate relationships is also asked by the discovery of monkeys in human burial contexts at Song Terus and Song Keplek sites. Among those monkeys, several pathological individuals with severe teeth and mandibular diseases (as four incisors agenesis), have surprisingly reached adulthood.

We studied dental micro-wears in *T. auratus* from Song Terus site in order to determine the diet of the fossils. Although this species is among the most folivorous of all the primates, the fossils we studied appeared highly frugivorous. Environmental conditions, even extremely dry ones, may not explain such a behaviour. Commensalism could be an other explanation to those peculiarities. In occupation layers excavated in Braholo cave, particular patterns of cutmark have been observed on many human bones discovered outside burial contexts. Such cutmarks are more frequently found on long bones extremities (femur and humerus).

A conspicuous case is a human mandible bearing cutmarks along the anterior and posterior borders of the ascending rami. Similar patterns of cutmarks are also frequently observed on the same anatomical parts in monkeys and large rodents. Those preliminary observations would not indicate a chaîne opératoire related to butchering but rather to skinning – defleshing processes. The objective could be the cleaning of the bones as part of mortuary processes for humans, and the removal of the skin and fur for monkeys and rodents.

## Iron and copper stable isotopes in human bones record sex and metabolism

Klervia Jaouen, Vincent Balter, Estelle Herrscher, Aline Lamboux, Philippe Telouk & Francis Albarède

Successful sexing of fossil human remains relies on the presence of the coxal bone or well preserved DNA. Iron stable isotope ratios ( $^{54}\text{Fe}/^{56}\text{Fe}$ ) have been measured in human organs, and an unexpected result was the discovery of a  $^{56}\text{Fe}$ -depletion in blood of males compared to that of females (Walczyk and von Blanckenburg, 2002).

Recently, it has been demonstrated that the copper isotope ratios ( $^{65}\text{Cu}/^{63}\text{Cu}$ ) also reflects the gender difference in blood (Albarède et al). This leads us to the idea that sexing might be possible through the determination of the iron and copper isotopic composition in bones. Bones are constantly renewed during lifetime and are therefore good candidates to record the iron and copper isotope signature of blood. We analyzed a suite of well-preserved phalanges ( $n=43$ ) from individuals buried in the necropolis of Saint-Laurent de Grenoble, Isère, France, whom gender was attributed according to the morphology of the coxal bone. We also collected liver and endometrium samples in order to question the metabolic origin of the difference: is the isotopic gender difference the consequence of the differential intestinal absorption under hormonal control or due to menstrual losses and subsequent solicitation of hepatic stores?

Metals were purified by liquid chromatography on ion exchange resin, and iron, copper and zinc isotope compositions measured by high resolution multiple-collector inductively coupled plasma mass spectrometry. We show that bones record the iron isotope signature of blood, males being  $^{56}\text{Fe}$ -depleted relative to females ( $n=40$ ,  $p<0.02$ ). Moreover, male bones are  $^{65}\text{Cu}$ -enriched compared to that of females ( $n=30$ ,  $p<0.03$ ).

No difference is found in the  $^{66}\text{Zn}/^{64}\text{Zn}$  composition of bone between males and females. Using metal isotope data measured in human blood and liver, we demonstrate by mass balance calculations that metabolic processes can be responsible for the isotopic pattern observed in males and females. The next step is to search for the isotopic difference in enamel for two reasons. First, the formation of enamel third molars is contemporary of the menarche and could record the gender difference if it occurs during the preadolescence. Second, enamel is less affected by diagenesis than bone. Preliminary data on buried and non-buried enamel will be shown and the metabolic and anthropological implications discussed.

These results are likely to be the first step towards the development of a new method to determine the sex of human fossil based on isotopic analysis of metals in bones and teeth.

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## Magneto- and strontium isotope stratigraphy of the hominin-bearing upper Burgi Member, Karari, Turkana Basin

Josephine C.A. Joordens, Guillaume Dupont-Nivet, Craig S. Feibel, Jeroen H.J.L. van der Lubbe, Mark J. Sier, Trine Kellberg Nielsen, Monika Knul & Hubert B. Vonhof

Over the past 40 years, a large number of hominin fossils (*Homo sp.*, *Paranthropus boisei*) have been and continue to be found in deposits of the upper Burgi Member (UBU), east of present-day Lake Turkana (Kenya). A famous example is fossil skull KNM-ER 1470, attributed to *Homo rudolfensis*. To interpret these finds in the context of climate-evolution hypotheses, a high-resolution (< 20 kyr) temporal and climatic framework is required.

A recent study has produced an astronomically-tuned cyclostratigraphic framework for the Koobi Fora region, by applying magnetostratigraphy with a novel strontium (Sr) isotope climate proxy in UBU paleolake deposits of Area 102. It was shown that hominins were present in both wet and dry periods of the precessional climate cycles. This suggests that the lacustrine Turkana Basin was an aridity refuge for lake shore- and delta-dwelling fauna, including hominins, during regionally dry periods (Joordens et al., 2011).

The rich hominin fossil record from UBU in the Karari region can be used to test the aridity refuge hypothesis. However, due to lack of regionally continuous marker beds (the capping KBS Tuff aged 1.87 Ma being the exception) it is at present not possible to correlate the UBU sequences from Koobi Fora to those of the Karari region, where most of the hominin fossils derive from.

To solve this issue we conducted magnetostratigraphy and Sr, C and O isotope analysis in the UBU sequences of Karari Areas 105 and 131, following methods outlined in Joordens et al. (2011a) and Joordens et al. (2011b). Sr, C, and O isotope analysis on fossil fish apatite revealed that the Karari UBU deposits represent environments located in the paleo-Omo delta, likely temporarily disconnected from the main well-mixed paleolake. Therefore, in contrast to lake deposits these deltaic deposits do not reliably capture paleoclimate cyclicality.

We identified the base of the Olduvai chron in Areas 105 and 131, thereby providing improved age control of hominin fossils, as well as a temporal anchor that can be correlated to the cyclostratigraphic framework for Area 102. Thus, the UBU hominin fossils from the Karari region can now be placed in this framework. Their position with respect to the precessional climate cycles supports our hypothesis that the lacustrine Turkana Basin was an aridity refuge.

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## The late Lower Palaeolithic of Western Eurasia

Olaf Jöris

The degree to which the spread of Palaeolithic populations is mirrored in their material culture has been much debated since the beginning of research on "fossil man". This question does not only concern the possible link between Anatomical Modern Humans and the roots of our modern human behaviour, but also the relationship between archaic hominins and different manufacturing traditions in lithic assemblages.

The presented paper aims to test the validity of the so-called Movius line in Europe and tries to establish whether or not the European Acheulian industries may be linked with a hominin clade that finally led to the Neanderthals of the last glacial on the one hand, while the Mid-Pleistocene non-Acheulian lower Palaeolithic industries of eastern Central and Eastern Europe could have been made by *Homo erectus*.

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## Group differences in proneness to inflammation influenced by cytokine polymorphisms

**Brett J. Kennedy**

All humans are primarily descendants from a diaspora out of Africa approximately 50,000 years ago although there are indications of admixture with local populations of archaic humans outside Africa. The burden of infectious disease is greater in tropical Africa than elsewhere on earth in historic times and it was less outside Africa, especially in the New World where passage through the Beringian filter kept many Old World parasites from entering the New World with humans.

As a consequence there is some expectation that the immune system, especially susceptibility to inflammation, will be “tuned up” in people with recent tropical African ancestry, intermediate in people of European and Asian ancestry, and perhaps “tuned down” in people of Native American ancestry.

A key regulating factor in the human immune system is the cytokine response. Polymorphisms in cytokine genes occur in all human populations. The variations in frequencies of polymorphisms of up and down regulating cytokines between populations suggest possible regional differences in immune response.

This may further suggest local adaptation to pathogens as well as a general pattern of diminished inflammatory immune response for human populations outside of Africa.

## Trabecular bone structure of the fossil hominin first metacarpals.

Tracy L. Kivell, Matthew M. Skinner, Richard Lazenby & Jean-Jacques Hublin

Two hominin first metacarpals from Swartkrans, South Africa have been the centre of much debate regarding both their taxonomic affiliation and their potential inference for stone tool-making in early hominins. Both specimens are from Member 1 (1.9-1.8 Ma) in which early *Homo* and, predominantly, *Australopithecus robustus* are found. SK 84 is smaller with a prominent sesamoid beak on the metacarpal head that is possibly similar to metacarpals attributed to KNM WT 15000 (*H. erectus*), but the trapezoidal facet is more curved than typically found in humans. SKX 5020 is larger, much more robust with a flatter, more human-like trapezoidal facet, but the potential presence of a sesamoid beak is obscured due to poor preservation. Variation in size and external morphology has led some to consider these fossils as belonging to different species; SK 84 as *H. cf. erectus* and SKX 5020 as *Au. robustus*, but attributing tool-making ability to both (Susman, 1988, 1994). In contrast, others feel such variation can be accommodated within a single taxon and, if both are considered *H. cf. erectus*, tool-making ability is constrained to the genus *Homo* (Trinkaus and Long, 1990).

Here we address this debate from a new perspective through the analysis of the internal trabecular bone structure. We investigate variation in trabecular architecture in these fossils in comparison with *Au. africanus* StW 418 and an extant sample of *Pan troglodytes* (n=12) and modern *H. sapiens* (n=10) to shed light on potential differences in function and taxonomy.

All fossil metacarpals were micro-CT scanned using a Skyscan™ scanner (MPI-EVA) at approximately 14 µm. Trabecular bone was segmented using the Ray Casting Algorithm (Scherf and Tilgner, 2009). Volumes of interest scaled to bone size were placed centrally in the head and base of each metacarpal using AVIZO 6.2® and trabecular bone was quantified using CTan®.

Results demonstrate that all fossil specimens have a greater relative bone volume, trabecular thickness and trabecular number in the metacarpal head compared with the base. However, there is variation in some trabecular parameters across the fossils. SKX 5020 is more human-like in having a lower relative bone volume and lower degree of anisotropy compared with SK 84 and StW 418, though all specimens are generally more similar to *Pan* than the derived condition of recent humans.

These results suggest that if SK 5020 and SK 84 do not belong to the same species, then it is more likely that SKX 5020 be attributed to *H. cf. erectus*, rather than SK 84. General similarity to *Au. africanus* (StW 418) and to *Pan* indicate that there is not a clear tool-making signal in the trabecular structure of either specimen, though comparison to fossil *Homo* (as opposed to recent modern humans) might help to clarify the functional significance of trabecular variation with regards to manipulative behaviours.

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## Mitochondrial DNA from Pleistocene and ancient Holocene Iberian horses. Rooting the Iberian domestic lineages

Jaime Lira, Pablo Arias, Marian Cueto, Carmen Olaria, Soledad Corchón, Josep Casabó, Julià Maroto, Jesús F. Jordá, Anders Götherström & Juan Luis Arsuaga

The main domestic livestock species (cattle, sheep, goats, pigs and horses) were domesticated through the Holocene. The horse was the latest one to be domesticated, but little is known about the process of horse domestication.

Recent studies support the origins of horse domestication in the Eurasian steppes around 5,000 BP (Ludwig et al. 2009), also evidenced by the fact that horses from the mid-fourth millennium BC and associated to the Botai Culture (Kazakhstan), were already domesticated (Outram et al., 2009). However, it has been proposed that independent domestication events have occurred more than once throughout Eurasia. Analyses on DNA from modern and ancient horses have supported this suggestion, giving a special distinction to the Iberian Peninsula (Warmuth et al. 2011; Lira et al., 2010; Jansen et al., 2002; Vilà et al., 2001). Some mitochondrial lineages from modern horses from the Lusitano breed (Lopes et al., 2005) were already found in wild Iberian Neolithic horses as well as in Iberian Bronze Age horses (Lira et al., 2010). Those results highlighted the importance of the Lusitano group C in ancient Iberian times, and subsequent studies have supported this conclusion (Cieslak et al., 2010). But even if it has been possible to draw in some detail from the Lusitano group C distribution during ancient Holocene periods, nothing is known about its presence in the Iberian Peninsula during the Pleistocene.

The aim of this study is to explore the genetic diversity of the Iberian horses during the last 47 kyr BP. We have analysed the mtDNA from *Equus ferus* and *Equus sp.* remains recovered in 9 Iberian archaeo-paleontological sites, associated to different Upper Pleistocene and Holocene chronologies. Iberian Pleistocene remains came from Jarama VI, La Garma, Bora Gran, Las Caldas, Cueva Oscura de Ania and Cova Forada sites. Furthermore, Neolithic, Calcolithic/Bronze Age transition, Bronze Age and Iron Age samples were selected from Cova Fosca, Portalón and Cancho Roano sites. Chronology of the samples ranges from > 32 kyr BP (Jordá, 2007) in a Jarama VI sample (and could be even > 47 kyr BP, Jordá & Wood pers. comm.), to the end of the 5th – beginning of the 4th centuries BC of Cancho Roano samples (Celestino, 2008; Celestino, 2001).

We carried out ancient DNA extraction over 119 samples, nucleotide positions 15,444-15,842 from the control region (Xu and Arnason, 1994), and were amplified using 3 primer pairs, and sequencing was performed in a similar way used in Lira et al. (2010). Mitochondrial DNA was recovered from 44 samples, obtaining complete and partial sequences. An overall 36.9% success rate was obtained, but with differential rates among sites, ranging from 5.26% success rate in Jarama VI, to 100% in Portalón site. Pleistocene Iberian horses display a high haplotype diversity and a weak phylogeographical structure, with a minimal presence of Lusitano group C. Furthermore, Iberian Holocene samples exhibit better clustering in the Lusitano group C, suggesting that this haplogroup expanded in Iberian wild populations after the end of the Pleistocene.

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## Hard times for Neanderthals? An isotopic investigation on the diet of the Late Mousterian humans that populated northern Italy during the Middle-to-Upper Palaeolithic transition

Marcello A. Mannino, Laura Longo, Jean-Jacques Hublin, Elisabetta Boaretto, David Caramelli, Silvana Condemi, Paolo Giunti, Martina Lari, Ursula Thun Hohenstein & Michael P. Richards

One of the main hypotheses invoked to explain the demise of Neanderthals is that Anatomically Modern Humans (AMHs) replaced them through competitive exclusion. An argument in favour of this hypothesis is that the dietary adaptations of *Homo neanderthalensis* were not as flexible as those of AMHs. This has been suggested as a result of palaeodietary reconstructions based on isotope analyses, which show that Neanderthals were 'trophically rigid' and that their diets relied heavily on the consumption of the meat of large mammalian herbivores.

Carbon and nitrogen isotope analyses are useful for reconstructing the ecosystem (terrestrial, freshwater or marine) and trophic position of origin of the dietary protein consumed by an individual. These biochemical approaches, hence, make it possible to investigate whether Neanderthals exploited resources originating from different environments and to establish their level of carnivory or omnivory, topics on which we have a growing body of data from central and northern reaches of the distribution of *H. neanderthalensis*, but not from southern Europe.

Here we report preliminary results of isotope analyses on bone collagen extracted from genetically-typed Neanderthal bone fragments, and animal bones contemporary to them, recovered at the late Mousterian site of Riparo Mezzena in the Monti Lessini plateau (NE Italy). This rockshelter is noteworthy because the human bones from it have been radiocarbon dated to a period when Proto-Aurignacian industries were being produced at the nearby site of Grotta di Fumane. This implies that Neanderthals might have co-existed with AMHs for what in evolutionary terms was a brief interlude and that, during this time, these two hominins competed for resources in the territory of the Monti Lessini.

The aims of our isotope-based palaeodietary study was, thus, (i) to acquire data on the diet of Neanderthals in a more southerly region of their distribution and (ii) to verify whether possible competition with AMHs might have affected the dietary habits of these Neanderthals.

The isotope analyses undertaken at the Max Planck Institute for Evolutionary Anthropology (Leipzig, Germany) on the bone collagen extracted from the genetically-typed Neanderthal from Mezzena show that the dietary protein consumed by this individual came exclusively from terrestrial resources. Its nitrogen isotope values are the lowest recorded for *H. neanderthalensis* and they are lower than those of local contemporary carnivores, indicating that this individual might have consumed a higher proportion of vegetal protein than any of its conspecifics analysed to date.

We will discuss whether this was a common adaptation of Neanderthals living in southerly regions of Europe or whether this diet was the inevitable result of competition with AMHs. This isotopic study provides insights on the possible role that intrinsic factors (i.e. trophic rigidity) or extrinsic factors (i.e. competitive exclusion) might have played in the demise of *H. neanderthalensis*.

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## Fossils, bits and decibels: communication and the origin of language

Ignacio Martínez, Manuel Rosa, Rolf Quam, Pilar Jarabo, Carlos Lorenzo, Alejandro Bonmatí, Ana Gracia & Juan Luis Arsuaga

In the present study, we use the theoretical framework provided by The Mathematical Theory of Information developed by Claude Shannon (Shannon, 1948) to measure the channel bandwidth of the sound power transmission through the external and middle ear in five human fossils from the Middle Pleistocene site of the Sima de los Huesos (SH) in the Sierra de Atapuerca (Spain), four modern humans (*H. sapiens*) and four chimpanzees (*Pan troglodytes*).

Assuming a similar signal to noise ratio for all individuals, the channel bandwidth becomes a proxy for channel capacity. A wider channel bandwidth would correspond to a greater channel capacity and would allow for the transmission of a larger quantity of information per second.

Our results show that the Sima de los Huesos humans had a widened bandwidth of heightened sensitivity in the midrange frequencies compared with chimpanzees but similar to that of modern humans. This wide bandwidth suggests that the channel capacity of the ears of the Atapuerca (SH) hominins was also similar to that of modern human and clearly greater than that of chimpanzees. The evidence for modern-human-like auditory capacities in the Atapuerca SH hominins (Martínez et al., 2004) is consistent with recent suggestions, based on other lines of evidence (Krause et al., 2007, Martínez, et al., 2008), that the Neanderthal evolutionary lineage (*Homo heidelbergensis* and *Homo neanderthalensis*) already showed a set of anatomical adaptations that allowed for a highly-efficient oral communication system to develop.

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## Hypercementosis study in the early and middle pleistocene human fossils of Atapuerca (Spain)

Laura Martín-Francés, María Martín-Torres, Ana Gracia-Téllez, Ignacio Martínez, Juan Luis Arsuaga & José María Bermúdez de Castro

The excessive production of root cementum leading to abnormal thickness of the root has been defined as hypercementosis (Pinheiro et al. 2008). Despite of being extensively registered in fossil and archaeological collections, the specific causes of hypercementosis remain unknown.

We present a detailed hypercementosis study of two fossil dental collections recovered from two Pleistocene sites in Atapuerca (Spain), Sima del Elefante and Sima de los Huesos, in order to identify the most probable aetiological factors. Sima del Elefante site has yielded the oldest fossil remains in Europe, with a chronology of 1.2 Myr. The fossil collection includes a mandible, a fragment of humerus and a phalanx. Sima de los Huesos site, with an estimate age (ESR, U-Series and palaeomagnetic analysis) of more than 530.000 years, represents the largest hominin sample from a single Middle Pleistocene site with more than 6000 human remains associated to 28 individuals.

This study has a twofold aim. Firstly the characterisation of the abnormal root morphology and, secondly, the identification of the most probable aetiology of the condition. In order to register the external and internal aspect of the root we applied macroscopic and microscopic techniques. Macroscopic study was applied to assess different morphological aspects such as degree of expression and root involvement. Microscopic techniques involved micro-Tomography ( $\mu$ CT) and scanning electron microscope (SEM) analyses. Micro-CT cross sections were used to obtain root canal 3D reconstructions, thickness and location of the excess of cementum. SEM was applied to identify and measure the main foramen diameter and foraminas. In addition, EDX analysis was carried out to analyse the chemical composition.

The complete analysis has resulted in a positive identification of hypercementosis in all dental remains of both samples (Martín-Torres et al. 2011 and Martín-Francés et al. 2011). Differences in the hypercementosis pattern were observed between the two populations. Sima de los Huesos teeth present a more heterogeneous root involvement (from slight to moderate), and expression (diffuse, focal and combined). In contrast, Sima del Elefante teeth are more homogeneous in the type of root involvement (severe) and expression (diffuse).

We relate the different hypercementosis typologies (degree of involvement and expression) to different types of pathological stress, such as infection and/or traumatic occlusal forces. We support the hypothesis that mechanical stress and for hence, tooth movement (Hillson, 2008), would have created excessive production of cementum, in opposition to some authors who have related hypercementosis to the lack of movement, for instance in impacted teeth (Zemsky, 1931).

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## Evolutionary scenario of the Pleistocene populations from Europe in the light of the Atapuerca hominin fossils

María Martín-Torres & José María Bermúdez de Castro

During the last two decades, the Atapuerca sites have provided three extraordinary hominin assemblages from the Early Pleistocene (Sima del Elefante and Gran Dolina-TD6 sites) and the Middle Pleistocene (Sima de los Huesos site).

These fossil samples have obliged to reconsider previous hypotheses about human evolution in Europe. The 1.2 Ma human mandible from Sima del Elefante site (ATE9-1) is currently the oldest hominin specimen from Western Europe. Despite its primitive conformation, shared with early African *Homo* and the Dmanisi hominins, ATE9-1 presents some traits on the internal aspect of the symphysis that are derived with regard to African early *Homo*, and indicate unexpectedly large departures from morphologies observed in Africa. These traits, together with a distinctive Eurasian dental pattern present in the Gran Dolina-TD6 fossils, has allowed the identification of a European identity for these hominin groups, possibly the result of one or more speciation events in this extreme part of Eurasia.

The analysis of the Gran Dolina-TD6 hominin sample, assigned to *H. antecessor*, has revealed some craniofacial derived traits shared with *H. sapiens* and *H. neanderthalensis* that place *H. antecessor* close to the node of divergence of both lineages. In addition, the comparative study of the dentition and the postcranial remains of the TD6 assemblage points to a suite of derived traits shared with the European Middle Pleistocene populations and Neandertals.

Given the older geochronological age of the TD6 hominins (ca. 900 ka), which is far from the age estimated by the molecular studies for the population divergence of modern humans and Neandertals (ca. 400 ka), we suggest that some of the “derived neandertal features” appeared early in the evolution of the genus *Homo* and thus, they are not neandertal apomorphies, but synapomorphies shared with other Pleistocene populations.

Our studies ratify the necessity of considering the morphology of the European Early Pleistocene populations to fully understand the origins of the Neandertal lineage, since they are crucial to assess the polarity of the so called “neandertal traits”. The expression of “neandertal” characteristics in the Early Pleistocene populations could explain some of the similarities found between the African and the Eurasian Middle Pleistocene fossils, as well as the presence of some “neandertal” features in some of the earlier representatives of the *H. sapiens* lineage. However, TD6 fossils do not express any neandertal autapomorphy that, in contrast, are present in the Sima de los Huesos hominins. With > 530 ka, the Sima de los Huesos hominin sample appears “more Neandertal” than other penecontemporaneous Middle Pleistocene samples such as Mauer or Arago. Thus, our studies do not sustain the linearity of the accretion process hypothesized for the origins of the Neandertals and obliges the consideration of alternative evolutionary scenarios also for the Middle and Upper Pleistocene populations in Europe. The possibility of more than one hominin lineage coexisting during the Middle Pleistocene in Europe seems plausible.

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## Unusual Anatomical traits on the unerupted upper deciduous incisor crowns of the Le Moustier 2 Neandertal perinate (Le Moustier Lower rock-shelter, Peyzac-le-Moustier, Dordogne, France)

**Bruno Maureille**

The Le Moustier 2 Neandertal perinate (LM2) was found during excavations by Denis Peyrony in 1914, but was lost to science and only rediscovered, some parts of the skeleton still in its original matrix, at the Musée National de Préhistoire (MNP, Les Eyzies-de-Tayac) in September 1996. Because of the fragile nature of the original skeleton, development out of its matrix required considerable time and patience. Once the skeletal elements had been recovered, a full and detailed analysis was undertaken and completed in November 2008.

With the support of the Region Aquitaine and the MNP, this study analysed each bone of the fossil in great detail, necessary because its fragility will limit open access for future studies. For comparison, the analysis employed a well preserved neonate from a Classic Kerma Sudan necropolis (8B 51 ; Saï Island, -2500 BC ; Murail et al. 2004). This 8B 51 necropolis was solely devoted to neonates and very young children (Maureille et al. 2007).

In addition to the anatomical description, a series of numeric images of every view of every LM2 bony fragment alone and with the appropriate element of the comparative extant neonate was made. Moreover  $\mu$ CT were realized in 2008 at the Bordeaux 1 University Maison Fr. Bordes (Les Eyzies-de-Tayac) using the portable industrial  $\mu$ CT scanner of the MPI for Evolutionary Anthropology of Leipzig (BIR ACTIS 225/300). The cranial fragments were scanned with an isotropic voxel-resolution of 70  $\mu$ m.

In the process of describing the germs of the deciduous teeth, an unusual anatomical feature was noted on three of the deciduous upper incisor crown germs. On the lingual faces of both central germs and a right lateral one, there is a tiny foramina at the top of a slight but clearly marked bulbous projection (projection only presents on the r. i1, l. i2). Further, on the pulp surface of the same teeth, a similar bulbous projection, with foramina, is also present. Of course, such features have not previously been described on the lingual face of any erupted Neandertal deciduous incisor. And, theoretically, at this stage of dental development and crown mineralization, there is no communication going through the lingual face between the zone of pulp fibroblastes and the germ crypt (Mitsiadis in Piette and Goldberg, 2001).

Although it is difficult to draw absolute conclusions to explain such traits, one reasonable hypothesis is that these foramina and bulbous projections could be related to the same underlying biological complex which could be implicated in the natural morbidity of neonates. If we give the priority to such an hypothesis, it is simply because the same slight bulbous projection and foramina is visible on the lingual face of one of the i1 of the Kerma neonate. Remember that this specimen was selected from a sample of 60 other skeletons because for use as a comparison with LM2 only because of its very good state of preservation and that we know that this necropolis was specialized to bury perinates.

**Acknowledgements:** BM thanks the Musée National de Préhistoire and his director as well as the the Région Aquitaine project Transitions d'une société à l'autre : processus d'adaptation et de peuplement, research program 2005, convention 20051403003AB for support during the necessary work of recovering of the bones from their matrix as well as first scientific description.

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## Morphological patterns and developmental age of Neanderthal juvenile postcranial remains from Altai

Maria Mednikova

The juvenile postcranial remains were found in Okladnikov Cave in 1984. They consist from partly preserved right humerus, right and left femurs and well presented navicular bone. The goals of the study were to describe morphological patterns; to understand how isolated fragments correspond; to discover peculiarities of developmental age of juveniles in this Neanderthal group.

We used macro-morphological evaluations, including CT scanned data of inner robusticity, the estimations of mineral content by non-destructive method of dual energy CT.

The body of humerus is straight, without torsional twist. Diaphyseal section has triangular form; medullar cross-section is oval and enlarged in anterior plane. Parametrically, the bone seems to be most close to the Asian Neanderthal from Teshik Tash Cave.

Basing on estimations of adult stature by the length of middle manual phalanx (Mednikova, 2011), the body size of this juvenile could reach about 86-95% from final values. The right juvenile femur demonstrates slight medial-lateral elongation of diaphysis both in the middle and in the subtrochanteric area, the absence of external pilaster, wide gluteal tuberosity. Low neck-shaft angle is comparable to values of early *Homo*. There seems to be an extreme robusticity and shortening of the neck, inner robusticity of diaphysis, especially the widening of lateral walls. The diaphysis of left femur is round, without pilaster. According to contours this femur is alike Teshik-Tash one, more than the previous find. Navicular bone belonged to a child not older than 8 years. The size of the bone reached about 59,7–47 percent of adult Neanderthal values. Tubular bones were compared with standards of recent *H. sapiens* parametrical development. The same work was done for Teshik-Tash child. Because earlier his biological age (about 8-9 years) was relatively accurate detected on the base of teeth eruption and postcranial condition, we used this skeleton as basic reference point for age estimations of Okladnikov juvenile bones. The degree of differences in age estimations for one child (Teshik-Tash) is very similar the isolated fragments from Okladnikov Cave.

Basing on study of cross-sectional properties percent of cortical area for both Altai femurs are very close. Comparative data of fossil and modern young *Homo* show that Altai femurs have enormous robust walls. Walls of humerus from Okladnikov Cave were still robust. In spite of external gracility of diaphysis corresponding to modern boys of 5,5–6 years, its cortical layer is like in 16-years old modern teenagers. In dual energy CT scanning all tubular bones show close values of mineral compound. But the larger dispersion of calcium degree for humerus might reflect its worst preservation. Navicular bone demonstrates quite different (higher) degree of mineral presence.

That means, Altai tubular bones could origin from one juvenile. Belonging of navicular bone to the same child cannot be argued. Altai remains demonstrate that data of modern children development have to be used cautiously. Although Siberian Neanderthal at about 8-9 years was small sized, in comparison with adult form and because of high inner robusticity of tubular bones he just reached degree of modern teenagers.

**Acknowledgements:** Author is deeply indebted for help in dual energy CT scanning of Professor, M.D. V.E. Sinitsyn (Medical-rehabilitation Centre of Russian Health Care Ministry).

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## Conflicting models for the Modern Human Colonisation of South Asia: new Genetic and Archaeological Perspectives)

**Paul Mellars**

The paper will critically examine currently conflicting models for the initial modern human colonisation of India and Southern Asia, employing evidence from the most recent genetic (DNA) studies, and newly-published archaeological evidence from India. It will be argued that on both genetic and archaeological grounds the current evidence conflicts with the hypothesis of an initial dispersal of anatomically and genetically modern human populations from Africa to southern Asia before the time of the Mount Toba volcanic eruption ca. 74,000 BP, and strongly favours a more recent dispersal associated directly with the dispersal of the L3, M and N mitochondrial lineages from eastern Africa around 50,000-60,000 years ago, who brought with them highly developed microblade and microlithic technologies, probably derived ultimately from the Howieson's Poort technologies of southern, central and eastern Africa. It will be argued that this dispersal followed a specifically coastal route along the coastlines of Arabia and western India, and only later dispersed into the interior areas of India around 40,000 BP, as a result of environmental changes along both the coastlines of India and in the sharply contrasting environments of the India interior. Both the genetic and archaeological evidence, it will be argued, are inconsistent with the current claims for a much earlier colonisation of southern Asia, prior to the time of the Mt. Toba volcanic eruption.

## Estimating missing data: comparison of the accuracy and precision of three methods applied on the pelvis.

Valentine Meyer, Frédéric Santos, Bruno Dutailly, Jaroslav Bruzek, Christine Couture & Bruno Maureille

The use of 3D tools in paleoanthropology, as geometric morphometrics, is made difficult by the fragmentary state of preservation of the material. Indeed, the fossils are usually discovered damaged, with numerous missing parts, and large database are necessary for these studies. To solve this problem, we can either ignore the fossils with too much missing parts, which has for consequence to reduce the sample and, therefore, the variability, or reconstruct these missing parts. Concerning this last solution, lots of methods exist. They have been tested and applied on different specimens, most of the time on skull. What could be such estimations on other skeleton parts, as pelvis, for example?

The morphology of the human pelvis is the result of an evolutionary adaptation to bipedal locomotion and parturition of neonates with big brains; its morphometrical study brings us a better understanding of bipedalism, encephalisation and obstetrics. Unfortunately, we often observe fossil pelvis whose state doesn't allow the use of 3D tools; therefore, the works on pelvic morphology require preliminary reconstructions.

We can logically wonder what could be the performance of the different reconstruction methods, tested on skull and rarely applied on pelvic material. We propose here the comparison of three different methods of reconstruction, one geometrical and two statistical ones. The first statistical method uses multiple linear regressions, and the second one uses the EM algorithm.

The regression method captures the correlation between the location of the different landmarks and uses the whole correlation pattern of the landmarks to estimate the position of the missing ones. The EM algorithm is a maximum-likelihood method based on the iteration of two steps: one of expectation, the other of maximization. The TPS (Thin Plate Spline substitution), the geometrical method, replaces missing landmarks by fitting and adapting on the specimen an average form learned on the reference individuals. These three approaches are applied on a sample of CT scans: 100 modern and 3 neandertal (Tabun C 1, Feldhofer 1 and Kebara 2) pelvises. The modern ones have been scanned in the Department of Radiology, Mediterranean University, in Marseille (France). The Neandertal ones have been gently loaned by different laboratories (Tel Aviv University; National History Museum, London; Max Planck Institute, Leipzig). Thirty landmarks have been taken on the pelvises, with the software TIVMI (Treatment and Increased Vision for Medical Imaging) developed by one of us (B. Dutailly). To compare the three methods, we aim to reconstitute two pelvises: Kebara (the most complete neandertal pelvis) and a modern one.

For each specimen, missing landmarks are randomly created. Finally, we compare the accuracy of these six different reconstructions.

Discussing the results of this comparison will allow us to evaluate the differences between these three methods and to assess the impact of different factors on their performance and the quality of the reconstruction: size of the reference sample, number of missing landmarks, inter or intra-specific reconstruction. Our work will make easier the choice of one or another method, depending of the further analysis wanted in the overall study.

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## The Early Middle Palaeolithic in the Balkans. The case of Velika and Mala Balanica (Serbia)

Dušan Mihailović, Ana Belen Marín-Arroyo, Katarina Bogičević, Mike Morley & Mirjana Roksandic

Balanica cave complex in Sićevo gorge is the most important of several newly discovered sites with artifacts that could be dated to Early Middle Palaeolithic. Excavation of this complex, which consists of the caves Mala and Velika Balanica, uncovered several horizons with a large amount of faunal remains and chipped stone artefacts. We have recently described a fragment of a hominin mandible that was found in the lower layer of Mala Balanica, beneath a layer with Middle Palaeolithic artefacts (Roksandic et al. 2011). Analyses of microfauna from Mala Balanica indicate that the complete sequence dates from the Middle Pleistocene, while similarities in the industry from layer 2b in Mala Balanica and layer 3 in Velika Balanica suggest that both caves had been inhabited in the Early Middle Palaeolithic.

However, certain distinctions between Velika and Mala Balanica have been noticed. In Velika Balanica, in spite of the high amount of small bone fragments it was possible to identify cut marks, impact notches as well as dynamic fractures of fresh bone in ungulate remains. The presence of carnivore gnawing was scarce. The human subsistence reveals a dual exploitation of the biotopes in the surrounding area, such as hunting of ibex in the mountainous area as well as red deer from the open terrain located on the mountain plateau. The site was preferably used residentially by human groups during the warmer months of the summer. On the other hand, bones from a diverse range of animals were identified in Mala Balanica, most showing carnivore gnawing but also a few with cut marks. Variations in structure of the artefacts correspond to the differences in length and character of occupation. In Mala Balanica, only around hundred artefacts were found, among them many artefacts of quartz produced at the site, together with curated tools made of higher quality flint. However, in Velika Balanica, several thousands of artefacts were recorded from all production phases, mostly made of quartz and other low quality raw materials. The industry from both caves is of Charentian character, both technologically and typologically, whilst a "Quina" component is more prominent in Mala than in Velika Balanica. In Velika Balanica, near the top of the sequence, we note the presence of some Levallois artefacts.

The investigations carried out in Velika and Mala Balanica fill the gap in our knowledge about Charentian in central and south-east Europe. It can be observed that at many sites this facies succeeds the "Clactonian" or "Clactonoid" (Slimak et al. 2008) and Taubachian assemblages and that there is an apparent temporal trend in its spreading from the southwestern Asia toward central Europe. It is still not quite clear which factors contributed to the spreading of the "Quina system" (Hiscock et al. 2009). Its appearance in the Interglacial milieu, as is the case in Balanica, indicates that its beginnings and development can not be linked only to climatic and ecological factors, and that social and cultural factors have to be taken into consideration.

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## The AST-RX platform: a new efficient X-ray tomography facility for the scientific community at the “Muséum national d’Histoire naturelle”, Paris.

Benjamin Mora, Florent Goussard, Gaël Clement & Antoine Balzeau

Conventional axial X-ray tomography (or CT scan) is an efficient imaging methodology for the digitalisation, exploration and 3D modelling of specimens from natural sciences. This methodology allows the observation of internal structures at micron-scale. This approach based on imaging datasets allows “virtual” manipulations of a specimen, or part of a specimen, with the capabilities of individualize, move, rotate, scale, restore, deform, or complete each structures. Moreover, prototypes can be obtained from the 3D reconstructions. In this respect, imaging methodologies represent an important opportunity for highly detailed anatomical studies, particularly of previously unavailable features. They allow the observation, description, and quantification of characters and, at the same time, they offer new perspectives for the preservation of collections.

These opportunities are particularly relevant for the field of (paleo)anthropological sciences. Indeed, the limited number of unearthed fossils and their accessibility are factors that hinder paleoanthropological studies. Original remains, but also osteological collections of extant specimens, have to be stored in optimal and adapted environments, and direct manipulations need to be limited in order to preserve this irreplaceable patrimony. Imaging methodologies have recently provided ways for innovative advances in the preservation of these collections as well as offered new perspectives to museographic displays and original scientific studies. T

The Muséum national d’Histoire naturelle has just acquired a high resolution scanner with unique performances and field of applications for the community of natural sciences. The equipment (v|tome|x L240, GE Inspection Technologies SCS Phoenix|X-ray) combines a microfocus XR source (240kV/320W), a nanofocus XR source (180kV/15W) and a large size detector (400x400mm, pixel size: 200µm). Therefore, CT scan data can be obtained for samples of varying size (from around one millimetre to a maximal size of detection of 800x600mm), varying density, and with a level of detail detectability potentially below one micron.

We here present some examples of applications obtained at the AST-RX platform (for “Accès Scientifique à la Tomographie par Rayons X”) with a special focus on anthropological and paleoanthropological specimens.

## The evolution of the human mind: The Solutrean, time of cultural transition

Ricarda Müssig

The first step in hominisation led to the evolution of language and tool making - from the first *Homo sp.* up to the Neandertals. The next step created the *Homo sapiens*, endowed with art and fantasy, sources of his high intelligence. Both steps were genetically determined. But from now on cultural factors became more important than genetic ones: art even became a kind of guiding fossil.

This poster demonstrates that in the Upper Paleolithic important changes of the human mind were caused by a climatic change: the extremely cold epoch of Würm 2, which reduced the European population of animal and men by 90%, thus making the Solutrean an epoch of cultural transition.

From a matrilinear society to a mild patriarchic one. Before the Solutrean only female figures are pictured: in the Aurignacian the lion headed mistress of animals and the tiny fat mother-figurine, in the Gravettian the Magna Mater from Laussel and many small mother figures. During the terrible cold the trust in mother goddesses expired. Now the sexy Gönnersdorf girls, only bosoms and buttocks, came dancing onto the stage. Correspondingly, the self-consciousness of man the hunter increased. We find depictions of wounded and fleeing enemies, indicating indirectly that now males feel stronger. But only in the Magdalenian men begin to depict themselves: as mixed beings, half human, half animal with a big penis. In La Marche we discover portraits of men, pregnant women and cute babies.

The animal - from brother to booty. All primates dispose of this inherited signal: the frontal mother schema, signaling primate babies where to cling to after birth. Therefore hunter gatherers look at animals as a kind of family members, and our children do it up to today. That's why before the Solutrean people painted strong animals with which they identified. Thereafter 40% of the depictions demonstrate magical killing by spears and arrows, impressing the lions of Lascaux with blood pouring out of their mouth, signaling a shot into the lungs. Religious mind – magic mind - Homo faber. The religious mind implores higher beings for help, while the magic mind is convinced that rituals are stronger than spirits and gods.

In the Aurignacian and the Gravettian hints on magical thinking are rare, there are neither signs of shamanism nor hunting magic. The mother goddesses were implored for hunting success and healthy children. The magic mind appears in the Solutrean in the form of wounded enemies and human skulls as drinking vessels. In the Upper Solutrean and the Magdalenian we see magic practices in hunting, the first masked dancers and the first shamans: The bird type in Lascaux, the stag type in Les Trois Frères — the first male god in history? Today such types can be found in Siberia and America. There are no clear signs of totemism. To look on animals as booty can also be considered as the first step to Homo faber, raising and killing cattle, leading to the Neolithic revolution and finally to modern men.

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## The site of Melka Kunture (Upper Awash, Ethiopia): the archeological record from Oldowan to Late Stone Age

Margherita Mussi, Marcello Piperno, Leah E. Morgan, Denis Geraads & Carmine Collina

Melka Kunture (Ethiopia) is a major paleoanthropological site a c. 2000m asl, on the banks of the Awash River and on the shoulder of the Ethiopian Rift. Excavations led by Jean Chavaillon started in 1965 and were directed by Marcello Piperno from 1999 to 2010. A minimum of 30 archaeological sites, and of 70 archaeological layers have been so far recognized, representing every major period of the African archaeological record, from the Oldowan to the Late Stone Age.

New  $^{40}\text{Ar}/^{39}\text{Ar}$  geochronological data for several volcanic ash horizons constrain the ages of interbedded archaeology and paleontology at the Garba, Gombore, Kella Melka Garba, Atebella, and Simbiro localities.

The earliest site is Garba IV, where the base of the section may approach  $1.8 \pm 0.2$  Ma, while the top is securely dated to  $0.86 \pm 0.04$  Ma. Another sequence is found at Gombore, with a most reliable age constraints, from  $1.4 \pm 0.3$  Ma near the base of the section to  $0.70 \pm 0.03$  Ma near the top. At Kella and Melka Garba an ignimbrite layer is dated to  $1.24 \pm 0.08$  Ma. The base of the Garba section with abundant Oldowan-style may be  $> 1.7 \pm 0.4$  Ma. Early Acheulean localities include Garba XII and Simbiro III; assemblages from Gombore II and Garba I are considered to be Middle and Late Acheulean, respectively. At Garba III there is evidence of an Acheulean-Middle Stone Age transition. Artifacts from Kella I and elsewhere represent the Late Stone Age.

Among the most conspicuous features of the archaeology at Melka Kunture is the overwhelmingly predominant use of obsidian as a raw material, starting at Garba IV with the Oldowan, 600 ka earlier than other known intensive obsidian exploitation. Obsidian was intensively used up to historic times in the area. The vertebrate paleontology is dominated by bovids, giraffids, hippopotamids, and suids, but primate remains were also discovered. Hominid fossils have been found during excavations at Gombore I and Garba IV, associated with Oldowan archaeology, as well as at Gombore II associated with Acheulean archeology. Further remains were discovered at Garba III, in a MSA level.

## A Neandertal femoral diaphysis from Les Pradelles (Marillac-le-Franc, France): morphometric and cross-sectional analyses

Célimène Mussini, Isabelle Crevecoeur, Maria Dolores Garralda, Alan Mann & Bruno Maureille

The excavations at the collapsed cave of Les Pradelles (Marillac-le-Franc, France) have resulted in the discovery of numerous artefacts of the La Quina Mousterian techno-complex, a rich mammalian fauna and the remains of at least seven individuals.

During Isotopic Stage 4, Neandertals used the site as a hunting camp, as suggested by the amount of butchered reindeer bones discovered in the sediments. There is no archaeological evidence that Les Pradelles was a living site but rather a place where hunted animals were brought to be butchered. Since the first discovery of human remains in 1934, 78 additional Neandertal fossil bones have been unearthed during the excavations carried out by B. Vandermeersch between 1967 and 1980 and by two of us (B.M. and A.M.) since 2001. Most of the Neandertal bones are cranial remains but there are also several postcranial remains, mainly long bones.

During the 2010 field season, the major portion of a particularly well preserved femoral diaphysis was recovered. Its particular interest is related to its dating to the oxygen isotopic stage 4 which is less documented in human remains compared to the ISO 3. The fossil is part of the left femur of a mature individual. General anatomical features, for example overall antéro-posterior curvature and lack of a pilaster, are those of a Neandertal, in agreement with the other fossil and archaeological data and the dating of the site. Tuberosities on the linea aspera associated with an osseous bulge (with related hypervascularization) may reflect a pathological reaction of the bone.

In order to study the cross-sectional geometry of this femoral diaphysis, the specimen was CT-scanned and the cross-sectional geometrical parameters were computed. This information has been compared with similar data from samples of Neandertals, European Upper Palaeolithic modern humans and Near-Eastern Middle Paleolithic archaic modern humans.

The results of these comparisons depend on the parameter examined: Les Pradelles femoral diaphysis is clearly within the range of variation of European Neandertals regarding its high percentage of cortical and its ratio of the two second moments of area which indicate an ovoid section, and closer to those of Middle modern humans for its J parameter, which is considered as a general indicator of the strengths applied to the bone. This study emphasized the necessity to better encompass the ranges of morphological variation within European Middle Paleolithic Neandertals.

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## Estimating endocranial volume of *A. africanus*: influences of variability among reconstructions and small sample size

Simon Neubauer, Philipp Gunz & Jean-Jacques Hublin

Documenting the evolutionary increase of endocranial volume in our own lineage is central to our understanding of brain evolution. However, two independent factors make it complicated to assess endocranial volumes (EV) for fossil groups. (1) Many fossils are only partially preserved and/or distorted. Form differences among different reconstructions affect EV estimates. (2) Estimates of the group mean EV of fossil species have potentially large standard errors due to small sample sizes.

Here we provide new EV estimates for the *Australopithecus africanus* specimens Sts 5, Sts 60, Sts 71, StW 505, MLD 37/38, and Taung. These estimates are based on new endocranial reconstructions using computed tomographic (CT) data; each specimen is reconstructed multiple times.

To better interpret these data we use a sample of 90 complete modern humans and 60 chimpanzees to assess (1) the effect of small sample sizes and (2) the influence of form variability among multiple reconstructions of the same specimen on EV.

We generated virtual endocasts using a combination of two- and three-dimensional semi-automated segmentation, measured their volumes (EVs), and obtained 3D coordinates of endocranial landmarks as well as semilandmarks on endocranial curves and surfaces. For the fossils, we generated partial endocasts, measured the preserved landmarks, and estimated missing portions via thin-plate-spline reconstruction based on humans and chimpanzees as reference sample.

We simulated the following two scenarios. (A) Iteratively, we randomly chose 5 adult chimpanzees (the number of adult *A. africanus* specimens) and computed a mean EV. The distribution of 10,000 iterations nearly spans the range of individual chimpanzee EVs, demonstrating that average EV could be easily over- or underestimated when based on only 5 individuals. (B) We used all adult chimpanzees but altered every specimen to reflect the preserved morphology of one of the *A. africanus* specimens, reconstructed every specimen based on the human reference sample, and computed a mean EV. We repeated this for the missing portions of all fossil specimens. The resulting average EVs fall within the 95% confidence interval of the actual mean EV, demonstrating that, given the regions missing in the *A. africanus* fossils, mean EV can be reasonably estimated based on reconstructed individuals, even when differently shaped individuals (humans) were used as reference sample.

Our estimates of EV for *A. africanus* specimens are similar to previously reported values and show a relatively low range of variation due to variability among multiple reconstructions. The resulting species mean EV (459 ml, S.D. 60 ml, ranging from only 456 to 463 ml due to the variability among reconstructions) is also similar to previous reports. Our first simulation demonstrates that small sample sizes are problematic for estimating average EV. Our second simulation shows that the shape variability among thin-plate-spline reconstructions of the same individual and its influence on EV are negligible, even when modern human endocasts are used to reconstruct missing portions of chimpanzee endocrania.

It follows that including reconstructions of partially preserved fossil specimens so as to increase the sample size will provide better estimates of the average EV of *A. africanus*.

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## Conceptualizing Behavioral Variability in the southern African Middle Stone Age

Khori Newlander & Jamie L. Clark

The Howiesons Poort (HP; 68-58 ka) has figured prominently in recent attempts to understand the behavioral variability evident during the African Middle Stone Age (MSA), as the innovative technologies of this Industry (e.g. geometric backed tools, finely made bone points, and possibly snares and traps) exhibit only a brief florescence. Current research describes the HP fauna as “specialized” or “broad,” and the technology as “reliable” or “maintainable.” These dichotomous characterizations have significant implications for modeling the waxing and waning of this phenomenon. Here we explore the efficacy of these concepts for elucidating the changes in subsistence, technology, and environment evidenced during and immediately after the HP, focusing on data from Sibudu Cave. Building on these insights, we offer two hypotheses to account for the transition from the HP to post-HP MSA. We conclude by considering the utility of this research for understanding behavioral variability in the MSA and Middle Paleolithic more generally.

**Acknowledgements:** We would like to thank Lyn Wadley for providing access to the Sibudu material. Research by JLC was partially supported by a research grant from Rackham Graduate School (University of Michigan), the National Science Foundation (Grant 0612606), the Leakey Foundation, and the Palaeontological Scientific Trust.

## The Out of Africa patterns Versus Middle Pleistocene European lithic industries [MIS 16-8]

Elisa Nicoud & Roxane Rocca

New data on lithic industries from both the “Acheulean” phenomenon in Western Europe (Nicoud, 2011, PhD) and the “small tools culture” in Central Europe (Rocca, PhD in progress) from 630 000 to 300 000 years allow us to reconsider the paradigm of the “Out of Africa” diffusion.

Indeed, Lower Palaeolithic settlements in Eurasia are commonly explained as being the result of one or several dispersals of people and/or material culture from Africa. Several paths are suggested to reach Central and Western Europe: across Middle East and Eastern Europe and by the straits of Sicily and Gibraltar. Considering the Acheulean diffusion, the Out-of-Africa theory only works at a global scale and only if we agree to make Africa and Western Europe uniform dots: MIS 16 appearances in Italy are blended with MIS 9 appearances in England. Moreover, lithic industry is not considered within a technical frame and non-bifacial industries are totally excluded from the debate. According to literature, wide geographical and chronological gaps exist in the diffusion patterns. Also, the technical or at least typological variability of the Acheulean is well known but not described yet and Central European industries are usually only described by their non bifacial nature. If the chronological, geographical, technical and cultural uniformity of both Western and Central Europe can be discussed, so can the Out-of-Africa pattern.

Our study consists in a critical analysis of lithostratigraphic contexts and a consideration of technical, technological and chronological diversities from more than 45 industries of Europe, from every part of the historic Movius Line. They occur at Ambrona, Aridos (Spain), Barnham, Boxgrove, Elveden, High Lodge, Hoxne (England), Cagny, Soucy, La Celle, Saint-Acheul (France), Castel di Guido, Notarchirico, Torre in Pietra (Italy), Bilzingsleben, Dorn Durkeim, Karlich (Germany), Korolevo (Ukraine), Verteszölos (Hungary), Stanska Scala (Czech Republic), Rusko and Tzrebica (Poland).

Pushing forward the Technological Lithic study, we used a “structural” approach based on techno-morpho-functional analysis (Boëda, 1997). We focused on how tools were built, then how the tool kit was made up and finally how the whole production was structured. To define these ancient and sometimes poorly elaborate lithic products, the concept of “chaîne opératoire” is not enough. This significant amount of technical data is set out on maps, MIS after MIS. It does not support the Out-of-Africa theory, within the current state of archaeological data.

We suggest pushing forward some hypotheses, already expressed but still not exploited. One hypothesis pertains to the invention and the evolution of the “bifacial piece” within Western Europe. Another hypothesis relates to the porosity and the necessity to redraw the Movius Line. The technical diversity within two of the major “cultures” of the European Lower Palaeolithic industries is shown and can no longer be ignored. Also, it is essential to consider a chronological location of each appearance as precise as possible, to create any pattern at a global scale (each MIS corresponds at least at dozen of thousands years). Above all, we need to rehabilitate the whole Lower Palaeolithic and its inner variability, often hidden by obsolete cultural labels.

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## Modern human climate-related variation: face vs. nasal cavity

Marlijn L. Noback, Katerina Harvati & Fred Spoor

Climate is generally seen as an important factor driving evolutionary change in human evolution. Whether or not the distinct face of various hominin taxa is correlated with, and perhaps adapted to, diverse climatic conditions remains unclear. A first step towards a better understanding of the impact of climate is to study modern humans, a species which lives worldwide under a uniquely diverse range of climatic conditions.

Modern human craniofacial shape has indeed been shown to correlate with aspects of climate, such as temperature and humidity (e.g. Roseman 2004, Harvati & Weaver 2006, Hubbe et al. 2009). However, the causal factors underlying this association are not well-understood. Recently, Noback et al. (in press) demonstrated that climate-related shape variation of the human nasal cavity is consistent with physiological demands of breathing, in particular with conditioning of the inhaled air. Hence, climate-related variation of nasal cavity shape could be a prime factor driving the apparent association between climate and facial morphology.

We examined this hypothesis, using geometric morphometric methods to analyze three-dimensional landmarks of the face and nasal cavity of 100 modern human individuals from five climatic zones (quantified by temperature and humidity).

A two-block Partial Least Squares (PLS) analysis of the nasal cavity shape versus external facial shape (not including nasal landmarks) shows a clear climatic grouping on PLS<sub>1</sub>, explaining 72% of the total variation in the sample. However, a relatively low RV coefficient was found, which indicates that the nasal cavity and face do not co-vary strongly. Moreover, PLS analysis of the external face versus climate shows a substantially higher RV coefficient than the nasal cavity versus climate, possibly indicating a stronger relation between climate and facial shape. Indeed, regression of shape data on the two climatic factors reveals that for the nasal cavity, 10.83% of the variation can be explained by climate, whereas for the face (excluding nasal landmarks) 30.55% of the variation is explained.

Climate-related versus nasal cavity related shape changes of the external face are found to be very similar, with populations from cold climates showing relatively longer faces that are broader at the base, but narrower at the middle and upper part. In lateral view such faces show a more posteriorly positioned glabella, nasion and prosthion and anteriorly positioned zygomatics, giving the appearance of a 'flat' face.

Our results indicate that the face and nasal cavity shape co-vary, both showing distinct differences in shape between cold and warm climate groups. In addition to factors such as body size, diet and genetic drift, the modern human face is thus influenced by climate to a certain degree.

However, the nasal cavity is not the main driver of this association, as external facial shape is mostly climate-related independent of nasal cavity shape. Against the background of our findings for modern humans we can now assess if facial diversity in fossil hominin taxa is consistent with the pattern of climate and habitat change throughout human evolution.

**Acknowledgements:** We thank Chris Stringer, Rob Kruszynski, Ian Tattersall and Giselle Garcia for allowing access to the cranial material and for sharing their knowledge on the collections.

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## Can we carry out comparative FEA analyses of fossil hominin crania that inform about diet?

Paul O'Higgins, Michael Fagan & Laura Fitton

Among early hominins facial morphology varies substantially, implying varying masticatory system performance. Increasingly, finite elements analysis (FEA) has been applied across a range of mammals, including fossil hominins with the aim of interpreting variations in form in terms of functional variation. The general thrust of these types of FEA investigations is to compare the mechanical responses of skulls to loads using parameters such as strain magnitudes, distributions and bite forces.

Variations in functional performance are often considered to reflect variations in habitual masticatory system loading and so, point to possible dietary adaptations. However, in extant primates with known dietary differences we have yet to understand if and how variations in FEA outputs reflect dietary variations. In addition, lack of adequate and accurate muscle loading information, data on material properties, and fidelity of model anatomy serve to add noise to FEAs. Thus, it is not clear whether differences in performance are useful dietary indicators rather than reflections of the sensitivity of models to varying input parameters. In fossils, modelling issues are particularly severe, since anatomy is often damaged and distorted, internal spaces often filled with dense matrix and muscle data are unavailable.

Here we investigate the impact of variations in several craniofacial model building parameters on deformations, predicted by FEA. These parameters reflect the types of errors that might be introduced when working with fossil material. To these ends we assess variability in the performance of a macaque craniofacial FE model under varying muscle loading scenarios, segmentations, and material properties of teeth. The impacts of such errors are subsequently assessed in relation to the performance of two extant primates with known dietary differences (*Macaca fascicularis* and *Cercocebus torquatus*).

We find that FE model deformations are affected by errors introduced in the model building process such that decisions made while reconstructing and loading fossil hominins will impact on eventual assessments of functional performance. However, we show that many such modelling 'errors' impact on deformation in very predictable and controllable ways. This has an important consequence; that by understanding the types and degrees of the effects of such 'errors' we can quantify and take account of the likely impact on eventual conclusions that may be drawn regarding functional comparisons. Further, variations in the mechanical performance of the macaque and mangabey with different diets are small. This suggests that attempts to relate comparative bite performance to dietary differences are likely to be successful, but much more work needs to be done in extant taxa to fully understand how phylogeny, form and function interact in the craniofacial skeleton before thorough functional interpretations of fossil material can be made.

Thus, our findings indicate that the effects of error are controllable such that meaningful functional parameters can be estimated despite considerable uncertainty about reconstruction and loading. However, broader comparative studies of masticatory system form and function are needed to guide the development and eventual interpretation of such studies in fossils.

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## The human remains from Maszycka cave – a new approach

Jörg Orschiedt, Stefan K. Kozłowski, Marta Polowicz-Bobak, Darek Bobak & Thomas Terberger

Only a very limited number of human remains are known from the Magdalenian of Central Europe. Since the double burial of Bonn-Oberkassel has been re-dated to the transitional period of the early Federmessergruppen, apart from the burial of Mittlere Klause dated somewhat earlier to c. 18.500 BP and the neonatus from Wilczyce in Poland found underneath a dwelling structure of a camp site and directly dated to  $12.870 \pm 60$  BP (OxA-16729; Irish et al. 2008), no inhumation grave can be reported any more. Human bones from Brillenhöhle and the Burghöhle Dietfurt in southwestern Germany probably belong to secondary burials and together with some scattered bones from further locations they indicate that caves might be of major relevance for burial rites during that period. In this context human remains from Maszycka cave in southern Poland seem to be of outstanding importance. Bones of several individuals were detected by early field work in the late 19th century and by St. K. Kozłowski in the 1960s. The authors have started to re-investigate the material. The poster will present first results of the new approach including the discussion of possible traces of manipulation. It is becoming increasingly clear that the human bones from Maszycka cave represent one of the most important assemblages dated to the period after Heinrich event 2.

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## Aurignacian origins in Central Asia

**Marcel Otte**

New excavations (Yafteh, Kul Bulak) as well as surveys and studies of old collections clearly show high density of old Aurignacian sites between Zagros and Altai. Local Mousterian technologies show transitional processes leading to bladelets, characteristic for Ahmariian or so-called Proto-Aurignacian. No other industries or tradition can be traced locally. The Obi-Rahmat Levallois-blades technology leads to the Kara-Bom in Siberia and are completely outside this process. Thus, it is one who believes Modern Man is coming with Aurignacian in Europe (as the most probable hypothesis), both culture and people were coming from central Asia. No single artefact shows any relationship whatsoever, with Africa.

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## Ankle bones of *Homo heidelbergensis* from the Middle Pleistocene site of Sima de los Huesos (Atapuerca, Burgos, Spain)

Adrián Pablos, Ignacio Martínez, Carlos Lorenzo, Ana Gracia, José Miguel Carretero & Juan Luis Arsuaga

Up to date, a total of 25 tali remains (11 right, 14 left) have been recovered in the Middle Pleistocene site of Sima de los Huesos (Atapuerca, Burgos, Spain). This site, dated in at least 530,000 years (Bischoff et al., 2007), has yielded the largest collection of human remains ever found of genus *Homo* in the world (Martínez and Arsuaga, 2009). Based on dental evidence, these remains belong to a minimum number (MNI) of 28 individuals of both sexes and diverse ages-at-death (Bermúdez de Castro et al., 2004). They have been attributed to *Homo heidelbergensis* species, considered ancestors of Neandertals (Arsuaga et al., 1997; Martínez and Arsuaga, 1997).

The Sima de los Huesos sample constitutes more than 60% of the tarsal bones in the *Homo* fossil record prior to Neandertals and fossil *Homo sapiens*. At least 14 individuals are represented by the talus bones; eleven present adult morphology, with an age-at-death of more than fourteen years old according to modern human standards (Scheuer and Black, 2000; Cardoso and Severino, 2010). This piece of information is entirely compatible with 28 MNI determined with dental evidence and with other cranial and postcranial elements. A total of 34 metric and anatomical variables have been studied; including linear, angular and morphological variables. Our comparative sample includes Neandertals, fossil *Homo sapiens* and Early *Homo* individuals from Pliocene-Pleistocene. Early *Homo* includes those from Turkana Lake (KNM-ER 803, KNM-ER 813, KNM-ER1464, KNM-ER 1476 and KNM-ER5428), a Dmanisi specimen (D4110) and that from Pliocene levels from the Ethiopian site of the valley of the Omo River (Omo 323-76-898). Also, we have used a modern human population sample of known sex and age-at-death.

The Sima de los Huesos talus bones present all the articular facets broader than those found in modern humans (e.g. the articular lateral maleolar facet). The same condition is present in the Neandertal specimens (Rhoads and Trinkaus, 1977). The lateral expansion of the articular facets can be related to high levels of biomechanical stress. Thus, the SH and the Neandertal talus bones, as well as the specimens from early *Homo* hypodigm studied, share a high robusticity pattern, which is clearly different from that of modern humans.

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## A long-term comparative perspective on the European Middle Palaeolithic and the African MSA

Philip Van Peer

Comparative research on Neanderthal and early modern human behaviour has been on the agenda for many years but it has been almost exclusively framed in terms of the concept of modernity. Herein, modern human behaviour has been often set as a standard to which Neanderthals are to be measured.

Few efforts have been made to approach this comparative question from a true evolutionary perspective, acknowledging diversity and time. The basic rationale of this paper is that in the human clade evolution is mediated through history, even in remote time periods, and that we cannot truly understand the former without the latter as already remarked by Kroeber (1931). Much of the patterning in the cultural record can be expected to be the secondary effect of demographic processes as much as an inevitable and direct by-product of a behavioural system. Prerequisite instruments of an analytical history are the control of time and demography, and cultural phyletics (O'Brien and Lee Lyman 2000).

The paper intends to draw some large scaled contours of Neanderthal and modern human histories, as recorded in the material records that they have left and taxonomically identified as Middle Palaeolithic and Middle Stone Age. At present, such contours remain necessarily vague due to the extremely coarse-grained nature of the archaeological records, especially for the earlier ranges from those periods. However, they can serve as a background model for an approach of the Neanderthal/modern humans question from a different, more historical perspective (Zilhão 2011).

Three of the propositions of this model are 1) that in the 300-200 ka time range technological innovation in European populations was actually more acute than in contemporaneous African groups; 2) that the tempo of cultural change during the full Middle Palaeolithic/MSA is higher in Africa (McBrearty and Brooks 2000); 3) that in the late Middle Palaeolithic/MSA there are fundamental changes in the demography of both meta-populations, resulting in similar patterns of cultural variability and heralding the onset of the Upper Palaeolithic and the history of Neanderthal/modern human interaction in Europe.

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## The impact of raw material availability in the SW Iberian Paleolithic

Telmo Pereira, Nuno Bicho, João Cascalheira, João Marreiros & Jonathan Haws

For decades, Paleolithic research in SW Iberia used the theoretical models developed for Central Europe. These models emphasized aspects such as retouched tools, flint usage over other raw materials, along with core configuration or long distance acquisition of resources.

In the last decade, data gathered in this territory became more consistent, and it seems to point towards a different scenario. Apparently, it has a considerable variety of raw materials, with excellent to average knapping qualities and often locally available. Once there are significant differences within places with clustered sites as within multicomponent ones along with differences between places, it seems possible to suggest diachronic and regional variations that can also be related with functional, cognitive and cultural aspects. During all Plistocenic periods, flint, quartz and quartzite are present in the inventories, unless the sites represent quarries. Flake production is constant and abundant, blades are few when compared with other blank types, core-and-flake industries are very common as seem to change through time, even within the Upper Paleolithic.

Based on these aspects, it was started a dedicated project for the study of the raw material management by Plistocene populations in this territory, with an especial focus on the differences between Middle and Upper Paleolithic. Preliminary results seem to show that flint is naturally present only in coastal zones, which are usually pinpointed by abundant yet often small flint sources. Quartz and quartzite are always available in the territory but, sometimes, with bad knapping conditions. In the interior regions, some minerals such as chalcedony or jasper were used to produce similar artifacts such as those on flint. In this paper, we aim to present this project as its preliminary results.

**Acknowledgements:** This paper combines results from three PhD, a post-doc and three research projects. The doctoral dissertations as the post-doc are founded by FCT - Fundação para a Ciência e Tecnologia (Portuguese Science Foundation). The research projects were founded by FCT, Calouste Gulbenkian Foundation, Leakey Foundation and National Science Foundation.

## Adding new evidence to the debate regarding Neanderthals and the exploitation of birds

Marco Peresani, Matteo Romandini & Antonio Tagliacozzo

In the extensive debate surrounding the modification in human behavior and dietary habit that occurred alongside the Neanderthal-Anatomically Modern Humans substitution and the alleged broadening of the diet by the first sapiens (Chase, 1989; Marean, 2005; Stiner, 1999), a role is played by the avifaunal complexes preserved in deposits ascribed to the last autochthonous representative of European humans dating to the 50-42 ky BP interval.

Although ephemeral, several archaeozoological and taphonomical bodies of evidence from across the European continent pre-date definitive indications for the human exploitation of some species of birds in the Upper Paleolithic. This suggests that Neanderthal populations also made use of avifaunal resources.

One of the most significant sites considered in our paper, Grotta di Fumane in the North of Italy, has recently yielded important material for the study of Neanderthal behavior, especially during the final Mousterian and the Uluzzian, a transition cultural complex recently identified at the foot of the Alps (Peresani, 2008). This cave has provided striking evidence for archaic humans' possible attention to symbolism related to the deliberate extraction of wings or especially big feathers from large raptors and other birds (Peresani et al., 2011). The taxonomic determination of the bird bones has been based on comparison with the zoological collection of the Quaternary Palaeontology and Archaeozoology Section of the Pigorini National Ethnographic Museum and Italian Institute of Human Palaeontology of Rome. Microscopic analyses of the bone surfaces were carried out using using Nikon 1000 (Rome) and Leica S6D Green Ough (Ferrara) stereomicroscopes with 20-220 magnification range. Besides backdating the acquisition of valuable elements of avian plumage in human history, this and other new evidence from final Mousterian and Uluzzian levels strengthens our picture of the behavioral complexity among Neanderthals.

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## A morphological study of the tooth roots of the Sima del Elefante mandible (Atapuerca, Spain).

Leyre Prado-Simón, María Martín-Torres, Pilar Baca, Aida Gómez-Robles, María Lapresa & José María Bermúdez de Castro

The application of microtomographic techniques to dental morphological studies has revealed an untapped source of information about extinct and extant human populations. Internal dental structures (enamel-dentine junction, pulp chamber and radicular canals) have been characterized. The amount of information that can be extracted from a given specimen is maximized by this technology.

The three-dimensional evaluation of the dental roots of Sima del Elefante mandible, ATE9-1 (Atapuerca, Spain) has been performed. With 1.2 Myrs of age, this fossil represents the earliest hominin remains in Europe, and one of the very few human fossils for this period and region. Through this case study we aim to present a protocol for the description of the internal dental spaces, exemplify how the application of microtomographic techniques can significantly increase the amount of relevant and informative morphological features (even in the case of fragmentary/heavily worn teeth or teeth with hypercementosis) and explore some biological considerations about external and internal root morphology.

The external morphology of the preserved isolated roots was assessed by visual inspection and it was classified according to Wood et al. (1988). The internal morphology of the roots (pulp cavity) of the ATE9-1 specimen and the external morphology of the in situ roots were analyzed by means of CT and microCT. The scanning process was performed after the restoration work. Microtomography could only be done in the teeth that remained isolated after the restoration process (lower left premolars, both lower canines and lower right incisor). For the description of the root canals the method described by Canalda and Brau (2006) was followed. This thorough and systematic method allows detailed anatomical descriptions of the root canals starting from the crown (that encompasses the pulp chamber) and following with the coronal, middle and apical thirds of the root.

Our study reveals that the external surfaces of the roots are affected by the environmental and individual's life conditions. The generalized hypercementosis of all the ATE9-1 teeth has been related to excessive movement of the tooth within the socket in a first stage and/or to a high compensatory eruption rate due to a lack of proper opposing teeth (Martín-Torres et al., 2011). Nevertheless, the root canals are more stable and not so affected by external factors. This is why, in our opinion, the morphology of the root canals is more reliable and complementary to the external root morphology, especially in the case of ATE9-1 where a high degree of hypercementosis is present.

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## New Anatomically Modern Humans directly-dated at 32 ky BP from eastern Europe (Buran-Kaya III, Crimea, Ukraine)

Sandrine Prat, Laurent Crépin, Christine Verna, Stéphane Péan, Dorothée Drucker, Johannes van der Plicht, Hélène Valladas, Simon Puaud, Martina Lázničková-Galetová, Marylène Patou-Mathis & Alexander Yanevich

The Anatomically Modern Humans are known to have spread across Europe during the period coinciding with the Middle to Upper Paleolithic transition. Whereas the arrival and dispersal of AMHs into Western Europe is relatively well established, data related to their early settlement in Eastern Europe are relatively scarce. Furthermore the timing of their appearance in Europe as well as their association with Upper Paleolithic industries are subject to continuous debate.

We present here the oldest Anatomically Modern Human remains excavated in the extreme southeastern part of Europe, in conjunction with their associated cultural and paleoecological background. They have been found in the site of Buran-Kaya III located in Crimea (Ukraine). Our study is based on a multidisciplinary approach (taxonomy, taphonomy combined with stratigraphy, archeology, zooarcheology, radiocarbon dating and paleoecology) (Prat et al., in press). More than 160 human bone remains were discovered in a well documented Upper Paleolithic archeological layer (Gravettian cultural tradition). Morphological features and metrics of the Buran-Kaya III human remains are compared to samples of Neandertals and European early modern humans. The combination of non-metric dental traits and the morphology of the occipital bones allow us to attribute the human remains to Anatomically Modern Humans.

Furthermore, the taphonomical observations on the human bones (cut marks and representation of skeletal parts) and their comparison with the taphonomy of the faunal remains allow us to discuss the post-mortem treatment of the dead and shed new light on the symbolic behavior of early Anatomically Modern Humans. Human and faunal remains were radiocarbon dated by Accelerator Mass Spectrometry. The human bone yielded an age of  $31,900 \pm 240 / -220$  BP. This new date provides one of the oldest direct evidence for the presence of Anatomically Modern Humans in Europe and therefore increases the number of European modern human remains directly dated between 40,000 and 29,000 BP.

**Acknowledgements:** We thank the National Academy of Sciences of Ukraine for permission to excavate at Buran-Kaya III and all the team members of the 2001, 2009 and 2010 excavations. The analyses were supported by the ANR "Mammouths" Research Program of the French National Research Agency. The ATM Program "Relations Homme-Nature" of the Muséum National d'Histoire Naturelle (Paris) and the CNRS-UPR 2147 funded the 2009 and 2010 field seasons. We thank Sylvie Crasquin (UPMC) for the access to the E-MEB and Evelyne Kaltnecker (LSCE/UVSQ) for her collaboration in the bone sample preparation and Christophe Moreau for the C-14 dating on Artemis (LMC-14).

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## Dansgaard-Oeschger events and the climatic context of human occupation events in Europe between 50,000-20,000ya

Alexander J. E. Pryor, Tamsin C. O'Connell, Jirí Svoboda, Martin Oliva, Andrey Sinitsyn & Rhiannon E. Stevens

The initial colonisation of Europe by anatomically modern humans 50-20 kya took place during a period of rapid, large-magnitude climatic oscillations known as the Dansgaard-Oeschger (D-O) cycles. Twelve such oscillations took place between 50-20 kya, which have been associated with large fluctuations in mean annual temperature in the Greenland ice cores and periodic cooling to levels similar to those experienced during the coldest part of the last glacial cycle c.20 kya. How these oscillations impacted in continental European climates is less certain, however, which has hampered our understanding of how these rapid climate changes affected the early human occupation of the area.

This presentation reports the results of an investigation into the human response to these D-O events at archaeological occupation sites in two focal study regions of Moravia (Czech Republic and south Poland) and the Kostenki site cluster (Russian Plain). Oxygen isotope analysis of mammoth (*Mammuthus primigenius*), horse (*Equus sp.*) and fox (*Vulpes vulpes* and *Alopex lagopus*) at 22 assemblages from 14 sites across the two regions are presented, including the Pavlovian “megsites” of Dolní Věstonice, Pavlov I, Milovice I, and Předmostí, the early (>39 kya) human occupation assemblages from Kostenki XIV, and Kostenki I-1. As the majority of faunal remains at human occupation sites represent animals killed and butchered by humans, the climatic signals may be directly related to the time that humans occupied the site.

A total of 270 samples of bulk tooth enamel were collected and submitted for carbonate oxygen analysis, and the climatic signals produced were interpreted in relation to palaeo-temperature at the time that humans occupied these sites, indicating maximum differences of c.5-6°C between the warmest and coldest occupations.

The resulting climatic signals are interpreted according to climatic variability associated with the D-O events, and the implications of the temperature differences for human groups living during the European Upper Palaeolithic are discussed.

## New excavation of the Mousterian site of La Chapelle-aux-Saints.

**William Rendu, Cédric Beauval, Thierry Bismuth, Bruno Maureille, Laurence Bourguignon, Géraldine Delfour, François Lacrampe-Cuyaubère & Alain Turq**

The “Bouffia Bonneval” at la Chapelle-aux-Saints (France) is well known for having delivered in the early XX century a nearly complete Neanderthal skeleton which was interpreted as the first Mousterian sepulture ever discovered. However, the “Bouffia Bonneval” is only one of the many small dismantled cavities that constitute the site. La Chapelle-aux-Saints has been the subject of a new recovery for the past 11 years. The majority of the cavities have delivered archaeological deposits attributed mostly to the Late Middle Paleolithic and linked to human and carnivore activities. One of them, the “Bouffia 118”, has delivered a stratigraphy possibly contemporaneous from the one of the main cavity, constituted of the succession of two archaeological levels, one dominated by reindeer remains, the other by bison. The new discoveries provide valuable information and propose new hypotheses on the site formation process. Since this June, the excavation has been centered on the bouffia Bonneval in the aim to test these hypotheses and propose a revised history of the La Chapelle-aux-Saints cavities, by discussing the status of the Neanderthal skeleton. The archaeological data of this latest excavation give a new view of the Neanderthal skeleton of the “Bouffia Bonneval”, one of the most famous of the French prehistory.

## The chronostratigraphy of the south-western French Middle Palaeolithic: New TL data for the sequences of Pech de l'Azé IV and Chez Pinaud (Jonzac)

Daniel Richter, Harold Dibble, Paul Goldberg, Jean-Jacques Hublin, Jacques Jaubert, Shannon McPherron, Laura Niven, Dennis Sandgathe, Marie Soressi, Teresa Steele & Alain Turq

The relative and chronological positions of the technological and typological variants of the Mousterian in Southwest France have been the subject of debate for over forty years. Since the advent of both ESR and TL dating methods in the 1980s, a database of chronometric dates for a growing number of Middle Palaeolithic sites has been steadily accumulating. Recent analyses of the available data by Guibert et al. (2008) and Jaubert (2008) appear to show a complex pattern of broadly overlapping Mousterian variants in the late Middle Palaeolithic, which has led some to conclusions very similar to Bordes' initial culture group models for Mousterian variability (e.g. Delagnes and Meignen 2006). Here we report new thermoluminescence (TL) dates from several levels of the Palaeolithic cave sites of Pech de l'Azé IV and Chez-Pinaud (Jonzac). Both contain deep sequences of mainly Mousterian industries with considerable technological and typological variability of the lithic assemblages, which are associated with well-preserved fauna. In conjunction with data from other localities at Pech it is now possible to integrate the sequence at Pech de l'Azé IV in a local framework, extend it with new data from Jonzac and contribute to the understanding of the chronostratigraphy of Southwestern France by comparison with published age estimates.

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## Environmental influence on the phenotype: insights from teeth

Alessandro Riga & Jacopo Moggi-Cecchi

“Phenotypic plasticity is usually defined as a property of individual genotypes to produce different phenotypes when exposed to different environmental conditions” (Pigliucci et al., 2006, p. 2363). An environmental disturbance can lead to a change in the phenotype that, usually, comes out by modification of developmental patterns producing a certain trait. In this work, we aim to test if an environmental stress acting during dental development can lead to a change in morphology.

We tested this hypothesis on the upper molar teeth of a modern human skeletal collection (part of the “Frassetto” collection of the University of Bologna) composed by nearly 600 remains from Sassari (Sardinia, Italy), of known age and sex, died in the first half of the 20th century. From this collection we first selected individuals with at least 2 molars on the same side and then we selected two groups: in the first group (“stressed” group) we included individuals with at least 3 intermediate degree or one high degree enamel hypoplastic events on one tooth; in the other group (“non-stressed” group) we included individuals without enamel hypoplastic events in all of the teeth (individuals without incisors or canines were excluded from this group). At the end of selection 45 individuals for the stressed group and 30 for the non-stressed one, equally distributed between sexes were available. Hypoplasia was considered as an index of environmental stress, since it is associated with malnutrition or systemic diseases during dental development. As for morphology, we examined development of upper molar cusps using the ASU-DAS standards (Turner II et al., 1991): metacone, hypocone, metaconule, Carabelli’s trait and parastyle were scored with a 0-5 to 0-7 scale.

Differences between the two groups were analysed for each cusp, first with a Mann-Whitney test, then with multivariate analyses (Hotelling T-square and Manova) on the cusps of each tooth and on all the cusps. We used Bonferroni’s method for repeated tests to correct p-values. While in the single-cusp comparisons significant p-values are few, the multivariate analyses showed all significant p-values (except Manova on M3 cusps, probably because of the small sample size).

When the results are plotted as barplots (for each cusp in the two groups and a principal component analysis for the cusps of each tooth and all the cusps) a clear pattern emerges: the “stressed” group has a trend towards an increase of variability in the direction of more developed cusps; the range of variation in the stressed sample is overlapping but wider than the other.

These observations are consistent with the idea that environmental stress increases the range of variation in a trait. Moreover the increase of variation in the stressed group is not isotropic, but has a direction probably imposed by some developmental constraints. More studies are needed in order to understand the molecular processes that could be responsible for this developmental constraints and to assess a possible role for it in evolution of dental shape.

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## Genomic Selection and Next Generation Sequencing for genetic characterization of ancient human remains from Italy.

Ermanno Rizzi, Martina Lari, Carlotta Balsamo, Silvia Ghirotto, Giorgio Corti, Annamaria Ronchitelli, Alessandra Fischetti, Gianluca De Bellis, Guido Barbujani & David Caramelli

The study of ancient nuclear DNA in humans has been severely limited by the difficulty to ascertain whether the DNA sequences obtained are really endogenous to the specimen. However, nuclear DNA sequences recovered from early modern humans could shed light on DNA diversity in the past, and could pave the ground for a deeper understanding of human evolutionary history. The advent of next-generation sequencing methods (NGS)(2), allowed in some cases to overcome these limitations.

We applied a combined method of target enrichment by in-liquido capture (3) and subsequent NGS to a human specimen of the Upper Palaeolithic (Paglicci of the layer 23)(4) previously successfully characterized. Enrichment capture probes were synthesized as oligo-nucleotides using in-situ synthesis customized design using Customarray(TM) platform. Oligos were subsequently RNA transcribed and biotinylated to allow target enrichment collection. Customarray's enrichment pool has a high grade quality due to the use of classical phosphoramidite chemistry. The high quality chemistry process allows reliable and reproducible data and moreover long oligos synthesis (up 120 mer). The fast turnaround and the limited cost of the custom pool, allowed to design and optimize target enrichment experiments in few days, for big or small region of interest. Target region for probe design encompassed the entire human mitochondrial genome and several nuclear loci in order to provide a phylogenetic and phenotypic classification. Genomic enrichment targeted several genes involved in the expression of features that may have played an important role in the evolution of humans such as skin and hair pigmentation, cognitive, cardiac and respiratory function, perception of different tastes. Enriched samples, after library preparation, were quantitated using quantitative PCR (qPCR), 454 pyrosequenced and analysed in order to identify endogenous sequences. Capture probe enrichment and NGS of Paglicci of the layer 23 ancient DNA sample validated the previous results obtained with standard methodologies.

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## The Loess Hypothesis: is the Central and Eastern European Lower Palaeolithic hiding deep underground?

Izabela Romanowska

The pattern of spatial distribution of Lower Palaeolithic (LP) sites east of the Rhine is peculiar. The sites are rare; they do not come in clusters; and they do not seem to be associated with ancient river terraces. This is a robust pattern that has been recognized but not addressed as a distinct research topic so far. It may represent either a real past phenomenon or simply reflect modern research bias i.e. the poor state of knowledge. It has been argued before that the state of the art accounts for the rarity of finds in Central and Eastern Europe (Darlas 1995; Bosinski 2006). It is a common, although usually not loudly pronounced assumption that the intensity and quality of archaeological research in countries behind the former Iron Curtain falls short of western European standards. However, this notion has never been subjected to a thorough historiographic analysis and probably mirrors sentiments rather than facts.

Careful and impartial investigation into the history of research in Central and Eastern Europe reveals that archaeology and especially Stone Age studies started very early (Sklenar 1983), they were for most of the time generously supported and due to their nature ideologically neutral (Lech 1997/98).

Two alternative explanations of the low site density in Central and Eastern Europe have been put forward hitherto: climate and dispersal routes. Both can be challenged on the basis of current evidence and even if they might have some impact on human dispersal and the distribution of sites this impact is not strong enough to generate a pattern as robust as the one observed.

Given the above, a new alternative is needed to explain the phenomenon of the low density of LP sites in Central and Eastern Europe. New developments in taphonomical studies may bring the answer. The latest loess distribution map by Haase et al. (2007) shows a virtually uninterrupted mantle of glacial derived silt sealing interglacial soil levels and therefore any potential traces of LP human activity at depths of over 5 metres under the present ground level. The loess is deposited in front of the retreating glacial sheets which means that everything north of its extent is probably destroyed by the devastating force of the glacial while everything south of it is covered by up to 100 metres of sediment for construction purposes considered bedrock (Muhs 2007).

The loess hypothesis can be tested by examining the location of each known LP site in Central and Eastern Europe. The spatial analysis shows that virtually all the currently known sites are situated in places where industrial aggregates extraction reached several metres underground or where archaeological visibility was not affected by loess sedimentation, i.e. caves.

With the downside of loess obscuring the visibility of LP sites in the region comes an amazing potential for currently unrecognised deeply stratified sites preserved in situ within an easily datable with the Thermoluminescence method (Berger et al. 1992) and already well-investigated environmental context. This potential should not be overlooked even if it is hiding deep underground.

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## Reconsidering the evolution of human rotational birth

Karen Rosenberg, Marcia Ponce de Leon & Christoph Zollikofer

It has long been argued that modern human childbirth is distinct from birth in nonhuman primates because the human neonate typically rotates as it passes through the mother's birth canal. The birth canal in humans is a tunnel of changing cross-sectional shape and the infant, whose head and shoulders fit tightly within that tunnel, rotates to align the longest axis of its head and then its shoulders along the longest axis of that canal.

It has been further argued that this unique path means that human neonates (and their mothers) benefit from the presence of an attendant who can provide assistance to the mother and child, thus explaining the uniquely social context in which human birth takes place. The fossil record provides evidence about when this pattern of birth may have evolved.

The consistently broad shape of the australopithecine birth canal (seen especially in STS 14 and AL 288-1) at all levels of the birth canal has suggested to some that they had a birth mechanism unlike that seen in any living hominoid species. If that represented the primitive condition, rotational birth would have evolved sometime later, presumably in early *Homo* along with the evolution of encephalization.

The human fossil record of female pelvic morphology has expanded considerably during the last 30 years with the discovery of fossils such as the Gona specimen, the Jinniushan specimen, new reconstructions of the Tabun specimen. The latter two (archaic human specimens) have been reconstructed in 3-D computer assisted reconstructions that along with reconstructions of modern and archaic human neonates allow us to simulate the birth process.

Additionally, our knowledge of male pelvic morphology has been enriched by the reconstruction of the Kebara specimen and the Atapuerca SH1 specimen. We also have a better knowledge of neonatal cranial morphology for Neanderthals (Mezmaiskaya specimen).

Finally, in this paper we also consider the implications of new observations (Hirata et al. 2011) of the birth mechanism in chimpanzees (based on three captive individuals) which suggest that an occiput anterior orientation of the neonatal head may not be unique to human but occurs at least sometimes, in our close living relatives as well. In light of this new evidence on chimpanzee birth, we re-examine the assumptions made in earlier work on the evolution of human birth about what aspects of human birth are unique and whether particular aspects of the human birth mechanism represent a primitive or derived condition.

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## Norms and variation within the lithic industry during the Châtelperronian. What they tell us about contact between Châtelperronian and Protoaurignacian?

Morgan Roussel

During the Middle to Upper Palaeolithic transition in France, one local population, Neanderthals, is replaced by a migrant one, Anatomically Modern Humans. Several scenarios have been proposed to explain the technical tradition of the Châtelperronian, last cultural facies of Neanderthals populations. These models seem to be irreconcilable, one is in favour of an acculturation of the last Neanderthals by the Anatomically Modern Humans (Hublin et al. 1996; Mellars, 2005) and one proposed an independent evolution of the Châtelperronian (d'Errico et al., 1998).

Recently, publications challenged the chronology (Higham et al., 2010) and the anthropological attribution of the Châtelperronian (Bar-Yosef and Bordes, 2010). Few sites yielded a stratigraphy with several layers of Châtelperronian: La-Grotte-du-Renne at Arcy-sur-Cure (Connet, 2002) and La-Grande-Roche-de-la-Plématrie at Quinçay (Roussel, 2011). Importantly, at Quinçay the stratigraphical sequence, composed of one Mousterian layer underlying three Châtelperronian layers is sealed by a roof fall and there is no other Upper Palaeolithic layer above (Roussel and Soressi, 2010).

The lithic technological analysis of the three Châtelperronian layers, preserved in sequence in the cave of Quinçay, allowed us to determine the origin and the signification of Châtelperronian technical system changes over a long time period. In the three Châtelperronian layers, organized flake production does not exist and the lithic production is orientated towards the production of blades and bladelets. The method for blade production is specific of the Châtelperronian and is different from the one used during the Protoaurignacian. Here, it is a unipolar debitage of blades in sequence, which follows a two-step rhythm on an angular flaking surface. The by-products are of two categories and are mainly used as blanks for backed pieces.

Bladelet production during the Châtelperronian until now was not formally recognized, even if it has been documented in few sites (Pelegrin, 1995). Here, at Quinçay, bladelet production is quite frequent in the three Châtelperronian layers. Carried out on prismatic bladelet cores, the retreat of the flaking surface is oblique to the volume's axis of symmetry. This method is different from the one used during the Protoaurignacian but the goal of this bladelet production is similar to the one of the Protoaurignacian : to obtain blanks for large Dufour bladelets.

At Quinçay, the coherence of the lithic technical system from one layer to another suggests little to no change through time. Thus, we can consider that there was no progressive evolution from the Châtelperronian to the Protoaurignacian. Nevertheless, we have to consider the possible influence of the Protoaurignacian on the Châtelperronian.

Using the theoretical framework established by G. Tostevin (2007) we propose that these groups might have been in contact at places with a low degree of social intimacy such as pathways, where only end-products were visible. In that case, the idea of projectile and the concept of retouched bladelets would have diffused from one group to another.

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## Evidence of cutmarks and usewear traces from the Plio-Pleistocene site of El-Kherba (Ain Hanech, Algeria); and their implications for Early hominid subsistence activities circa 1.8 Ma.

Mohamed Sahnouni, Jordi Rosell, Jan Van der Made, Josep Maria Vergès, Andreu Ollé, Nadia Kandi, Abdelkader Derradji, Zoheir Harichane & Mohamed Medig

The current archaeological data on early hominid subsistence activities in Africa is derived primarily from Sub-Saharan Plio-Pleistocene sites, e.g. Dikika (however, the evidence is controversial), Bouri, Gona (Ethiopia); FLK Zinj, BK site (Tanzania); FxJj50 (Kenya); and Sterkfontein Member 5, Swartkrans Member 3 (South Africa).

The ongoing studies at the locality of El-Kherba (Ain Hanech) in northeastern Algeria expand the geographic range of evidence of hominid subsistence patterns to include the earliest known archaeological sites documented in North Africa. Dated to  $\geq 1.78$  million years ago; excavations from El-Kherba yielded an Oldowan industry associated with a savanna-like fauna contained in floodplain deposits.

The faunal assemblage is dominated by large and medium-sized animals (mainly adults), primarily equids. The mammalian archaeofauna preserves numerous cut-marked. Made chiefly of limestone and flint, the stone assemblage consists of core forms, débitage, and casual retouched pieces. Evidence of usewear traces is found on several of the flint artifacts, indicating early hominid activity of meat processing.

Overall, our subsistence analysis indicates that early hominids were largely responsible for the site accumulation, which is also corroborated by other relevant taphonomic evidence. Moreover, at 1.8 Ma, the cut marked bones recovered from El-Kherba represent the earliest known evidence for ancestral hominin butchery activities and large animal foraging capabilities in northern Africa.

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## Dietary adaptations in the Middle and Upper Palaeolithic of Eastern Iberia

Domingo Carlos Salazar-García, Valentín Villaverde & Michael P. Richards

Isotopic analysis carried out in Neanderthals from cold environments indicate that in all cases Neanderthals were top-level carnivores and obtained mainly all dietary protein from large herbivores. In contrast, isotopic evidence from European Upper Palaeolithic modern humans portrays a wider range of dietary protein resources, including evidence of partial marine and freshwater consumption.

We report here on the direct isotopic evidence for Neanderthal and Palaeolithic modern human diets in Eastern Iberia from Cova Negra, Abric del Salt, Cova del Parpalló and Cueva de Nerja.

Our results confirm that the top-predator model is also applicable to Neanderthals that lived in more temperate southern areas, although not as rigid as seen on northern Neanderthals, and that Palaeolithic modern humans from the Mediterranean are definitely intensively exploiting and consuming marine resources. A clear isotopic dietary shift is hence described for Eastern Iberia between the Middle and Upper Palaeolithic.

## Multi-proxy chronological approach of *Homo erectus* bearing sites in Indonesia : the Ngebung example

François Semah, Christophe Falgueres, Anne-Marie Semah, Andri Purnomo, Tony Djubiantono, Hassane Saleki, Boris Brasseur & Anne-Marie Moigne

The Sragen area, within the axial depression of Java Island, presents several deeply eroded volcano-tectonic boutonnières that allow explore an almost complete evolution of the area from Late Pliocene to Middle Pleistocene times. The most famous is the Sangiran dome (c. 50 sq. km) that yielded numerous *Homo erectus* fossils distributed between c. 1.5 and 0.8 M.a. Though, building a consistent chronological frame of hominid- and artefact-bearing layers proves to be somewhat complex on such large areas with discrete exposures, owing to the rapid horizontal changes of facies, linked to complex palaeogeographical patterns: comparable lithofacies and deposition environments in different places are far from being necessarily coeval; the relative scarcity of suitable dating material (e.g. for Argon and palaeomagnetism methods) owing to facies constraints and frequent reworking of volcanic effluents.

We present here an attempt to simultaneously implement several absolute dating methods (and compare them with some available palaeomagnetic records) around the significant palaeontological and archaeological site of Ngebung 2, which yielded a taphonomical assemblage (vertebrate fossils, artefacts and some hominid remains), at the basis of the so-called Kabuh or Bapang series in the North-Western part of the Sangiran dome: ESR analysis of volcanic bipyramidal quartz crystals; combined ESR/U-Series analysis of herbivore mammals teeth enamel and dentine;  $^{40}\text{Ar}/^{39}\text{Ar}$  fresh amphibole grains isolated from pumice matrix and from fine-grained tuffaceous deposits. Quartz grains ESR analyses use the aluminium centre, an approach likely to yield quite reliable ages. Results obtained on teeth are quite informative beyond age calculations: modelling their U-uptake suggests an opening of the system c. 130 ka, an event which may be related to both the doming up of the site and/or increased water circulation in sandy deposits during MIS 5. Compared Ar analyses of amphiboles in fragile pumices and tuffaceous beds allow to ascertain the penecontemporaneity of the volcanic minerals and the studied horizons.

The results present significant convergence to assign the addressed horizons an Early Middle Pleistocene age, c. 800 ka. This period is critical in the long Sangiran stratigraphy, as it documents the expansion of the most numerous, Trinil-like hominids; the emergence on Java Island of Acheulian-like lithic tradition; the progressive set up in the sedimentary record of Mid-Pleistocene climatic and environmental conditions (increased seasonality, severe fragmentation of the forest, dispersal in the archipelago of new mammal immigrants).

## The Neandertals of Spy (Belgium) and their context: results of the radiocarbon dating program

Patrick Semal, Anne Hauzeur, H el ene Rougier, Isabelle Crevecoeur, St ephane Pirson, Damien Flas, Mietje Germonpr e, C ecile Jungels, Bruno Maureille, Michel Toussaint, Herv e Bocherens, Paul Haesaerts, Thomas Higham & Johannes van der Plicht

The precise chronological context of most of the Neandertal remains discovered in Eurasia is not accurately known. This is mainly due to insufficient knowledge of their stratigraphic position and associated archaeological data as they come mostly from old excavations (primarily in the 19th century and the first part of the 20th century). Neandertal remains from only a handful of sites have been directly dated. Among them, those of Spy were radiocarbon dated and may be attributed to the period of Middle to Upper Palaeolithic transition.

In the present study, 32 bone and dentine samples of human specimens, fauna remains and artefacts from Spy were dated. The three Neandertal individuals (Spy I, II & VI) were dated using 6 samples at the CIO (University of Groningen) and at the ORAU (University of Oxford; using an ultrafiltration protocol) (Semal et al., 2009; Crevecoeur et al., 2010). Different ages were obtained, ranging between 33 ky and 36 ky BP uncal.

The youngest dates are probably minimum ages due to contamination and taphonomical problems like most of the dates directly obtained on the other Eurasian Neandertals (Pinhasi et al., 2011). Nevertheless, the oldest dates obtained by the CIO at ca. 36 ky BP provide a consistent cluster for which we have no reason to suspect contamination since all quality parameters of the collagen are in the defined intervals of confidence. Moreover, the dates around 36 ky BP were obtained on bone as well as dentine samples related to both Spy I and Spy II individuals. This age corroborates a previous date obtained by the ORAU using an ultrafiltration protocol on an unattributed human vertebra (Toussaint & Pirson, 2006). The three oldest dates are situated in a diagonal portion of the calibration curve and correspond to a time slice between 42 ky and 40.5 ky calBP at 95.4%.

According to the <sup>14</sup>C dating results on fauna remains belonging to the three "fauna-bearing levels" (FBL) identified at Spy, the Neandertals Spy I and Spy II, discovered in the upper part of the lower FBL, are actually contemporaneous of the middle FBL where Late Mousterian, LRJ and Aurignacian artefacts were identified. The excellent preservation state of the Neandertal bones, lacking gnawing traces, indicates that the bodies were protected from scavengers thus supporting the hypothesis that Spy I and II were buried from the middle FBL into the lower FBL. Given the radiocarbon chronology established for the techno-complexes in Northern Europe, the Spy Neandertals may be related to the LRJ although this hypothesis cannot be verified in the absence of direct association established during the excavation of 1886. We will present how the data from Spy can be integrated in the population history of Western Europe during the period that saw the replacement of Neandertals by anatomically modern humans.

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## Morphological integration between palatal orientation, cranial base and orbits in *Pan* and *Pongo*

Sascha Senck, Fred L. Bookstein, Philipp Mitteroecker, Michael Coquerelle & Gerhard W. Weber

The orientation of the face relative to the basicranium is an important aspect of interspecific and intraspecific variation in hominoids and demands consideration in models of hominoid evolution and systematics. In contrast to the African apes, orangutans are characterized by a structural condition known as airohynchy, an upwardly deflected face relative to the basicranium. It is likely that the orientation of the face is morphologically integrated with the shape of the cranial base and the cranial vault, but little empirical evidence exists for such an association. In this analysis we introduce a new method for delineating the covariation between midfacial orientation and basicranial and orbital shape in 3D, and apply it both to chimpanzees and orangutans.

Our sample comprises 40 adult specimens of *Pan troglodytes* and 43 specimens of *Pongo pygmaeus*. The shape of the face and the basicranium are represented by 99 landmarks and curve semilandmarks in three dimensions which were digitized on CT images. Position and orientation of the palate is represented by its rigid motion with respect to the Procrustes superpositions of the basicranium and orbits. Prediction of palatal position is by partial least squares analysis of these rigid motions vis-a-vis basicranial and orbital shape.

In this study we statistically quantified patterns of morphological associations between the basicranium and upper face and midfacial orientation. Our results indicate a high magnitude of integration among the shape of the anterior cranial base and the orbits and the relative position of the middle face for both species. We found a higher degree of airohynchy in *Pongo* as compared to *Pan*, but find several additional patterns of covariation and sexual dimorphism that have apparently not been anticipated in the literature. In both species, a more dorsally rotated palate is covarying with a decrease in relative orbital height. In *Pongo*, a dorsal deflection of the palate covaries with an inferior displacement of the anterior border of the temporal surface of the greater wings of the sphenoid bone and a superior displacement of the anterior border of the cribriform plate. In contrast, a more dorsally oriented palate in chimpanzees covaries with an anterior displacement of both the anterior border of the temporal surface of the greater wings of sphenoid bone and anterior border of the cribriform plate.

This approach overcomes most of the disadvantages of traditional approaches such as the employment of reference planes for registration and allows the visualization of covariation patterns in relation to facial orientation in three dimensions. We predict the position and orientation of the midface according to the shape of the cranial base and orbits, thus providing essential information for the interpretation of hypotheses about facial orientation.

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## Schöningen and its importance for research into the cultural evolution of humans

Jordi Serangeli, Thijs van Kolfschoten, Brigitte Urban & Nicholas J. Conard

Several late Lower Paleolithic sites have been discovered and excavated at Schöningen (Germany) over almost two decades. Apart from the well-known site with eight spears and the remains of at least 19 horses and the site with possible wooden shafts (Thieme 2007), there are several sites with a low density of archaeological finds. These sites enable research into settlement dynamics amongst Lower Paleolithic hominins in Central Europe. The sites are remarkable for the high quality of organic remains, allowing for a broad range of scientific analyses. The published data from Schöningen concern ballistically perfect spears, possible wooden shafts, burnt wood, potential evidence for fireplaces, worked and hominin-modified bones, stone tools indicating complex hunting and butchering strategies. Furthermore, data from geological, stratigraphical, and organic analyses contribute towards understanding the interglacial successions between the Elsterian and the Saalian glaciation, a period of great importance for hominin cultural evolution in Europe. The archaeological sites of Schöningen are thus of immense relevance in the discussion about human cultural evolution and for our understanding of the late *Homo heidelbergensis* or the late pre-Neandertals.

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## Re-examination of *Pan* sub-species differences – what the cranio-facial data show us

Nandini Singh, Katerina Harvati & Christophe Boesch

Genetic evidence (Becquet et al. 2007) has suggested that eastern, western and central chimpanzees represent three different populations, with the latter (*Pan troglodytes verus*) diverging before the other two and possibly being a distinct species. Morphological differences among these groups, however, are not clear-cut and bear directly on questions concerning taxonomy, sexual dimorphism and phylogeny in extant hominoids as well as in early human evolution. In this study, we re-examine *Pan* cranial variation using Procrustes-based geometric morphometrics to: 1) quantify and examine overall cranial shape variation among *Pan* species and sub-species; 2) investigate whether different cranial regions (face, basicranium and cranial vault) can distinguish sub-species of *Pan*; this is because different regions of the cranium have been shown to preserve phylogenetic information differentially (Harvati and Weaver 2006).

Our dataset comprises adult individuals representing 42 *P. t. troglodytes*, 44 *P. t. schweinfurthii*, 37 *P. t. verus* and 36 *Pan paniscus* specimens. A total of 53 3-D craniofacial landmarks were taken on the entire cranium. To analyze cranial shape variation, we conducted principal component (PCA) and canonical variate (CVA) analyses on Procrustes shape coordinates.

The PCA of the full cranial landmarks set shows a separation between the *Pan* species, but no distinction between the sub-species. Shape differences between bonobos and chimpanzees mainly relate to the relative height of the neurocranium, basicranial flexion and position of the premaxilla. The CVA distinguishes bonobos from common chimpanzees, and also shows subtle separation among the chimpanzee sub-species. In the separate face, basicranium and cranial vault analyses, bonobos are best distinguished from chimpanzees in aspects of the face and basicranium. Among the sub-species, *P. t. troglodytes* consistently overlaps with *P. t. verus* and *P. t. schweinfurthii* in all three cranial regions. *P. t. verus* and *P. t. schweinfurthii* overlap the least with each other in aspects of the face. *P. t. troglodytes* and *P. t. schweinfurthii* are more similar to each other in basicranial shape than they are to *P. t. verus*, and *P. t. troglodytes* and *P. t. verus* show the most overlap in aspects of the vault.

These results suggest subtle population differences between the western and eastern chimpanzees, but indicate no consistent separation of the western chimpanzees as suggested by the genetic data (Becquet et al., 2007). Our results further show that cranial regions bear distinct taxonomic signals that help to better identify morphological differences among *Pan*.

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## Crown shape correspondence between the EDJ and the enamel surface of hominoid molars

Matthew M. Skinner, Philipp Gunz & Alessandro Riga

Teeth are made up of two tissues: the dentine core and the overlying enamel cap. The surface between these two tissues is referred to as the enamel-dentine junction (EDJ). Metric studies of the enamel surface, and more recently the EDJ, have revealed strong taxonomic patterns in both surfaces.

The degree of correspondence between each surface has a long history of debate in anthropology because it has implications for our interpretations of variation in tooth crown shape in hominin systematics, as well as, our understanding of the process of tooth development. A strong correspondence facilitates the comparison of variably worn samples of fossil teeth because one can make strong inference about the shape of the hidden EDJ and/or the shape of the original, unworn enamel cap. Poor correspondence would necessitate examination of both the EDJ and outer enamel surface to insure robust taxonomic and phylogenetic hypotheses based on tooth crown shape.

Recently, Skinner and colleagues have demonstrated in a number of papers that there is a strong correspondence between the EDJ and enamel surface with regard to discrete dental traits, as well as, the gross morphology of molar tooth crowns. These studies indicate that tooth crown morphology tends to derive from the EDJ and is not substantially altered by enamel deposition. However, debate continues regarding the degree of correspondence between the EDJ and enamel surface in terms of cusp size and positioning (and specifically, that each surface may yield different patterns of metamerism variation).

We conducted a geometric morphometric analysis of unworn lower molars of extant hominoids to test the null hypothesis that there is a strong correspondence in cusp size and position between the EDJ and the enamel surface. Landmark datasets, capturing the shape of dentine horns (at the EDJ) and cusps (at the enamel surface) were processed using standard GM protocols. A two-block partial least squares analysis was used to quantify shape correspondence between each surface and digital surface models were used to visualize shape co-variation.

Results are consistent with previous findings in demonstrating a strong correspondence between the EDJ and enamel surface indicating that differential distribution of enamel is not substantially altering cusp patterning on lower molar tooth crowns.

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## Sexual dimorphism and laterality in the evolution of the anthropoid prefrontal cortex

Jeroen Smaers, Christophe Soligo, Katrin Amunts & Karl Zilles

Cross-species behavioural variation goes hand in hand with variation in the anatomical traits supporting the behaviour that is selected for (Plavcan and van Schaik 1992, 1997). This principle also applies to brain-behaviour interactions (Barton and Harvey 2000). Because males and females inherently face sex-specific reproductive investments (Key and Ross 1999), social behaviour is often observed to be sexually dimorphic (Emlen and Oring 1977; Lindenfors et al. 2004).

Little is known, however, about sex-specific evolutionary patterns of brain structures supporting sexually dimorphic social behaviour in primates. Moreover, lateralized brain functions relevant to sex-specific social pressures have been described (Casperd and Dunbar 1996), leading to the hypothesis that lateralized brain structure evolution interacts with sex-specific evolutionary patterns.

We investigate evolutionary patterns of the brain structure most relevant to higher cognitive processing (prefrontal cortex) across anthropoid primates (including humans) and find sex-specific and hemisphere-specific evolutionary trends for relative volume and white/grey matter ratio in both humans and non-human primates.

Results indicate that sexual selection operates on quantitative aspects of brain structure evolution in primates, and does so differently between the two hemispheres.

**Methods:** To investigate variation in prefrontal cortex volume across species we employ a bootstrap approach based on the cytoarchitectonic delineation of the frontal lobe (Smaers et al. 2010). The bootstrap approach consists of considering cumulative volumes along the anterior axis of the frontal lobe (Smaers et al. 2011). For each hemisphere coronal sections at 20 equidistant intervals between the area 4 – area 3 boundary and the most anterior end of the neocortex are used to compute frontal lobe volume. For each individual and for each hemisphere cumulative volumes are then computed along the 10 most anterior intervals. To investigate variation in relative prefrontal volume across species, we compute phylogenetic regressions along all 10 intervals so that a detailed overview of volumetric evolutionary trends along the anterior axis of the frontal lobe is revealed.

**Brain data:** We examined 42 individuals from 20 anthropoid species (humans, 5 apes, and 14 monkeys). For each species both male and female individuals are available. Brain data comes from the Stephan, Zilles, and Zilles-Amunts collections housed at the C. & O. Vogt Institute for Brain Research (University of Düsseldorf, Germany) (Zilles et al. 2011).

**Results:** Relative prefrontal volume in the left hemisphere is increased in female compared to male smaller brained primates. This sex-specific neuroanatomical difference decreases in larger brained species with humans becoming monomorphic. In terms of right prefrontal cortex volume, males significantly hyperscale to rest of brain volume while females scale isometrically. This trend is explained mainly by the increased right prefrontal investment in males versus female chimpanzees, gorillas, and humans.

**Contributions:** Our results provide an evolutionary framework for observations of sex-specific cerebral lateralization in humans, inform us on the possible ways in which great apes are different from monkeys, and increase our understanding of how social behaviour influences primate adaptation.

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## Static data and active agents: Palaeolithic landscape use and meat procurement behaviour in Britain and north-west Europe

Geoff Smith

This paper details the results of recent PhD work into landscape use by early hominins in Britain and northern Europe. The research collected primary zooarchaeological data from four key British Palaeolithic sites (Boxgrove [MIS<sub>13</sub>], Swanscombe [MIS<sub>11</sub>], Hoxne [MIS<sub>11</sub>] and Lynford [MIS<sub>3</sub>]). The principal aim of this project was to assess the importance and intensity of human behaviour at each site; in short to test the assertions that faunal accumulation at each site was a direct result of human meat-procurement behaviour. Such research is required to act as a check and balances in our approaches and interpretations of past hominin behaviour and land use.

The methodology used for this study required the detailed collection of primary zooarchaeological and taphonomic information from all four sites. This included information on weathering, fragment size, carnivore modifications and human modifications. Faunal elements were recorded using diagnostic zones, which allowed for detailed comparisons within and between each study site. The same diagnostic zones were used to record bone surface modifications to allow for the precise location and comparison of bone surface modifications. This primary data was contextualised with information from each site in order to understand, in full, the formation history of each assemblage. Such an approach allowed for a contextualised understanding of human behaviour and land use.

The results from this study illustrate the wide variation in the scales of interpretation offered by each site. For example, the fine grained deposits at Boxgrove allow for detailed discussion and understanding of human behaviour across a large palaeolandscape. This site provides the clearest and most unambiguous evidence for primary meat-procurement behaviour by ancient hominins. Similar the well excavated site of Lynford provides a similarly high quantity of information but a different strategy of hominin landscape use and meat procurement; focussed on marrow-extraction from a known location. Importantly no evidence of mammoth-hunting behaviour was identified at Lynford, in contrast to previously published reports (Schreve, 2006).

The sites of Swanscombe and Hoxne provide a cautionary tale in using faunal remains from fluvial locations particularly in terms of poorly understood context with little temporal definition. The data from these sites were compared with faunal material from published sites in northern Europe including Schöningen and La Cotte de St Brelade and producing some interesting similarities between Schöningen and Boxgrove and some considerable differences between La Cotte and Lynford.

This study has questioned whether faunal remains from deposits that also contain lithic tools are de facto associated. The research has demonstrated that as archaeologists we must be aware of the different scales of interpretation and can be discussed and detailed. The study has also highlighted similarities and differences in human land use and meat-procurement behaviour across northern Europe. It is important to emphasise that the scale of the site may also limit the behaviour visible at the site. Finally, it is important to emphasise that hunting and scavenging can no longer be seen as either end of a spectrum of behaviour but rather as a continuum.

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## A CT-based reconstruction of the OH 7 *Homo habilis* type mandible

Fred Spoor, Christopher Dean, Susan Anton, & Meave Leakey

The eastern African fossil record of early *Homo*, not attributable to *H. erectus* (*s.l.*) has been interpreted as representing either a single variable species, *H. habilis* (Tobias, 1991), or two distinct taxa. In the latter case, however, there is no consensus over the hypodigms of these two taxa. To some they are primarily defined by differences in neurocranial and dental size (Rightmire, 1993; Blumenschine et al, 2003), but to others the difference mainly concerns facial form related to masticatory function (Stringer, 1986; Wood, 1991).

Confusingly, the associated names vary as well, depending on which of the two taxa includes the type specimen of *H. habilis*, the OH 7 partial skull and hand from Olduvai Gorge. Grouped with other larger fossils such as KNM-ER 1470, OH 65 and KNM-ER 1802 this hypodigm of *H. habilis* contrasts with smaller specimens for which the name *H. microcranous* Ferguson, 1995 is available, with KNM-ER 1813 as its type specimen. Alternatively, if OH 7 is associated with the other Olduvai specimens, such as OH 13, 16 and 24, as well as the Koobi Fora specimens KNM-ER 1805 and KNM-ER 1813, this hypodigm of *H. habilis* contrasts with specimens inferred to show masticatory specialization rather than a different cranial size. The latter take the name *H. rudolfensis* from its lectotype, the orthognathic cranium KNM-ER 1470.

Central in this debate is the question, rarely addressed directly, whether the OH 7 *H. habilis* mandible can make a plausible biological match with the KNM-ER 1470 cranium. Answering this question is greatly hindered by the preservation of the OH 7 mandible. In particular the shape of the dental arcade is difficult to reconstruct from the better preserved left side because there are no visible landmarks reliably indicating the midsagittal plane, and the degree of distortion of the symphyseal area is unclear.

To clarify the preservation and morphology of the OH 7 mandible we examined the specimen using medical computed tomography (CT), and the resulting images form the basis of a reconstruction of the dental arcade.

The CT images reveal that the lingual symphyseal area, hidden from direct view by the dislocated right corpus, is well-preserved. The presence of a marked genial spine in combination with the observation that the apical halves of the incisor roots are not dislocated makes that the symphyseal midline can now be identified reliably for the first time. Using additional information about local distortion of the left corpus and symphysis, it is possible to reconstruct the 'in-vivo' placement of the incisors and of the left canine and premolars, based on the alveoli and interstitial facets. This process was done both virtually and by physically matching high-resolution casts of the individual teeth.

The reconstructed dental arcade and other aspects of the corpus of OH 7 can now be compared with other mandibles such as KNM-ER 1802, and with the preserved morphology of the KNM-ER 1470 maxilla, shedding new light on the associations of these specimens.

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## Cut marks and their natural alterations: archaeological imagination meets carnivore activities

Leif Steguweit

Functional and/or deliberate cut marks on animal bones have offered important evidence of anthropogenic activities in Palaeolithic find assemblages since the beginning of functional studies in the early 1980-ies. Criteria such as regular cross sections are used to distinguish marks caused by mechanical processes or re-deposition. Differential diagnostic features – especially microscopic analyses of the marks – are today the main criteria used for objective assessments (Steguweit 2003; 2009).

From the first investigations (Binford 1981), the distinction between anthropogenic marks and alterations like trampling, re-deposition or bite marks has been seen as a detachable matter of differential diagnosis. A recent faunal assemblage with bite marks of young Siberian Huskies (sled dogs) displays that the dog's jealousy about food seems to produce a range of bite marks what is much larger and more heterogeneous than previously believed (Steguweit 2009). Regular and parallel scratches on the bone surface are a typical feature. A mark depth of more than 100 micrometer is more typical for carnivore jaws than for anthropogenic cuts. In conclusion, an evaluation of asserted cut marks in Palaeolithic bone inventories is required to detect unclear and "more than questionable" cases.

On the other hand, the poster presents measurements on animal bones from the Middle Pleistocene site of Bilzingsleben with regular engravings (first published by Mania & Mania 1988). Analysing the marks with a Laser Scanning Microscope, it became possible to quantify relevant information, such as the wall-angle of their profile, their width and depth (Steguweit & Mania 2000; Steguweit 2003). Those quantitative data helps to describe the exceptional regularities at the microscopic scale, probably on every bone produced by one specific edge of a flint tool. Those engravings are relatively clear distinguishable from butchery marks and the majority of non-human bone modifications, most likely produced by canines of carnivores. A few examples of canine marks will be illustrated and discussed.

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## Quantitative comparison of dental occlusal wear patterns in *Australopithecus afarensis* and *Pan troglodytes* lower molars

Stefanie Stelzer, Bence Viola, Ottmar Kullmer & Horst Seidler

Early hominin diets are an essential question in paleoanthropology. Since teeth are the most commonly fossilized skeletal part of the body, several approaches have been developed to reconstruct diet from teeth. These include studying the diet of a fossil individual using stable isotope analyses, giving insights on the diet during tooth development, and microwear analyses, throwing light on the last meals of an individual. The occlusal fingerprint analysis (OFA), applied in this study is a more holistic approach, as it quantitatively describes and compares dental occlusal macrowear patterns, and thus reflects the individual's diet during the time-span the tooth was in occlusion. The macrowear pattern consists of attritional wear facets and abrasion zones, such as tip-crushing areas. They develop during the processing of the food over a longer time period, and lead to differences in the size and spatial position of enamel loss, depending on different food types, and possibly other behavioural factors. In this contribution we compared the macrowear pattern of *Australopithecus afarensis* and *Pan troglodytes verus* lower molars in order to assess whether their molars show similarities in tooth wear, pointing towards a similar diet in both species.

Surface scans and  $\mu$ CT data were used to generate virtual crown models suitable for OFA using the 3D software package PolyWorks® (Innovmetric Inc.). The results show that the macrowear pattern is different in the two examined species. While *Pan* shows steeper facets with sharp margins, *A. afarensis* shows less inclined facets with mostly blurred margins and a considerable amount of tip crushing areas. Therefore, we suggest that the diet of both species differed, although *A. afarensis* was probably able to cope with fibrous foods just like *P. t. verus*. The difference is that the wear pattern in *Pan* shows evidence of fibrous food that requires higher cutting and shearing capabilities, while the flatter pattern with enlarged abrasion areas in *A. afarensis* is indicative of a higher portion of hard and brittle foods including hard-fibrous objects. We will discuss these implications on diet in comparison to molar microwear and stable isotope analyses.

## Late juvenile, early adult cranial growth in a chimpanzee population from the Tai forest

Andre Strauss, Philipp Gunz & Fred Spoor

Some of the most prominent specimens in the hominin fossil record are either late juveniles or early adult individuals (M2s but not M3s in occlusion; unfused speno-occipital synchondrosis). Among others, examples include type specimens (MH1, OH5, and OH7), as well as well-preserved skulls (KNM-WT-15000 and D2700). Such specimens are frequently considered in studies assessing taxonomy or phylogeny, with the explicit or implicit assumption that at this stage of development various relevant characters are already fully adult in morphology. However, little is known about this later phase of growth and development in hominid taxa, with a marked absence of comprehensive quantitative studies specifically mapping morphological change from late juveniles into adulthood.

Here we contribute to this issue by analyzing the shape changes in cranial morphology during late stages of ontogeny in a sample of 41 wild chimpanzees from the Tai Forest (Ivory Coast). This collection is particularly suitable, because the individuals are derived from a single population, reducing the influence of genetic and environment factors, and in many cases calendar ages are known.

Cranial morphology was quantified three-dimensionally, using 152 landmarks and 38 curves. Data was collected in a virtual environment, from surfaces extracted from high-resolution CT-Scans of the original specimens. Changes in size and shape are being analyzed by means of morphometric geometric techniques including Procrustes analysis and PCA.

Preliminary results show that after the eruption of M2 the chimpanzee cranium shows little change in overall size and shape, but localized events can be discerned. These findings are in agreement with previous studies (Krogman, 1931) done using more traditional morphometric approaches. As a next step this study will be expanded to include growth series of modern humans and gorillas.

The developmental models obtained for the three extant taxa will subsequently be used to predict the changes in cranial morphology which would have occurred had various late juvenile hominins lived.

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## Sorting the muddle: human species and their relationships in the Middle Pleistocene

**Chris Stringer**

Considerable debate surrounds the nature of Middle Pleistocene humans, and how they relate to later populations. In my view, *Homo heidelbergensis* was a geographically widespread species which apparently gave rise to at least three descendent populations: *Homo sapiens* in Africa, *Homo neanderthalensis* in western Eurasia, and the ‘Denisovans’ in eastern Eurasia. However, the Atapuerca Sima de los Huesos sample should be assigned to *Homo neanderthalensis* rather than *Homo heidelbergensis*, and the age of this sample must be younger than 450,000 years rather than older. Nevertheless, there is growing evidence for an overlap of *Homo heidelbergensis* and its putative descendants in the later Middle Pleistocene of Europe and Africa.

Together with recent indications of late Pleistocene archaic-modern gene flow, these issues highlight the complexity of any taxonomic framework for these populations.

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## The paleoenvironment of Pliocene Laetoli (Tanzania): a synthesis of diverse habitat indicators

Denise Su

The Pliocene site of Laetoli in northern Tanzania has produced a large and varied faunal assemblage, including specimens of *Australopithecus afarensis* from the Upper Laetolil Beds (3.6-3.8 Ma) and *Paranthropus aethiopicus* from the Upper Ndolanya Beds (2.7 Ma). A deeper understanding of the paleoecology of Pliocene Laetoli can be illuminating for questions of *A. afarensis* and *P. aethiopicus* habitat access, use and preference.

Attempts to reconstruct the paleoenvironment of the site, however, have yielded a wide variety of interpretations regarding habitat composition and vegetation types. The reconstructions for the Upper Laetolil Beds range from arid to semi-arid grasslands to bushland to woodland, and even gallery forest. Different habitat indicators from the Upper Ndolanya Beds result in conflicting paleoecological reconstructions that are open and arid as well as humid and closed.

The difficulty in reconstructing the paleoecology of Laetoli stems from the complexity of the paleoenvironment, the coarse resolution of the available data, and the contradictory nature of the different lines of evidence.

In order to circumvent some of these problems, the community structure of the large mammal fauna and relative abundances of bovid tribes are analyzed and the results are interpreted within the context of other forms of data, including small mammals, gastropods, phytoliths, stable isotopes and mesowear. Furthermore, GIS analysis was also conducted on various paleoenvironmental indicators for a better visualization of their geographic and temporal relationships, as well as a better understanding of the changes in these indicators through time and space.

The balance of evidence suggests that the paleoecology of the Upper Laetolil Beds was a true mosaic of grassland-shrubland-open woodland habitats with extensive woody vegetation in the form of shrubs, thickets and bush, as well as a significant presence of dense woodland habitats. The reconciliation of the contradictory evidence from the Upper Ndolanya Beds, however, is problematic and full resolution requires further detailed taphonomic studies.

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## The British Late Middle Palaeolithic: technological practices during the MIS<sub>3</sub> Neanderthal re-occupation

Rebecca Wragg Sykes

A clear archaeological signature of the Late Middle Palaeolithic (LMP) re-colonisation of Britain by Neanderthals during Marine Isotope Stage (MIS) 3 can now be identified based on a corpus of sites dating to after 55 kyr BP, containing Mousterian-type lithic assemblages. Although lacking in high-resolution/deeply stratified deposits, these sites represent a coherent body of data for understanding the late Neanderthal re-colonization of the northwestern-most part of their range. Detailed lithic analysis of assemblages from locales in varied landscape and geological contexts, at a mix of resolutions, allowed the investigation of various aspects of the British LMP including raw material exploitation and technological organisation (Wragg Sykes, 2009).

The results demonstrate that while the British LMP record is in many ways comparable to other Continental LMP entities, particularly the Mousterian of Acheulean Tradition, in certain aspects it appears distinctive. Patterns of raw material selection and transport, the treatment of bifaces as plastic, curated artefacts and the spatio-temporal extension of the reduction sequence seen on the Continent are evident in the British LMP. However, a notable idiosyncrasy is the almost total lack of Levallois technology and a strong focus on discoidal/centripetal and informal systems of reduction in many raw materials, usually in association with bifaces. This signature of a technological system focused on flexibility and predictability in flake production, alongside the reliability and maintainability of bifaces and scrapers in transported toolkits, is interpreted as reflecting very high levels of mobility as a strategy for facing uncertainties during the colonization, and reacting to the fluctuations in environments and resources resulting from the instability of the climate during MIS<sub>3</sub>.

In addition, uni-directional patterning in the transport of high quality flint artefacts suggests an organisation to landscape use and technological strategies on very large scales. This could reflect movements into central and western Britain to exploit megafauna, either from Belgium/northern France across Doggerland or via the Channel Plain, highlighting the possible sources for the colonizing groups as an important unresolved question, which is being addressed through current research on the post-MIS<sub>5</sub> layers of La Cotte de St Brelade and other sites surrounding this region.

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## The challenge of bipedal balance. How sagittal balance is acquired during gait acquisition? Comparison with non-human primates. Evolutionary implications

Christine Tardieu, Noémie Bonneau, Christophe Boulay, Jérôme Hecquet, Jean Legaye & Geneviève Duval-Beaupère

While learning to stand and walk, the challenge is to ensure an efficient sagittal balance of the trunk on the lower limbs. Duval-Beaupère (1992) demonstrated experimentally which conditions are required: the trunk line of gravity must act anterior to the dorsal curvature but posterior to the lumbar curvature and hip joints. In the absence of this harmonious weight distribution, additional muscular force is needed and compressive stress on the vertebrae arises.

Using x-rays, we discovered a sagittal pelvic parameter the “angle of sacral incidence”, which is tightly positively correlated with the degree of vertebral curvature, thus demonstrating the role of the pelvis in this balance (Legaye et al. 1998). Describing the position of the acetabula in relation to the sacral base, this angle characterizes the anchorage of the vertebral column on the pelvis (Boulay, Tardieu, Hecquet et al. 2006).

To elucidate the morphological components of this angle, we compared 50 adult, 17 infantile and 20 intact newborn pelvis. We used the software package, “DE-VISU”, developed by J. Hecquet (Tardieu et al. 2006). From a set of 47 landmarks, we reconstructed the three pelvic joints, the angle of incidence and many other functional parameters. In adults (mean angle of incidence: 54°; range: 35°-75°), a high angle —associated with a strong lumbar curvature— is correlated with a strong sacral slope and a low anchorage of the sacrum on the iliac bones. A low angle -associated with a weak lumbar curvature- is correlated with a weak sacral slope and a high anchorage of the sacrum on the iliac bones. From the neonatal to the adult state, the mean angle of incidence increases (newborns: 28°; infants: 40°).

We describe how sagittal balance is acquired during gait acquisition. Among the implied anatomical changes, the backward sagittal displacement of the sacrum with respect to the acetabula represents a crucial element in the economy of erect posture. We also show the significant increase in the angle of incidence in young Japanese macaques trained for bipedalism. Such a plasticity of incidence in relation to an erect position appears to be a strong argument for the influence of gravity on this parameter. The angle of incidence is not sexually dimorphic.

We measured on x-rays the angle of incidence in 10 non-human primates and observed far lower values (16°- 40°), consistent with the greater instability of the vertebral column in human subjects with very low incidence. The values in australopithecines pelvis (AL 288-1, Sts 14) are located in the lower range of the variation observed in humans. We propose a scenario for the evolution of the incidence in primates.

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## Stable isotope $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$ evidence for Mid-Upper Paleolithic Hominines' palaeodiets in Gorny Altai

Alexei Tiunov & Maria Dobrovolskaya

Bioarchaeological investigation of the skeletal materials from Paleolithic cave sites of the Gorny Altai gives new information to main events of anthropogenesis and humankind peopling in Eurasia. Cultural continuity through Middle-Upper Paleolithic makes the Altai region a crucial for the human evolution study (Derevianko, 2009). Dietary ecology is one of the main approaches to reconstruct the lifestyle and local environment of ancient humans. In this study, new human skeletal fragments from Okladnikov Cave and a new sample from Denisova Cave have been analyzed to get isotopic data for the paleoecological and paleodiet reconstructions of Asian late Pleistocene humans.

The bone fragments were obtained from collections of the Institute of Archaeology and Ethnology of the Siberian Branch of RAS. We sampled 7 fragments of postcranial skeletons from levels 1, 2 and 3 in Okladnikov Cave and one fragment of the cranial vault from level 11 of Denisova Cave.

**Method.** The collagen was extracted from the bone using a conventional method (Jørkov et al., 2007). Stable isotope analysis of bone collagen was conducted using a Thermo-Finnigan Delta V Plus continuous-flow IRMS coupled with an elemental analyzer (Thermo Flash 1112) located at the Institute of Ecology and Evolution RAS. Samples were analyzed with reference gas calibrated against IAEA reference materials USGS 40 and USGS 41 (glutamic acid). The drift was corrected using internal laboratory standard (acetanilide). The isotopic composition of C and N was expressed in the  $\delta$ -notation relative to international standards (VPDB and atmospheric nitrogen, respectively). All samples were analyzed in duplicate, the variation in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values among replicated samples did not exceed 0.1 and 0.2‰, respectively.

**Results.** The  $\delta^{13}\text{C}$  values of Okladnikov Cave samples varied from -20.1‰ to -19.1‰. The values of  $\delta^{15}\text{N}$  were also very similar in all fragments (from 13.4‰ to 14.1‰). Isotopic data from European Middle-Upper Paleolithic sites suggests that hominines from Okladnikov Cave hunted large herbivore mammals. The range of  $\delta^{13}\text{C}$  values of European Neanderthals and individuals from Okladnikov Cave is similar, though the  $\delta^{15}\text{N}$  are higher for Okladnikov Cave than for most European specimens. The studied fragment of the cranial vault goes from level 11 of Denisova Cave. The tooth from the same level was used for the paleo-DNA study (Reich et al., 2010).

The unique taxonomic position of the Denisova Cave inhabitants implies that newly obtained isotropic data are of high importance. The Denisova Cave specimen had relatively high  $\delta^{13}\text{C}$  values (-18.9) and extremely high  $\delta^{15}\text{N}$  values (16.0), comparable with those of some Eastern European Early Upper Paleolithic individuals, for example, from Kostenki 1 (Richards et al. 2001). Similar isotopic signatures of the Denisova Cave individual and Early Upper Paleolithic humans from Eastern Europe can be a result of the similar behavioral patterns (food source using, landscape and climate preferences). Further investigation will verify this suggestion.

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## The effect of image segmentation method on the cranial response to load: a finite element analysis sensitivity study

Viviana Toro-Ibacache, Miguel Prôa & Laura Fitton

How a skull deforms and how well it resists loads are important performance indicators and frequently used in studies of form-function relationships in evolutionary biomechanics. In order to carry out such studies three dimensional virtual models are first created. These models are laboriously constructed from medical images, via image segmentation techniques. How much detail is needed to build models that reliably predict performance?

Several segmentation approaches are possible, varying in the degree of detail of internal external bone form and how the image is partitioned into segments. This study investigates the sensitivity of finite element modelling to variations in the image processing technique.

Using two extreme image segmentation techniques, threshold and manual segmentation, two cranial models, lacking internal detail, of an adult female grey-cheeked Mangabey (*Lophocebus albigena*) were reconstructed from medical CT images. The threshold technique was automated and facilitated the delimitation of anatomical structures by partitioning the image into non-overlapping regions which were homogeneous with respect to intensity (grey scale). Manual segmentation involved manually separating structures (bone and air) into the desired materials based on the operator's visual assessment of the resulting segmentation. Finite element models were produced for both models. The models were loaded using maximum muscle forces, predicted via bony proxies for the main muscle of mastication and all muscles were fully activated. Several biting scenarios were simulated (both central incisors, left I<sub>1</sub>, right I<sub>1</sub>, left M<sub>1</sub>, right M<sub>1</sub>). Facial deformations and strains were computed. The resulting cranial deformations were compared using two approaches; strain maps and geometric morphometric analyses.

The results indicate that overall deformation and the patterns of strain were similar for both models, however, the model produced via manual segmentation showed very small regional increases in strain. These peak strains were, as expected, localized to where the model had thinner structures. Differences were also apparent when comparing the results of the incisor bites, the threshold segmented model recording higher bilateral facial strains under unilateral loading. This increased bilateral strain was explained by the artificial fusion of the central incisors during the threshold segmentation process, and eliminated by manually unfusing the teeth. Differences recorded between the two models were however negligible when compared to the differences recorded in each model during different biting tasks.

In conclusion, threshold segmentation allows for the rapid production of models. However, ambiguities in delineation of structure can arise and may have an effect on FEA interpretation. By combining it with additional manual segmentation in specific regions, it should be possible to rapidly create models that behave reliably. Furthermore, the small variation between these two extreme segmentation methods suggests, depending on the sensitivity of the question, data exchange among researchers where different segmentation methods may have been applied should be acceptable.

## Changing patterns of human subsistence in North Africa during the Middle Palaeolithic and Iberomaurusian: evidence from the Grotte de Pigeons at Taforalt, Morocco

Elaine Turner, Nicholas Barton, Abdeljalil Bouzouggar & Louise Humphrey

Northern and Eastern Morocco is a region of key interest for the understanding of human evolution and behavioural development. Recent investigations at a number of key sites in this region are beginning to produce the chronological, palaeoenvironmental and archaeozoological background necessary to understand this process. One of these sites is the Grotte des Pigeons at Taforalt. Located some 50 km from the present Mediterranean coastline, close to the Algerian border, the cave has an unparalleled sequence of human occupation spanning well over 100ka.

In this paper we focus on new analyses of the faunas from the Middle Palaeolithic (MSA) levels which have produced Aterian finds, as well as animal remains from the upper part of the sequence which includes the transition to the Epipalaeolithic (LSA). The Middle Palaeolithic (and Aterian) faunal assemblage is contrasted with the later Iberomaurusian one in order to identify and assess changes in the procurement and exploitation of game. Barbary sheep (*Ammotragus lervia*), a montane species, is dominant in all levels reflecting a continuity of hunting practices focussed mainly on locally available fauna. While faunal remains from the Middle Palaeolithic levels tend to display evidence of a more intensive utilisation of the game (higher percentage of bones with cut marks and impact notches), the remains from the younger deposits show relatively less evidence of butchery and, in particular, fewer marks associated with the extraction of bone marrow. Similarly there is a higher percentage of bones with burning marks and bones bearing traces of use as tools (bone compressors) in the older deposits than in the younger levels.

These changes are probably related to a major transition from low to high intensity use of the cave during the later Iberomaurusian, as indicated by very thick midden deposits containing vast quantities of burnt land snails, microlithic stone tools and many human burials.

## New Paleolithic Cave sites of western Georgia New approach to study the caves

Nikoloz Tushabramishvili

The geographic situation of Georgia – as a cross-road between Europe and Asia and simultaneously as a natural refuge, where the Pleistocene glacial periods had less severe influence, could provide a key information for deciphering the processes that have taken place during the Paleolithic in Eurasia: changes of its major chronologic and cultural-technological stages, driving forces of transitions from one phase to another, ways and directions of human migrations.

Generally, the beginning of Upper Paleolithic in the Caucasus is contextualized as part of a larger debate about the arrival of *Homo sapiens* in Europe between 45 and 30 ka, and the replacement of existing Neanderthal populations.

In this context, the discovery of the new sequence of Bondi Cave brings new data on this key-period in the South Caucasus around 40 ka BP and on the UP of Georgia. In this cave the UP layers are just in contact with the recently un-covered Middle Paleolithic layer.

Preliminary paleobotanical and pollen analysis has revealed presence of flex in the Cave. This could be the earliest record of flex (38 000 BP) which is in accordance with speculations of scientists regarding the possibility of textile production in the beginning of the Upper Paleolithic.

Another newly discovered unique cave-site is Undo Klde. The middle and mixed UP layers are represented in the cave. For the present days in Middle Paleolithic layer was discovered about 120 pieces. Most of the tools are the Mousterian points. Layer is contained big number of faunal material (mainly *Ursus sp.* – 99%). Here deeply in the cave were found engraved marks made by prehistoric men, it can turn out that we are dealing with so far the sole and oldest trace in the region of Paleolithic rock-art.

The 48m deep karstic pit at the end of the cave is especially intriguing. During explorations some material was collected from the pit, among the fossils several faunal (*Ursus sp.*, *Canis lupus*, *Cervus elaphus*, *Capreolus capreolus*, etc.) and human remains were found (*H. sapiens sapiens*, 2 individuals).

Research of this site is very promising for the investigation of origin of initial forms of religion and art. The novelties of study the caves are: 1. launching of tectonic and seismic research in Rioni-Kvirila basin. This region represents a fault zone and seismically is very active. Mounting a seismograph and assay to correlate seismic data with the recent sedimentation processes will help us to analyze the role of past seismic processes in the character of sedimentation in the caves, also their influence on the environmental adaptations of our ancestors; 2. The molecular genetic works will be conducted in the laboratory of the Ilia State University. The sequences will be aligned with the available sequences of brown bears. The time and the reasons of replacement of *Ursus sp.* by the *Ursus arctos* will be established. Cave-bears together with some others survived in Georgia until Mezolithic because of presence of the natural refuge in Western Georgia.

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## New data concerning the taxonomy of the Bañolas human mandible (Girona, Spain)

Almudena Alcázar de Velasco, Ignacio Martínez, Alejandro Bonmatí, Rolf Quam & Juan Luis Arsuaga

Since the discovery of a fossil human mandible in 1887 near the town of Banyoles (Girona, Spain), there has been considerable disagreement among scholars as to its taxonomic allocation. In different studies the specimen has been included within *Homo neanderthalensis* (Hernández-Pacheco and Obermaier, 1915; Sánchez, 1993), ante-Neandertals (de Lumley, 1971-72) or an antewürmian (Roth and Simon, 1993) species. More recently, the Bañolas mandible has been argued to lack derived Neandertal traits (Daura et al., 2005).

After a recent examination of the original specimen, we present the results of principal component and discriminant analyses based on a set of 14 linear measurements related to the general dimensions and proportions of the mandible with the goal of clarifying its taxonomic affinities. Mandibles from individuals representing *Homo heidelbergensis*, *Homo neanderthalensis* and both Pleistocene and recent *Homo sapiens* have been included in the comparative sample. Our results suggest the Bañolas mandible clusters closer to the *H. sapiens* group than to specimens representing either *H. heidelbergensis* or *H. neanderthalensis*.

The only direct dating of the mandible yielded an age of  $66 \pm 7$  kyr B.P. (Grün et al., 2006). To date, the oldest fossil evidence of *H. sapiens* in Europe is dated to c.40 kyr cal. B.P. (Trinkaus et al., 2003; Rougier et al., 2007). If the preliminary conclusions of the present study are confirmed through future in-depth analyses, a reconsideration of the timing of the arrival of the earliest modern humans in Europe may be warranted.

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## Morphological and morphometric analysis of the Middle Pleistocene hominin mandible from Payre (Ardèche, France)

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In June 2010, a hominin mandible from an old adult was discovered at the site of Payre (Ardèche, France). The specimen was found in the level Ga that is radiometrically dated to the end of MIS 8/beginning of MIS 7, a time period for which very few fossils are known in Europe.

This piece retains the complete symphyseal region, most of the right lateral corpus until the level of the right second molar, and a tiny infero-posterior portion of the right ramus. Two teeth, the right P<sub>4</sub> and M<sub>1</sub>, and part of the M<sub>2</sub> (whose crown is broken) are preserved *in situ*.

High-resolution micro-CT scan data were acquired and reveal details of the internal anatomy and dental tissues. These data also allowed us to reconstruct the mandibular body by symmetry.

We present a detailed comparative analysis of this specimen that includes morphological features as well as morphometrics analyses. Our comparative samples encompass specimens attributed to the Neandertal taxa — divided into early (MIS 7-5e) and late Neandertals (MIS 5d-3) — as well as European Middle Pleistocene specimens that are generally attributed to *Homo heidelbergensis*. Discrete morphological features of the mandibular body present on the Payre mandible are compared to their frequency distribution in the comparative samples. 2D metrics include the height and breadth of the body as well as symphyseal angles and cross section geometry. Linear measurements are analysed through univariate and multivariate analyses. We also present the results of Geometric Morphometric analyses in order to take into account size-related shape changes.

The Payre mandible shows a combination of primitive and Neandertal-like features and is characterized in particular by a receding symphyseal profile without any element of the mentum osseum, a posterior and inferior location of a single mental foramen and a posterior location of the prominentia lateralis. Its mandibular body is tall and thick, with values at the M<sub>1</sub> exceeding those of all the Neandertals included in our samples. By its dimensions and combination of features, Payre falls well within the variation of Middle Pleistocene European hominins, including the range of variation observed among the Sima de los Huesos sample. Compared to stages 6-5e Neandertals, Payre differs from the majority of them by the more archaic morphology of its symphysis and inner corpus.

Overall, our analyses show that the mandible from Payre exhibits an archaic and robust symphysis whereas the lateral corpus is less robust and shows a more derived morphology. Although there is a general agreement that Neandertals represent a hominin lineage rooted in Europe during MP times, the tempo and mode of evolution in the Neandertal lineage and the taxonomy of late Middle Pleistocene European hominins are the subject of debate.

In this context, our results underline the mosaic pattern of change in the evolution of the European lineage and that the total pattern of Neandertal derived morphology was not achieved at the beginning of the stage 7.

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## The study of the human remains from Baouso da Torre cave: implications for lifestyle, sexual dimorphism and burial practices during the Gravettian

Sébastien Villotte & Dominique Henry-Gambier

BT<sub>1</sub>, BT<sub>2</sub>, and BT<sub>3</sub>, three Gravettian skeletons from Baouso da Torre cave (Liguria, Italy), are largely complete skeletons excavated by E. Rivière in 1873. After his death in 1922, his collection was auctioned. Since that time, two of these skeletons, BT<sub>1</sub> and BT<sub>3</sub>, were lost, and the only descriptions of these specimens are found in the principle studies done by E. Rivière (1887) and R. Verneau (1906). BT<sub>1</sub> (an adult) and BT<sub>3</sub> (an adolescent) were rediscovered recently in the collection of G. Goury, a French prehistorian (Villotte and Henry-Gambier 2010). The third individual, BT<sub>2</sub>, has only received partial study to date. The ongoing study of these remains addresses three critical issues with regard to human evolution during the Gravettian: 1) lifestyle, mobility and subsistence strategies, as reflected in upper and lower limb robusticity; 2) sexual dimorphism based on new stature estimates and cranial morphology of the two adult subjects; and 3) burial practices as revealed by taphonomic study of the remains. Finally, palaeopathological findings (three probable congenital conditions) indicate a possible close genetic relationship for at least two of the three individuals. These pathological conditions have not been described previously for the Upper Palaeolithic.

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## Middle Palaeolithic associated hominin remains from Chagyrskaya Cave, Altai Mountains, Russian Federation

Bence Viola, Sergey V. Markin, Adeline le Cabec, Mikhail V. Shunkov & Anatoly P. Derevianko

Since the early 1980s, intensive research in the Altai mountains by researchers of the Institute of Archaeology and Ethnography, Siberian Branch, Russian Academy of Sciences, Novosibirsk significantly improved our understanding of the Middle and Upper Palaeolithic of this area. In the course of the investigation of numerous cave and open air sites, hominin dental and postcranial remains were recovered from both Middle and Upper Palaeolithic contexts. Most of these remains are extremely fragmentary, so ancient DNA research played a key role in unraveling the affinities of these hominins.

Krause and colleagues (2007) showed that the hominins from Okladnikov Cave are genetically closely related to, while in Denisova cave a completely different hominin population existed at about the same time (Krause et al. 2010, Reich et al. 2010). Since 2007, one of us (SVM) leads the excavation of a new, very rich Middle Palaeolithic site, Chagyrskaya cave. The deposits yielded a Mousterian industry very similar to Okladnikov cave, and several very fragmentary human remains.

Absolute dates for the site are not yet available, but biostratigraphic data indicates that the material probably belongs to the Karginian interstadial (OIS 3).

Chagyrskaya 1 is a very small, worn upper deciduous canine with marked labial convexity and marginal ridges. Chagyrskaya 2 is an atlas fragment of an about 2-3 year old child, both of these remains derive from layer 6b. Chagyrskaya 3, an upper P4 fragment and Chagyrskaya 4, a lower incisor worn to the cervix come from the underlying horizon 6v. Both seem rather small, and have very short roots outside the range of variation reported for Neanderthals (Bailey, 2005, Walker et al., 2008), even though comparative data collected by one of us (ALC) indicates that these samples significantly underestimate the variability of Neanderthal tooth root size. Chagyrskaya 4, the lower incisor has an extreme case of hypercementosis, a feature frequently seen in Neanderthals.

As a very similar industry in Okladnikov cave, about 100 km away, is associated with Neanderthals, our hypothesis is that these remains also belong to this group. No derived Neanderthal morphology is preserved in these remains, and no direct comparisons are possible with the material from Okladnikov cave, as no anatomical elements are present at both sites. A possible link with the Okladnikov material are the very small tooth crowns and roots at both sites, that are at the lower limit of the Neanderthal range of variation.

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## Biomechanical modelling of hominoid skulls and teeth

Gerhard W. Weber, Stefano Benazzi, Ottmar Kullmer, Amanda Smith, Fred L. Bookstein & David S. Strait

Some technological approaches now used in physical anthropology such as Virtual Anthropology (VA) and Finite Element Analysis (FEA) have significantly enhanced our ability to study aspects of functional morphology. Understanding the feeding biomechanics of hominoids per se and in particular the impact of mastication on the evolution of the skull are of central interest.

VA allows us to expose, reconstruct and compare the geometry of biological objects using quantitative methods and statistics (Weber & Bookstein 2011). FEA brings along the exploration of how loadings are distributed over structures and how they might change under different conditions (e.g., Strait et al. 2009; Kupczik et al. 2009; Grine et al. 2010; O'Higgins et al. 2010; Wroe et al. 2010; Groening et al. 2011). The fusion of the two fields promises a much broader view of evolutionary questions. However, it also entails a series of problems (Weber et al. 2011), for instance, because some fundamental bridges between them are missing and because an experimental design for validation of results is not available.

In this contribution, we review some current results to demonstrate the potential as well as the apparent problems of the combined approach. Examples will include a biomechanical analysis of human molars (Benazzi et al. 2011) that refers to their supporting structures using wear information (Kullmer et al. 2009) in order to create more realistic loading scenarios, the use of geometric morphometrics for the selection of biomechanical models to capture intraspecific variation (Smith et al. 2011), and advances on our first biomechanical model of an australopith. In closing, we will summarise appropriate next steps from our point of view.

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## Gravel pit archaeology: a valuable source for the Older Palaeolithic periods in Central Europe?

Thomas Weber

For long time spans of the Central European Lower and Middle Palaeolithic, the discoveries in gravel pits seem to provide often the only input for reconstructing cultural history. As a result of the geological circumstances during the Middle and Upper Pleistocene, the archaeological remains have been sedimented in fluvial deposits which are now exploited for building material. Therefore the archaeological context is limited in its evidence but the geological arrangement is nevertheless excellent: As even in Central Europe (and especially in Central Germany south of the largest Upper Pleistocene – Weichselian – Glaciation) the territories of human settlement and glacial expansion alternated, it is possible to reconstruct the changing history of mankind's advances up to the northernmost borders of the *oikumene*.

Generally, we can distinguish two large glacial expansions in the Elsterian and Early Saalian (*sensu stricto*) Glaciations. They have brought large till (moraine) sediments to Central Germany, which can often be found in the opencasts (lignite mines) and also in gravel pits. Before the glaciers arrived, the rivers sedimented (Early or *Anaglacial*) gravel banks under the circumstances of decreasing vegetation in the mountains. In these gravels we discover Palaeolithic artefacts and the faunal remains of different animals from the large and small mammals up to fish remains and mollusc shells.

In Wallendorf, some 15 km south of Halle, we recognized the classical position of the Palaeolithic stone (mostly flint) artefacts more or less immediately on the base of the gravels. As ecological indications (growing presence of “colder” molluscs, the larger portion of chalk (*Muschelkalk*) pebbles, and ice wedges in the Upper gravels) show, the temperature decreased during the gravel accumulation up to conditions in which the glaciers gradually approached, the waterflow dried up and glacialimnic sediments were accumulated.

Perhaps we can distinguish two large periods of gravel sedimentation in the Central German rivers between Elsterian and Saalian Glaciations – the so-called “Older Middle Pleistocene” and the “Main Terrace” (in Central Germany more or less immediately preceding the Drenthe phase) containing different types of archaeological material – “Clactonian” and “Acheulian”. As these two technocomplexes can easily be distinguished, the third gravel sedimentation phase in the “Lower Terrace” of probably Early Weichselian Age seems to frequently contain “Acheuloid” archaeological finds and the “typical” Upper Pleistocene inventories have often been found in other – e. g. lacustrine – sediments (like Königsau) or different kinds of sedimental trap (like Westeregeln: carstic conditions). It cannot be excluded that the special conditions of the sedimentation in fluvial gravels leads to a selected survival of even more “robust” stone artefacts showing a “biased” picture of the originally left artefact inventory.

Sometimes – like in the Middle Elbe valley – the gravels are removed up to 20 m below the ground water level and it is impossible to reconstruct the exact conditions of sedimentation also for a number of potentially “spectacular” discoveries like several human fossils.

## The variability of the first hominin technologies. New approach of Oldowan and Mode 1 assemblages. Questions about the emergence of stone tool technologies and their diffusion

Louis De Weyer

Oldowan and Mode 1 are two common words used to describe the first industries. Those terms refer to the most ancient human productions and characterize the Earliest Stone Age in Africa (Oldowan) and the Lower Palaeolithic in Eurasia (Mode 1). Originally, a huge gap was separating the Oldowan sites with the Mode 1 ones. In other words, very ancient sites took place in Africa while sites older than almost one million years were observed in Eurasia. Nowadays, this gap is no longer relevant. Indeed several sites around 2 Myr were found in China, (Longuppo, Renzidong), around 1,8 Myr at the gates of Europe (Dmanisi) and around Western Mediterranean sea (Ain Hanech, Algeria). Orce sites in Spain (1,2 Myr) and Pirro Nord in Italy (1,5 Myr) also constitute data older than one million years in Western Europe.

This new record underlines different problems in Out of Africa theory. Then, it now seems appropriate to study the material again in order to bring new information to the issue of the emergence of the first stone tools productions. Is there a single line of evolution, starting from Africa to all over the Old World? Or can we define several areas of emergence for those earliest technologies?

Indeed, using concepts as “Oldowan” or “Mode 1” to describe the first stone tools productions is too general. This kind of attribution hides the variability of the first hominins productions, usually explained by contextual causes, such as the site occupation context (butchery, knapping workplace, habitat) or the raw material quality. According to the site context, remains are obviously different and the production can appear less complex if the raw material quality is bad. Thus, with this contextual point of view, the interpretations about abilities and knapping skills of the first hominins are limited.

Our work deals with two different and related issues. First, it involves a new methodology, focusing on the tool productions and trying to understand in details the variability of those earliest technologies. This methodology is based on the techno-functional and structural analysis. It was developed in French archaeology by Michel Lepot and Eric Boëda from the works of the philosopher Gilbert Simondon and the ergonomist Pierre Rabardel. They both worked on the relationships between the human being and its tools and focused on two major aspects: production patterns and tool structure. This analysis uses criteria as cutting edges, volume and morphology. That leads us to understand how the combination of the different structural parts makes the tool up. Then, it becomes possible to compare stone tool structures and production patterns variability. This variability will be documented inside two different areas: East Africa and the Mediterranean surroundings. Secondly, it will be possible to compare several geographical areas and address the issue of the emergence of the first technologies. The first results of our research will be presented, particularly those on the assemblages from Koobi Fora FxJj-1, 3 and 10, and Olduvai Gorge DK sites.

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## The Last of the Neandertals: preliminary results of New dating and excavation work at Gruta da Figueira Brava (Setúbal, Portugal)

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Figueira Brava is a cave system excavated in Miocene biocalcarenes of the Serra da Arrábida, in relation to an abrasion platform and cobble beach of MIS-5 age some 5 m amsl. But for a few remnants cemented against the walls, no Upper Pleistocene sediments survive inside of Entrance 1, which connects via a shaft to the sea below and may have been emptied by Holocene marine erosion. Entrances 2 and 3 are speleothem-cluttered but the interior areas behind them can be accessed via Entrance 1 and their sediment fill is preserved under thick flowstone. In 1987-88, the paleontological excavation of the deposits behind Entrance 2 yielded a Mousterian context and Neandertal tooth associated with a date of 30.9 ka (ICEN-387) obtained on a bulk sample of *Patella* shells (all ages herein are uncalibrated 14C BP).

In order to assess the archeological significance of this result, we undertook research along the following lines: AMS dating of individual shell samples from the area of the 1987-88 dig, and U-series dating of flowstone capping that area; geological description, sampling and dating of the brecciated, partly eroded but stratigraphically complete Upper Pleistocene sequence preserved in the exterior area of Entrance 3, and excavation of a test trench in its interior area.

We obtained the following results: (a) as four *Patella* samples from 1987-88 were dated to 36.4-44.9 ka and one to 2.7 ka, the ICEN-387 result may reflect the undetected presence of a minor component of recent Holocene age; (b) the Paleolithic time range obtained coincides with the hiatus in speleothem formation revealed by high-resolution U-series dating of stratigraphically associated flowstone; (c) in the exterior area of Entrance 3, the corresponding stratum (Unit 2) yielded two dates of 36.5 and 34.5 ka for aragonite shells (*Glycymeris* and *Mytilus*) from its base and two dates of 41.9 and 44.0 ka for calcite shells (*Patella*) from its top; (d) whether this discrepancy reflects undetected contamination with remobilized bedrock carbon of the calcite shells or that Unit 2 is an unstratified colluvium remains to be clarified; (e) the persistence of the Mousterian beyond 36-5-34.5 ka is documented by the archeological contents of the 50 cm-thick Unit 0 of the interior area of Entrance 3, separated from Unit 2 by a thick flowstone that, given the chronometric evidence, must have been deposited during GI-8. In the test excavation, the Unit 0 Mousterian lithics are found in a midden of marine mollusc, sea urchin and large crab shell fragments that also contains mammal (red deer, ibex) and human (diagnostically Neandertal teeth) remains.

Directly dated Tardiglacial or younger shells exist in subsurface burrowed areas but all the lithics recovered therein are also of Mousterian affinities, implying non-human introduction (by e.g., sea birds, otters or small carnivores) of this younger material at a time of present or near-present sea level. As the 50 m bathymetric line is 1.5 km away, the mid-MIS-3 massive accumulation of marine foods characteristic of this site reflects human activity indeed.

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## Lamarck and landmarks: evolving morphometric tools for anthropology

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Geometric Morphometrics (GM), which was introduced by Fred Bookstein 20 years ago, has become an essential analytic tool of physical anthropology, and has provided a plethora of new insights into patterns of variation of highly complex anatomical structures such as the hominoid skull. GM is based on the definition of anatomical landmarks, which denote biological and/or geometric correspondence between specimens of a sample.

Many anatomical structures of considerable functional and phyletic interest, however, exhibit morphologies that are difficult or impossible to quantify with landmark-based methods. Using a variety of examples from physical anthropology, we investigate how GM methods can be extended and/or complemented with new morphometric methods and concepts.

First, we consider the “landmark-free” morphologies of long bone diaphyses, and propose morphometric mapping as a method for feature detection and quantitative comparative analysis. Second, we consider the “stochastic” morphologies of interosseous sutures and air-filled spaces of the cranium, and propose a combined morphogenetic/morphometric approach to quantify these highly irregular structures. Third, we consider the “multi-periodic” morphology of dental microstructures, and propose a tensor-based approach for their visualization, characterization and quantification.

Common to these examples is the Lamarckian notion that morphometric tools need to be devised according to the anthropological questions asked, rather than questions adapted to existing morphometric environments.

## Laminar technology and the Upper Paleolithic in Gorny-Altai: a chrono-cultural model

Nicolas Zwyns

Laminar technology and the Upper Paleolithic in Gorny-Altai: a chrono-cultural model The Altai region has yielded a cluster of Middle and Upper Paleolithic stratified sites that have been recently excavated using a multidisciplinary approach. These sequences provide key-evidences illustrating changes in material culture corresponding to the transition from Middle to Upper Paleolithic. In Europe, this phenomenon is associated with the replacement of Neandertal by anatomically modern humans. Based on this data set, researchers have put forward different scenarios regarding the transition processes, ranging from hypotheses of local evolution to migrations. The most popular model proposes a parallel development of two distinct Upper Paleolithic traditions that both emerged from a local Middle Paleolithic background (Derevianko, 2010).

The Middle Paleolithic strata from Denisova cave thus show a locally-developed levalloisian blade-based Upper Paleolithic tradition also occurring at the open-air site of Kara-bom. Simultaneously, the Ust-Karakol tradition would testify of a different path leading to the Upper Paleolithic, with some techno-typological similarities with the European Early Upper Paleolithic. In addition, the Chagyrskaya tradition would represent an intrusive late Mousterian facies, overlapping chronologically with the first occurrence of Upper Paleolithic in the area.

Questions remain regarding who was responsible for making these tool technologies. Recent developments in ancient DNA studies have shown that Neandertals were present in the Altai Mountains around 40 ka (Krause et al., 2007). However, a previously unknown genome was sequenced, demonstrating the presence of another type of hominin in the region, the so-called 'Denisovans' (Krause et al., 2010, Reich et al., 2010). Moreover, the presence of anatomically modern humans is confirmed since at least 28 ka in Siberia (Akimova et al., 2010).

This study focuses on laminar technology based on a sample of lithic material from open-air sites following a three-tiered approach. First, the integrity of the sample is assessed based on a taphonomic analysis. Second, the lithic material is described using an attribute analysis focusing on the quantification of technological features and their variability. This data set is used to support a reconstruction of the laminar reduction sequences and more generally, of the technical systems (Zwyns et al., 2011). Third, technical traditions are identified and their distributions through time and space are evaluated. Based on a taphonomic and technological analysis of the laminar material from Kara-Bom and Ust-Karakol Upper Paleolithic open air sites, existing models explaining the early development of Upper Paleolithic traditions in the area are tested. Questions regarding the integrity and the variability of the lithic assemblages, their geographic extension and their chronological attribution are addressed. Based on these results, an alternative regional chrono-cultural model is proposed and implications for understanding the Middle to Upper Paleolithic transition and the Paleolithic peopling of Northern Asia are briefly discussed.

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