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Paedomorphosis and neoteny in human evolution

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The modern human cranial vault is anecdotally considered paedomorphic, at least relative to the great apes. Yet vault development relative to ancestral hominids has not been evaluated. We test the hypothesis that modern human neurocranial form is paedomorphic relative to *Homo erectus*, then distinguish which of several heterochronic processes best accounts for this pattern. Comparisons of ontogenetic trajectories in *H. erectus* and *H. sapiens* form the core of this analysis, with *H. erectus* treated as an ancestral baseline.

Angles reflecting the shape of the neurocranium are applied to tests of hypotheses that predict paedomorphosis. Linear measures from a larger sample, including a worldwide sample of anatomically modern *H. sapiens* ($n=320$), supplement the angular data. We assess shape change within and between taxa, then test for size and shape dissociations between taxa using ontogenetic allometric methods. These analyses strictly adhere to theoretically-established methods for diagnosing heterochronic processes and outcomes.

Measures of cranial shape demonstrate that modern humans resemble juvenile *H. erectus* far more closely than adult *H. erectus*. Moreover, the degree of shape change in modern humans through ontogeny is slight compared to that in *H. erectus*. Ontogenetic allometric comparisons between taxa suggest that paedomorphosis is produced through dissociations between size and shape, signalling that neoteny is the source of our cranial paedomorphosis.

Evolution toward a juvenilized morphology by means of neoteny appears to account for the morphological evolution of the human neurocranium. We infer that juvenilization of brain structures plays a major role in producing the significant disruptions in ancestral size and shape trajectories that are responsible for this pattern of neurocranial evolution. This may be part of a wider phenomenon in which major morphological shifts are accommodated by heterochronic changes in growth patterns. Such paedomorphosis of the brain may enable greater neural flexibility in modern humans and thus have major adaptive implications for our origin and dispersal. Increased neural flexibility may represent the link to increased behavioral plasticity that appears to differentiate modern humans from indigenous hominids archaeologically.

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Understanding site formation processes at Bois Roche (Charente, France), a Late Pleistocene hyena den

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We present preliminary results of our recent excavations and analyses of the Bois Roche cave (Charente, France). The main objective of the Bois Roche Project is to develop better diagnostic criteria for separating hominid from carnivore signatures in bone accumulations from European caves. This is a vital component of the archaeology of modern human origins in Europe because many Middle and Upper Pleistocene cave sites contain both artifacts and carnivore remains. At these sites contextual evidence is rarely sufficient to

separate hominid activities from those of carnivores. Unlike studies of modern carnivore faunas, however, Bois Roche also shows the results of long-term diagenetic processes characteristic of archaeofaunas but which are difficult to replicate experimentally. Bois Roche contains a well-preserved bone assemblage dominated by Upper Pleistocene large herbivore remains. The bones are abundant and well preserved. Based on unambiguous contextual evidence (chamber morphology, low ceiling height, coprolites, juvenile hyena dental remains) it is clear that European cave hyenas (*Crocota crocuta*) were the principal agent of accumulation at Bois Roche. Some Mousterian lithic material (less than 1% of plotted items) has also been recovered. The size distribution, state of preservation, and the geometry of the deposits suggests that the artefacts do not correspond to *in situ* hominid activities but were transported into the cave via slopewash.

Comprehensive recovery techniques, careful geological and micromorphological studies, and state-of-the-art mapping and analytical techniques guarantee data of high integrity and analytical value from a well controlled context. Using the Bois Roche data, archaeologists will be able to make more accurate inferences about the nature of bone assemblages from Lower and Middle Paleolithic sites in Europe. Moreover, by closely investigating the site structure of an intact hyena den where site formation processes are well understood, we shall be in a better position to isolate what distinctive spatial patterns might be uniquely hominid in origin at cave sites where both hominids and carnivores were present.

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Paleolithic research in Western Transcaucasia, the Republic of Georgia

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Prehistoric research in western Transcaucasia, which commenced almost a hundred years ago, demonstrated that human occupation was continuous during the Last Glaciation. The varied habitats of this region, located adjacent to the Black Sea, provided reliable, predictable, and relatively easily accessible animal and vegetal food resources even under Glacial climatic conditions. Abundant natural shelters and good raw material (e.g., radiolarite, flint) enabled Middle Paleolithic knappers to easily procure material to produce stone tools. During the Upper Paleolithic other raw materials, such as the obsidian, were brought over large distances.

The reconstruction of the Upper Pleistocene paleoenvironmental and cultural history in this particular region holds great importance. It will assist us in testing hypotheses concerning the dispersals of Neanderthals, the cultures and survival strategies of Middle Paleolithic humans, and the migration of Cro-Magnons from the Near East into Europe.

The published Georgian archaeological evidence demonstrates similarities with the Middle Paleolithic industries of Anatolia, the Zagros region, the Levant, and the Russian plains. Mousterian assemblages characterized by blades and elongated points, as recovered in Djrujula and Koudaro, resemble the "Tabun D-type" and Hummalian entities in the Levant. They are possibly dated to the same age, i.e., 250–150 ka.

Charentian-type Mousterian assemblages, such as in Ortvale Klde, seem to be later in time and date to the Upper Pleistocene. The Upper Paleolithic sequence, although not yet dated, indicates the presence of various entities and the early appearance of microliths. Bone and antler industries, including some beads and pendants, are relatively common during the Upper Paleolithic. However, a full-blown Aurignacian assemblage has not yet been found, although “Aurignacoid” features were recognized by previous researches. The current project aims to date available sites in order to build the chronology of the Upper Pleistocene sequence in western Georgia.

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The Pleistocene human occupation of Santa Cita (Central Portugal): geoarcheology, lithic technology, raw material economy and habitat structures

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The site of Santa Cita is marked by three different Paleolithic occupations. The lower two occupations are Mousterian, while the top one is Terminal Upper Palaeolithic. All three show very distinctive differences in their geology, paleoenvironment, lithic technology, raw material procurement and economy, giving important information on the local site formation processes.

Unlike the rest of Europe, Mousterian seems to have appeared in Portugal very late. Neanderthals lasted to well after 30 Kyr BP, and contrarily to the French and Spanish cases, did not mimic the Upper Paleolithic industries of the *H. s. sapiens*, such as the Chatelperronian. The lithic industries from Santa Cita, while within the range of Mousterian characteristics, do not fit any of the traditional facies known in Western Europe.

The lithic industries are marked by high frequency of notches and denticulates. Though Levallois and discoidal methods are present, the first was not used frequently. A wide range of raw materials was used, including quartz, quartzite and chert, from both known local and non-local sources. Clear evidence indicates the use of preferred raw materials, while some level of curation seems to be present in, at least, one assemblage.

Habitat structures were found in the lowest Mousterian level in Santa Cita. These are marked by a group of five post-holes, forming a trapezoidal shape, that can be interpreted as a shelter.

The Terminal Upper Paleolithic level is characterized by a microlithic assemblage, that includes unidirectional, opposed, multidirectional and carinated reduction sequences to produce bladelets, and backing and microburin technology to make the microlithic weaponry.

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Middle Paleolithic subsistence and land use in the Rhineland

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The more we dig, the more interesting the picture of Middle Paleolithic subsistence and land use in the Rhineland becomes. Over the last two decades a half dozen Middle Paleolithic localities, including over 20 find horizons with artefacts and preserved faunal material, have been excavated. All of these localities are from open air settings, and much energy has been invested to excavate large surfaces. The taphonomic integrity of the find horizons ranges from reworked and heavily weathered to pristine. In many cases very complete geological sequences allow stratigraphic dating, which has been supplemented with thermoluminescence dates. A wide range of organic remains provides detailed information on the environmental conditions at the time of the occupations, and in several cases good data on seasonality are available.

This paper focuses on results from *in situ* find horizons at Wallertheim and other sites. Results from detailed refitting studies on faunal remains and lithic artifacts will be presented in combination with spatial analyses of features and activity areas. Additional information on skeletal part representation, sequences of lithic production, use and maintenance, provide important arguments for interpreting the find horizons, as do patterns of faunal and lithic densities. The available data document a wide range of occupations with durations in the order of several days to several weeks. Hunting of medium and large animals appears to have been common with cervids, equids and bovids being the preferred prey. In some settings single species dominate, while in others multiple species were of economic importance. The current research also offers insight into problems related to dissecting overlapping occupations and determining the duration of occupations. Through this research a complex and diverse picture of Middle Paleolithic land use in the Rhineland is beginning to emerge.

Late Pleistocene children from Central Eurasia: a cross-sectional study of cranial metric variation

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The assertions for differential growth between Middle and Upper Paleolithic hominid samples commonly restrain linear measurements derived from cross-sectional analyses of cranial size development.

In Eurasia the available data documenting variation in cranial size between children, within a single site, are restricted to two Upper Paleolithic sites located in the Czech Republic (Predmosti) and Russia (Sungir). In both cases cranial size from childhood to adulthood can be approached.

In order to detect the potential differences between these early modern humans and Neanderthals from the same geographical area, this comparative study examines metric data from non-adult Neanderthal specimens from Subalyuk (Hungary) and Teshik-Tash

(Uzbekhistan). Recent data recorded from a 11–15th century collection housed in the National Museum of Praha ($n=117$) are used to document the diachronic variability in Central Europe. The results of the comparative analysis indicate that similarities in cranial size are prevalent in the selective samples through time.

This research was partly supported by a grant from the Aquitaine Regional Council.

Asian fossils and African origins

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Chinese fossil hominids are becoming increasingly important for interpreting the course of human evolution not only in east Asia but worldwide. A case in point is the status of fossil material from Longgupo, a karst cave in Sichuan, southwest China. Huang *et al.* (1995) contend that the fossil specimens, which consist of a partial left mandible preserving P4 and M1 and an isolated upper incisor, represent the earliest hominid material from Asia, dating to approximately 1.9 mya. They further state that the Longgupo hominid is an example of an early species of *Homo* that dispersed from Africa and was the source for the subsequent evolution of *Homo erectus* (Huang *et al.*, 1995, 1996). This evidence has been used to buttress the argument that *H. erectus* was an evolutionary dead-end restricted to Asia (Ciochon, 1995; Tattersall, 1997). Others (Wang 1997; Etlér *et al.*, n.d.), have already shown that the isolated incisor is morphologically and metrically identical to a modern east Asian's and its association with the mandibular fragment must be viewed as a palimpsest.

We will compare the mandibular dentition to the morphologically and metrically similar Mio-Pliocene fossil ape *Lufengpithecus* from Lufeng (Xu & Lu, 1979) and Yuanmou (He, 1997) in the southwestern Chinese province of Yunnan. Given the close similarity between the Longgupo mandibular dentition and homologous material of *Lufengpithecus yuanmouensis* there is no reason to suggest that the Longgupo material shares any particular relationship to Plio-Pleistocene hominids from East Africa. On the contrary, the evidence we present indicates an ancestor/descendant relationship between *Lufengpithecus* and the Longgupo mandible. What then is the phylogenetic significance of the Longgupo mandible? One possibility, which we advocate, is that the Longgupo mandible has nothing to do with human evolution and merely represents a late occurring Chinese fossil ape. If, however, it is argued that the Longgupo material represents an early species of *Homo*, then the possibility exists that *Lufengpithecus* is also closely tied in with early human origins, a position taken by many Chinese investigators, but one which we suspect few in the West will seriously consider.

No matter how one views the affinities of the Longgupo specimens their overall similarity to previously described Asia fossil hominoids makes continued use of this material to argue for the dispersal of early *Homo* from Africa to Asia totally unwarranted.

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Gesher Benot Ya'aqov, Israel: new evidence for its stratigraphic and sedimentologic context

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The Acheulean site of Gesher Benot Ya'aqov (GBY) is stratified within the Early to Middle Pleistocene Benot Ya'akov Formation. Exposures of the formation south of the bridges at GBY comprise some 34 m of lake margin and fluvial deposits, and preserve a detailed record of paleo-Lake Hula.

Strata at GBY include three dominant lithofacies: (1) coquinas, sands and gravels of the beach facies, (2) calcareous muds of shallow-water lacustrine facies, and (3) conglomerates of the fluvial channel facies. Most of the archaeological and paleontological wealth of the site is found within the beach facies. These deposits occur in two modes: (a) stacked, multi-component beach complexes, and (b) discrete, single-unit accumulations. In both cases, major depositional events appear to be storm-related accretion episodes, which collect molluscs, sand and gravel and deposit them in 10–20 cm units on the beach face. Accumulations of artefacts and fossils are generally found on surfaces above or below these accretionary units. The calcareous muds of the shallow lacustrine setting include both organic-rich and organic-poor types, related to variability in bottom-water anoxia. These facies preserve a rich assemblage of aquatic fossils. Fluvial conglomerates are localized in occurrence, appearing as lenticular units within the sequence, and as more laterally continuous sheets at the top and bottom of the local section. Several paleosols record exposure of the lacustrine muds.

The sequence at GBY is strongly cyclical. Fine-grained intervals of lacustrine muds record deepening of the paleo-lake, while coarser intervals of beach and channel facies reflect drops in lake level. The 34 m sequence includes six such cycles which may reflect base-level control by the 21,000 y precessional mode of orbital forcing, with the 100,000 y eccentricity mode showing in the uppermost and lowermost sheet-like conglomerates.

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Anterior tooth scratches, handedness and manual dexterity in fossil Europeans

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In Neanderthals, their precursors and their relatives, mandibular and maxillary anterior teeth often bear distinctive scratches on the nonocclusal, labial surfaces. These self-induced cutmarks are mostly located on the central portion of the labial face or near (but not on) the occlusal margin. The scratches lie at various angles (horizontal, vertical and oblique) and similar marks are not found on lingual or interproximal surfaces. Only erupted teeth possess the marks, suggesting that these were made during the lifetime of the individuals, most likely an unintended consequence of stone tools being raked across items clenched between the

teeth. As the materials were pierced, the cutting edge sometimes came into contact with the enamel surface and left these characteristic marks. Both deciduous and permanent teeth show labial scratches indicating that the behavior producing them began in childhood and persisted though adulthood. Since all age groups possess similar marks, they likely relate to culinary habits and not tool making or other nonsubsistence activities.

In addition to documenting paramasticatory activities, the cutmarks furnish evidence for handedness. Marks oblique to the occlusal plane indicate that most were made by a righthanded action which typifies more than 90% of the cases. Furthermore, the placement of the cutmarks mainly in the center of the labial face suggests that Neanderthals, their ancestors and relatives, were not as clumsy and thumb-tied as commonly depicted.

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Gesher Benot Ya'aqov: the Acheulian cultural sequence

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Seven field seasons at the Early/Middle Pleistocene site of Gesher Benot Ya'aqov (GBY) have documented a 35 m thick sequence of the Benot Ya'akov Formation. This interval is characterized by evidence of human activity in the form of repeated archaeological occupations. The archaeological evidence is associated with a variety of environments of deposition, ranging from deep to shallow waters and margins of the paleo Hula Lake.

The archaeological data is composed of lithic and paleontological assemblages. The former occur mainly in primary depositional contexts. All lithic assemblages are assigned to the Acheulian Industrial Complex. They share the typical tool-kit of that technocomplex and are dominated by bifaces (handaxes and cleavers), as well as other tools. Three types of raw material were exploited at the site: basalt, flint and limestone. Basalt was used mainly for the production of bifaces, flint for flakes and flake tools, and limestone mainly for chopping tools.

Lithic analysis resulted in the identification of various reduction sequences for the modification of the different morpho-types. Furthermore, a unique combination of techniques are documented at GBY, and for the first time in the Levant at such an early date. These include soft-hammer, Kombewa, and the earliest documented Levallois Technique.

Seven archaeological horizons were excavated (including multilevel ones), documenting clear African technological affinities. The GBY cultural sequence is viewed as hard-core evidence of a distinct episode within the "Out of Africa" phenomenon, of which only isolated events of a general trend are known at present. The early stage of the site and the evidence of human activity in it supply further evidence for hominid demographic and geographical behavior during Middle Pleistocene times.

Stone artefact assemblage variability and scales of temporal resolution at Bone Cave, Tasmania, Australia

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Bone Cave is one of a number of limestone caves in the southwest of Tasmania, Australia that have produced a rich record of Pleistocene human occupation spanning the period from 10,000 to 35,000 BP. This paper reports the results of a technological analysis of 23,000 stone artefacts excavated from Bone Cave. Artefacts found at the site were manufactured from both local and imported stone, and suggest a variety of reduction strategies. Twenty-nine radiocarbon determinations from the site permit a precise chronology to be constructed that indicates the site was abandoned for substantial periods between occupations during the late Pleistocene. Stone artefact assemblages constructed on the basis of the radiocarbon determinations are compared through time to determine the significance of these periods of abandonment. Also considered are the effects of differing temporal scales of resolution on measures of assemblage variability.

The origins of modern human behavior: a Levantine point of view

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Discussions abound in recent anthropological literature concerning the nature of modern human behavior and its origins. Some workers perceive the occurrence of this behavior as a gradual process, the beginnings of which can be traced to the European Neandertals and possibly earlier, and which thus cross-cuts the traditional rubicon of the Middle-Upper Paleolithic transition. Others see it as a rapid event associated with neurological changes which appeared after the occurrence of modern human anatomy, and which should be considered species-specific to *Homo sapiens*. The Levantine Middle Paleolithic provides a unique opportunity to examine the alternative models. Yielding as it has the skeletal and cultural remains of two contemporaneous human populations, Neandertals and Anatomically Modern Humans (AMH), both associated Mousterian lithic industries, their behaviors can be studied and compared against a similar, if not identical, ecological background. Once taphonomic agents are accounted for, similarities and differences observed in the archaeological record are less likely to be the result of external conditions, and reflect the abilities of the hominids which created the record.

A comparison of several aspects of the archaeological record at Qafzeh and Amud Caves, associated with AMH and Neandertals respectively, suggests that there were no significant differences in the cognitive abilities of the two populations, in their capability for rational organizational strategies, and in their capacities for symbolic behavior. It is also noted that the archaeological manifestations of the Middle-Upper Paleolithic transition in the Levant are not as spectacular as in Europe. The implications of these observations for tracing the origins of modern behavior and for understanding the conditions which favor its representation in the material record are further discussed.

Vertebral canal size and function: a comparison of extant and fossil hominoids

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Recent investigators have suggested that KNM-WT-15000 was unable to speak because of low innervation of the musculature of the thoracic region of the body (MacLarnon, 1993; Walker & Shipman, 1996). This hypothesis requires a relationship between vertebral canal size and functional differences between species. Also, it requires that KNM-WT-15000 canal sizes fall outside the range of humans.

To test these requirements I compared vertebral canal size between a sample of chimps and humans from the Hamann-Todd collection. I also compared KNM-WT-15000, as well as Sts 14 and Al 288-1 with the sample of chimps and humans. These specimens were chosen because they represent the very few fossil hominids that preserve significant portions of the vertebral column.

Significant absolute differences in these measures were found between chimps and humans. These differences persisted after standardizing for individual cranial capacity and for body weight. Further confirmation was attained by considering the thoracic column as a whole, through principle coordinate analysis that compensates for the problem of comparing functionally different individual segments of the thoracic column in isolation in different species. The hypothesis of a relationship between variation in canal size and functional difference between species cannot be rejected.

KNM-WT-15000 falls within the range of humans when controlling for cranial capacity. Functional differences between it and humans cannot be inferred from differences in vertebral canal size. The two australopithecines fall outside the human range but within that of chimps. Since australopithecine were bipeds, explanations for divergence from the human condition must owe to factors other than locomotion.

Recent excavations at La Quina (Charente), France

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Excavations from 1985 to 1994 at the classic Mousterian "Station Amont" locality of the site of La Quina in southwestern France produced significant new information relating to the activities of Neandertals during the early last glacial cycle. The enormous quantities of animal bone that are concentrated in a depositional sequence at the base of a stepped series of cliffs suggest repeated successful hunting episodes, that made use of this locally unique topography. The depositional sequence reflects a succession of changing habitats from stream and pond, at the base, through an accumulating slope, to a level surface in front of a shallow overhang at the top of the lowest cliff face. Many changes in the artefact assemblages left in the site through this sedimentary accumulation can be related to the changing habitats in which the activities that produced them took place. This information, combined with the paleontological and palynological evidence of climatic change, provide a record from a single locality that is perhaps unique in its potential to contribute to an understanding of Neandertal abilities and adaptation, as well as to circumstances that

contributed to variability in the lithic industries that remain as residues of Neandertal technology.

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Sexual dimorphism in *Gigantopithecus blacki*

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Extinct hominoids may have exceeded the range of sexual dimorphism seen in living primates. This has proven difficult to demonstrate because most fossil specimens lack clear indicators of sex. Here we use method-of-moments to estimate the degree of dental dimorphism in *Gigantopithecus blacki*, by far the largest primate known. Previous studies suggested that this species exhibits the greatest degree of dimorphism. To the contrary, we find that *Gigantopithecus blacki* was only as dimorphic as the most dimorphic living hominoids, gorillas (*Gorilla gorilla gorilla*) and orangutans (*Pongo pygmaeus pygmaeus*), even though they were likely to have been 2–3 times larger in body size. Our results place the species among the most sexually dimorphic primates known, and suggests a mating system for *Gigantopithecus* which involved intense competition between males for reproductive access to females. It also contradicts previous hypotheses concerning the relationship between sexual selection and body size in primates, and suggests that there may be an effective upper limit for sexual dimorphism in primates.

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The Early Upper Paleolithic of the Hatay (Turkey): Ūçağızlı cave and Kanal

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As a result of recent discoveries and advances in radiometric dating, the main questions surrounding the early Upper Paleolithic (or EUP) in Eurasia have shifted from the origins and spread of anatomically modern humans to the origins and spread of “modern” behavior. However, studies of the distributions of both early Upper Paleolithic industries and specific behavioral traits are hampered by geographical lacunae in the archaeological record.

The Hatay region, a zone of topographic, biological and cultural transition between the Near East and Anatolia, contains the only well-documented early Upper Paleolithic deposits in Turkey. Two sites, Ūçağızlı cave and Kanal, contain especially rich EUP layers. Ūçağızlı cave was first discovered and excavated by A. Minzoni-Deroche, and is the focus of ongoing research by the author. Kanal was excavated in the 1960s by E. Bostanci. Previous investigators had classified the assemblages from both sites as Aurignacian. Reinvestigation indicates that at least two distinct types of early Upper Paleolithic industry are present. Both Ūçağızlı and Kanal yield assemblages very similar to “transitional” or “initial Upper Paleolithic” industries from the Levant and Syria. Ūçağızlı cave also contains a later EUP component that most closely resembles early Ahmarian industries from

Levantine cave sites, although the presence of numerous bone tools and shell ornaments in association with this assemblage is unusual for western Asia. The Hatay sites help to fill a major gap in knowledge of early Upper Paleolithic “cultural geography”. They also promise to provide valuable information about behavioral transitions within the early Upper Paleolithic.

Evolutionary trends in sexual dimorphism of cranial capacity in Pleistocene *Homo*

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A recent study by [Arsuaga & colleagues \(1997\)](#) observes no difference in the sexual dimorphism of cranial capacity between the Middle Pleistocene hominid fossils of Sima de los Huesos and modern humans. As their study challenges the general understanding that sexual dimorphism decreases with time in human evolution, it is important to examine the argument further by using other fossil samples of hominid crania. However, studying the evolution of sexual dimorphism poses a difficulty in that fossil samples are of small size and unknown sex. Although several methods have been proposed to address this problem, none has reached a full solution, as they require assumptions that are unlikely to be met by a fossil sample. This study addresses this problem by using a new estimate of sexual dimorphism developed for samples of small size and unknown sex, to test the hypothesis of no change in the sexual dimorphism of cranial capacity in Pleistocene *Homo*. To examine evolutionary trends, this study employs the method developed by [Kitchell, Estabrook & MacLeod \(1987\)](#). In light of recent findings ([Lee, 1994](#); [Ruff, Trinkaus & Holliday, 1997](#)) that show a change in direction in cranial capacity between Early and Middle Pleistocene, fossil samples are examined in terms of the two time periods dividing the Pleistocene at 700 kya. Data used in this study are both published and non-published and were kindly provided by M. H. Wolpoff. Results of the analysis show that null hypothesis cannot be rejected, and lead to the conclusion that sexual dimorphism shows no change from 700 kya. The implications of stasis in sexual dimorphism are discussed.

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New estimates of fossil hominid vocal tract dimensions

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Archaic humans (e.g., Neanderthals) were as encephalized and behaviorally sophisticated as contemporary, Middle Palaeolithic modern *H. sapiens*, and therefore probably had

comparable language capabilities. However, reconstructions of their phonetic capabilities remain the subject of much speculation because they require accurate estimates of the dimensions of the supralaryngeal vocal tract (SVT). Adult modern humans have a unique two-tube SVT whose horizontal and vertical portions form a right angle, are equal in length, and have cross-sectional areas that can be independently modified roughly tenfold by the tongue. This configuration has been shown to be adaptive for producing acoustically distinct vowels. Although a low hyo-laryngeal complex is essential for setting up the modern SVT, it is unknown when this configuration evolved.

This study presents new developmental data on the descent of the human hyoid and larynx in relation to the cranial base, oral cavity, and mandible in humans and non-human primates. We also present new functional data on the movement of the hyoid during chewing, swallowing and phonation. We demonstrate that previous attempts to estimate hyoid and larynx position from the dimensions of the cranial base alone are problematic. Variations in cranial base flexion do not predict hyoid position in humans or other primates. Instead, these data indicate that although the low human hyoid and larynx are adaptations for speech production, hyo-laryngeal descent relative to the palate and mandible is constrained by functional demands imposed by swallowing. These data, in combination with cranial measurements of palatal and oropharyngeal length, allow new reconstructions of the range of potential SVT configurations and vowel production capabilities in fossil hominids. While Neanderthals may have had larynges as low as those of modern humans, their SVTs may have been less optimal in terms of height-to-length ratios because of their greater degree of facial projection.

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A critique of the evidence for Middle Paleolithic/Middle Stone Age scavenging: new data from Kobeh Cave (Zagros Mountains) and Die Kelders Cave 1 Layer 10 (South Africa)

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Four basic models have been presented for the faunal exploitation behavior of hominids during the Middle Paleolithic/Middle Stone Age. Two of these models posit a significant role for obligate scavenging (Binford, 1981, 1984, 1985, 1988) or regular opportunistic scavenging (Stiner, 1991a, 1991b, 1991c, 1993, 1994). The scavenging interpretations rely primarily on the presence of a skeletal element pattern dominated by head and foot parts, the presence of carnivore tooth marks on bone fragments, and infrequent cut marks that

typically are not located on shaft regions of long bones or on fleshy bones. Five sites have been used to argue for scavenging (Klasies River Mouth, Combe Grenal, Grotta Guattari, Grotta dei Moscerini, and Grotte Vaufrey) and four of the five sites are biased samples in that long bone shafts were discarded at excavation while Grotte Vaufrey was studied in a way that mimics the bias present in the other sites. This sample bias systematically shapes the skeletal element and surface modification patterning in ways that make the assemblages appear to fit a model of scavenging. Skeletal element abundance at Kobeh Cave and Die Kelders Layer 10 is calculated in a way that mimics the bias in the samples listed above by excluding the shafts: both sites display a head and foot skeletal element pattern and thus appear scavenged. Both assemblages are then analyzed in their entirety and a pattern consistent with hunting is revealed. Excluding shaft fragments from the analysis also biases the surface modification patterning in such a way as to produce a pattern where cuts appear most frequent on long bone ends and low utility foot bones. The conclusion is that there is no reliable evidence for scavenging by Neandertals or early modern humans.

A Szeletian in the Eastern Crimea: Buran Kaya III, Level C

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The traditional view of the Crimean Middle to Upper Paleolithic boundary saw a late Mousterian with so-called progressive features, such as that claimed for Starosele, replaced by a typical, if somewhat late, Aurignacian, as seen at Suiren I, in the western Crimea. Recent excavations in the western and eastern Crimea have shown this view to be simplistic, at best. This paper will introduce a Szeletian-like assemblage found at Buran Kaya III in the eastern Crimea. Stratigraphically, it underlies a thick and typical Kiik-Koba Middle Paleolithic occupation which has been dated by AMS to ca. 28,000 BP. The Level C assemblage consists of a fully bifacial technology which produced foliates and points, some similar to those produced in the American Paleo-Indian in shape and quality but produced no blades. Other tools consist of endscrapers, scaled pieces, and microlithic, bifacial geometrics. In addition, a number of bone tools were recovered, including a large bone handle made on an *Equus* metatarsal, all produced by a ring and snap technique. AMS dates on two of these tools places the assemblage in the mid-30,000s BP. While most similar to the Szeletian, an industry hitherto unknown in Crimea, this assemblage has a number of unique features which cannot be linked to already known materials in other areas.

Long-term settlement of lowland tropical rain forests: the evidence from Ituri, D.R. Congo

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Archaeological data on Pleistocene human occupation within the current boundaries of lowland tropical rain forests or in its vicinities have been available since the 50's. These localities, however, seem to have experienced severe deforestation during Pleistocene hypothermals. For the last two decades, some ecologists and socio-cultural anthropologists have postulated that humans could not survive in tropical rain forests without some

dependence on agriculture. New research at ten sites in the Ituri forest (D.R. Congo, former Zaire), however, suggests that the human colonization of the lowland tropical forests of the northeast Congo Basin occurred in Pleistocene times, that shifts in forest composition and structure resulting from a combination of human and natural factors followed human colonization, and that from the Late Pleistocene on the interactive sphere of northeast Congo forest dwellers is linked with the adjacent peoples and environments of the Western Rift. Although the archaeological data suggest Pleistocene connections between the Ishango area and the Ituri, data from human remains are problematic, since the Ishango data reflect a robust linear African population with ties to other East African groups. The only skeletal evidence so far uncovered from the Ituri is dated to 1250 AD and indicates the presence of "pygmy" population at that time.

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Lithic variation in the Western European Middle Paleolithic: a multivariate statistical analysis

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The nature and causes of Middle Paleolithic variability have been debated since Lewis and Sally Binford offered an alternative functional hypothesis to François Bordes' interpretation of stylistic and ethnic variation. Recently, Nicolas Rolland and Harold Dibble have suggested that factors other than style and function explain this variability. All of these positions rest, at one level or another, on statistical observations. Bordes thought that the distribution of racloir frequencies was multimodal and that each "mode" corresponded to an ethnic tradition. In their 1966 factor analysis, Binford and Binford posited the existence of functional toolkits as the primary cause of variability. Rolland and Dibble provide evidence which challenges Bordes' racloir distributions and the existence of functional toolkits. They believe that variability in Middle Paleolithic assemblages is continuous and that tool reduction intensity and lithic economizing explain the differences between assemblages.

There has not been an extensive multivariate statistical examination of Middle Paleolithic assemblage composition and distribution since Callow and Webb's (1977, 1981) analysis of 96 assemblages. Their study suffers from important statistical and interpretive errors. I have conducted multivariate analyses of 103 Western European Middle Paleolithic assemblages using Bordes' tool types, bifaces and unretouched flakes. The results of principle components, factor, discriminant and cluster analyses point to the continuous distribution of assemblage types and suggest that racloirs are the primary cause of variation in the sample. Other variables that account for significant although secondary proportions of variance are also identified.

The factor and principal component analyses reject the findings of Binford and Binford, whose work suffers from fatal statistical flaws. The present multivariate analyses support several important premises of Rolland and Dibble's model explaining Middle Paleolithic variability. Although the differences between Bordes' defined assemblage types are generally upheld, the idea that they constitute statistically discrete populations is not supported.

Taphonomy of a purported Mousterian bone flute from Divje Babe I, Slovenia

April Nowell¹ and Philip G. Chase²

In Europe, prior to the Upper Paleolithic, the evidence for ritual is scarce and rather controversial. Music, one important aspect of ritual, is often left unexplored due to a dearth of evidence. Common to all cultures, music is unique in its ability to evoke emotion and to convey symbolic ideas. For this reason, we consider a re-examination of the purported Mousterian bone flute from Divje Babe I in Slovenia to be essential. We examined the specimen for any evidence of human modification as well as for carnivore action. We conclude that the most parsimonious explanation for this object is that it is simply a heavily chewed bone rather than a flute, and therefore, cannot be used as evidence for early symbolic behavior and ritual in Europe.

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Evidence of secondary burial from the Late Paleolithic in Southwestern Germany

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During excavations at the Brillenhöhle near Blaubeuren, a paleolithic cave site on the Swabian Alb, Baden-Württemberg, southwestern Germany, in 1956 human skeletal remains of the Magdalénien were found. The skeletal remains were grouped inside a fireplace in the centre of the cave.

The skeletal remains were very fragmentary and consisted of an adult skullcap, numerous heavily damaged elements of the postcranial skeleton of three adults and a few skeleton parts of an infant. It is remarkable that long bones were missing at the site and that only small skeletal remains or bones broken into small pieces were found. During the first examination the find was interpreted as the result of cannibalistic activity. During the author's reexamination, numerous cut marks were noticed on the damaged parts of the bone surfaces. A complete examination of the surfaces of all skeletal remains was undertaken using a scanning electron microscope (SEM). With the SEM, chop and scratch marks accompanying the cut marks were identified. A comparison with Magdalénien butchering marks on animal remains uncovered major discrepancies. The most marked difference is that on the human remains the frequency of cut marks was more than double that discovered on contemporary animal remains. The scratch marks on the human bones show that they have been intensively cleared from flesh. That means that the manipulation of the human bones was far more intense than that of the animal bones. As the conditions for preservation are extremely good at the site, and carnivores had no evident means to influence it, the skeletal remains must have been at a different place before they finally came to the site.

The finds' context and the high frequency of butchering and defleshing marks in combination with the evident selection of the skeletal elements allows an identification of the finds in the Brillenhöhle as a secondary burial of human skeletal remains.

The Paleolithic of India and its bearing on the hominid record

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A long-term, multi-year project is being conducted on Paleolithic occurrences in two major valleys on the Indian Peninsula, the Hunsgi-Baichbal Valley and the Malaprabha Valley, in the state of Karnataka. The occurrences have been chronometrically dated to the Middle and Late Pleistocene, and consist of Acheulian biface assemblages and Middle Paleolithic prepared core-flake industries. A range of small to large Paleolithic occurrences have been identified in buried Pleistocene landscapes, localities consisting of variable artefact densities, tool types, and raw materials. Geomorphological observations indicate variability in depositional environments and preservation contexts with many intact occurrences situated in alluvial contexts and along spring margin habitats. A major Acheulian quarry source has been test excavated, yielding bifaces (i.e., handaxes, cleavers) and a high density of reduction waste. The quarry study has indicated the systematic nature of Acheulian lithic reduction from siliceous limestone beds, analysis yielding information about procurement, biface manufacture, and discard behaviors. A major technological finding is that mineralogical measurements show intentional tool designs on the part of the manufacturers. This paper, centering on hominid technology and activity variation, makes the case that paleoanthropological investigations must be conducted on the Indian Subcontinent if a full picture of the hominid adaptive process is to emerge.

Klasies River Mouth post-cranial comparisons

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Descriptions of the Middle Stone Age human post-cranial fragments from the Middle Stone Age site at Klasies River Mouth (KRM), South Africa, have noted their small external dimensions. Rightmire and Deacon (1991) noted similarities to subsequent Khoisan populations, Wolpoff (1996) has interpreted the remains as showing a kind of generic smallness and Churchill *et al.* (1996) concluded that the KRM ulna was most similar to archaic humans. This study reports on comparison of the KRM fragmentary clavicle, ulna, radius, metatarsal and lumbar vertebra to measurements from two small-bodied samples: 94 Later Stone Age (LSA) skeletons (C14 dated to 12-2kya), and 30 Anadamanese skeletons from the early historic period. Measures of cross-sectional bone mass are taken from CT and conventional X-ray images. The size and shape of the KRM material are most similar to the LSA group, indicating a possible ancestral-descendant relationship. Consistency among the KRM skeletal elements suggests that they represent a very small number of individuals. This interpretation can be accommodated within the archaeological context. The robustness of the KRM material is normally at the upper end of the LSA range, but for the metatarsal it is beyond that range, suggesting an *in situ* gracilization of the population. Radiation of the ancestors of anatomically modern humans appears to have preceded the depositional events at KRM by a number of generations, such that some population differentiation had occurred.

The Early Late Stone Age and evidence of modern human behavior

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Documenting archaeological evidence of modern human behavior is of critical importance in examining the problem of the origins of anatomically modern humans in Africa. Current research has suggested that there is a significant hiatus between the appearance of anatomically modern humans and modern human behavior. It is clear that information from the early LSA is of critical importance in examining this issue, yet this period is one of the most inadequately known in African prehistory. This paper describes the early LSA of White Paintings Rock Shelter in the Kalahari Desert in the context of pertinent data from other sites. The uppermost early LSA deposits contain well-made bone artefacts as well as numerous fish bones. The bone artifacts include a unique point with a series of incisions as well as other bone points. The underlying early LSA levels contains a blade industry with burins. The blade technology continues into the underlying MSA deposits. This new information from the Kalahari adds to the growing body of data regarding early evidence for complex technical skills in Africa.

Spatial analysis of Lower Palaeolithic settlement pattern in Central South Africa

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The upper Karoo region of central South Africa is a semi-arid plateau with sparse plant cover and very thin soils. Consequently Lower Paleolithic surface sites are highly visible and reasonably complete site distribution maps are attainable. One such map covering a 5000 km² area provides unique insights into Acheulian spatial organization. It contains over 400 sites and 600 hornfels outcrops with quarry debris which can be correlated to the Acheulian on the basis of similar patination thickness. The site distribution pattern is markedly unlike those of terminal Pleistocene and Holocene industries in the same area, which are sharply concentrated around the many available water points. The Acheulian sites are organized into three large concentrations on the landscape, with relatively empty ground between them. These site-swarms cannot be explained as spurious or random, nor do they equate with areas of thinner sediment cover, nor do they occur in more intensively searched areas. The only correlation seems to be with the abundance and concentration of hornfels outcrops, although individual sites are not closely tethered to the outcrops. Within site concentrations, spring eyes were consistently avoided. Isolated handaxes indicate that these objects were carried from one site to another. One possible interpretation is that the concentrations represent group ranges. Another is that they were way-stations within even larger mobility patterns. Testing of either hypothesis only becomes possible if hornfels can be chemically fingerprinted to outcrop or at least to the swarms of adjacent outcrops.

Neanderthal skeleton from Tabun: U-series date by gamma-ray spectrometry

Henry P. Schwarcz¹, John J. Simpson² and Christopher B. Stringer³

A relatively complete specimen of a Neanderthal hominid was found at the site of Tabun, Israel, by Garrod and Bate, in either layer B or C of their stratigraphic sequence. We have

used gamma-ray spectrometry to determine the $^{230}\text{Th}/^{234}\text{U}$ and $^{231}\text{Pa}/^{235}\text{U}$ ratios of two bones from this skeleton. The ages calculated from these ratios depend on the uranium uptake history of the bones. Assuming a model of early U uptake the age of the Tabun C1 skeleton is 32 ± 11 ka. A model of continuous uptake would give an age of 70 ± 25 ka. These new age estimates for the skeleton suggest that it was either buried into layer C or was actually in a younger stratigraphic level. Its age is closer to estimates for other Neanderthal burials found in Israel rather than for those of Skhul and Qafzeh burials. This suggests that Neanderthals did not necessarily coexist with the earliest modern humans in the region. The majority are known from the cool period of isotope stages 4–3, possibly as a result of the southward expansion of their habitable range, or of the temporary disappearance of early modern humans from the region.

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Coupled carbon and oxygen isotope niche partitioning of Plio-Pleistocene fauna: implications for hominid dietary reconstruction

Matt Sponheimer¹ and Julia Lee-Thorp²

Stable carbon isotope analysis is now routinely used to reconstruct diets of Plio-Pleistocene fauna. Previous isotopic work suggests that *Paranthropus* and *Australopithecus* had significant quantities of animal foods in their diets along with C3 vegetation such as leaves, nuts, and fruits. Recently, however, it has become apparent that the discriminating power of isotopic analysis can be improved if carbonate oxygen is analysed as well as carbon. In the past, carbonate oxygen has been avoided due to concerns that diagenesis completely obscured biogenic oxygen signals. Work at South African sites such as Makapansgat Limeworks, Swartkrans, Border Cave and Equus Cave, however, suggests that sound oxygen numbers can be obtained from tooth enamel at least 3 million years old. Particularly exciting is the fact that diets that are indistinguishable using carbon isotopes are disparate when oxygen data are included. For instance, *Papio robinsoni* and *Dinopithecus ingens* from Swartkrans have nearly identical C3 signatures but strongly different oxygen numbers ($P < 0.001$). This suggests that we may be able to discriminate between the consumption of different C3 foods such as leaves, fruits, and geophytes. Data also indicate that carnivore oxygen signatures are depleted compared to their prey. This has important implications for the study of ancient hominid diets.

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Inferring diet and range use from lithic transport data

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Lithic transport data are used to estimate home range areas of Paleolithic hominids at Caune de l'Arago and at Grotte Vaufrey, using standard estimation techniques. Modern comparisons demonstrate that these home ranges were of a magnitude consistent with use by local groups of a few families, and whose dietary focus was on meat. This is consistent with faunal evidence from Lower and Middle Palaeolithic Europe, and also with stable isotope evidence (later in date) from Neanderthal bone collagen. We ask whether such techniques can also be used to help resolve interpretation of early sites at which hominid activity is more controversial, such as FLK *Zinjanthropus*.

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Tardiglacial settlement in the Cantabrian Cordillera, Northern Spain

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Following the environmental crisis of the Last Glacial Maximum (21–17 kya), surviving human populations in the lowland refugia of S. Europe began to extend their distribution, both by recolonization of N. Europe's higher latitudes and by expansion into the higher altitudes of the mountain chains and plateaux of the South. In W. Europe these biogeographic phenomena are associated with the Magdalenian cultural complex. Despite considerable recent research into major lowland open-air and rockshelter sites and into the N-ward recolonization, much less attention has been paid to the altitudinal expansion, especially in Spain. This has meant that our knowledge of Magdalenian settlement-subsistence systems and social territories has been limited by a distinct bias toward sites near cities in the coastal lowlands. The only major exceptions to this skewed pattern are the small specialized ibex-hunting cave sites of Collubil in the Asturian Picos de Europa and Rascaño in foothills of the Cantabrian Cordillera above Santander.

The 1996–97 test excavations of vast El Mirón Cave in the upper Río Asón drainage in the Cantabrian Cordillera on the Cantabria-Vizcaya border began to complete the picture of human settlement and upland expansion during the Magdalenian, with one of the longest stratigraphic sequences for this period at any site, newly discovered rock engravings, portable art and decorated artefacts, all datable to the Magdalenian. Mirón is on a dramatic cliffside adjacent to the cave painting loci of La Haza and Covalanas, with strategic views of the principal intermontane valley in the E. Cantabria region, immediately surrounded by 800–1000 m peaks, but near the lowest pass between the Atlantic shore and Castilian *meseta*. It is the first Paleolithic site to be excavated in the montane hinterland of the Asón, whose lowland zone of the drainage contains several Magdalenian and Azilian sites which will make possible comparative studies and reconstructions of human movements and/or contacts (indicated by marine shells in Mirón Magdalenian levels) along the 40 km that separated it from the Tardiglacial shore. Mirón is at the center of and probably related to a concentration of 12 cave art sites of socio-ideological importance in the montane zone.

Magdalenian deposits have been found so far in 3 areas of Mirón: mid and rear vestibule and non-sunlit inner cave. So far, 13 radiocarbon dates place the sequence between 16.4–11.7 kya. Preliminary indications suggest that this is underlain by levels pertaining to

the Solutrean, early Upper Paleolithic and Mousterian. It is overlain by a spectacularly rich and well-dated sequence of Neolithic, Chalcolithic and Bronze Age layers. A full suite of natural science analyses (including paleobotanical studies of systematic sediment flotation samples) is currently underway. Faunal assemblages include some which are heavily dominated by ibex, but others that are more diversified, in keeping with Mirón's potential as *both* a specialized hunting camp and a multi-purpose residential site. There is a wide range among the artefact assemblages in terms of antler points and such lithic types as backed bladelets and "nucleiform endscrapers"/cores. Evidence for changing human use of the cave sheds light on the nature (temporal, functional, stylistic) of Magdalenian interassemblage variability, which has been long debated both in Spain and France.

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Open-air Mousterian sites in the French Alps: an integrated supply strategy

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Lithic assemblages of the Middle Paleolithic document seasonal penetration of high-altitude peri-alpine areas. High-altitude open-air Mousterian sites appear to be linked to the supply of siliceous raw material while cave sites are linked to the exploitation of animal resources. An interesting question is what motivated prehistoric hunter-gatherers to move into and through high-altitude zones?

If a group is going to be mobile it cannot transport a large stock of stone tools. Consequently a supply of raw material had to be available on the journey and a group would have had to have planned their journey in relation to the availability of that raw material. The raw material may have only been used in the context of the renewal of useful tools during the seasonal stay in the peri-alpine zone. Alternatively, alpine areas could have been used as source areas for lithic raw material. This distinction is important and requires the evaluation of the occurrence of siliceous raw material of alpine origin in Middle Paleolithic sites. The Neandertals at the site of Jiboui (Vercors) appear to have adopted the second strategy and used the flint of Bellemote Mountain as a source. The transportation of raw material, however, would have posed considerable problems in terms of volume and weight. Alpine-source flint at Jiboui (Vercors) appears rather to have been transported as finished tools.

The age of the Yunxian hominid fauna

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Twenty species of fossil mammal have been discovered at the Xuetaolangzi hominid site, Qu Yuanhekou, Yunxian, Hubei, China. The character of major elements of the Yunxian fauna, including *Rhinopithecus lantianensis*, *Hyaena lydekkeri*, *Ailuropoda melano-leuca wulingshanensis*, *Equus yunnanensis* (*E. sanmeniensis*), *Tapirus sinensis*, *Megaloceros*, and *Leptobos*, etc. is nearly identical to comparable specimens from the Gongwangling hominid site, Lantian, Shaanxi, currently dated in excess of 1 million years. This is important

evidence for the contemporaneity of the two sites. Results of both the paleomagnetic stratigraphy and ESR dating of the Yunxian site tend to support the age estimate based on faunal analysis. A synthesis of the available evidence suggests that the Yunxian hominids are from the late early Pleistocene, approximately 1 million YBP.

Location of the Matuyama/Brunhes boundary in the Gesher Benot Ya'aqov archaeological site, Israel

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We have conducted a paleomagnetic and mineral magnetic study of 155 samples from the Gesher Benot Ya'aqov archaeological site in Israel. The samples were collected from four trenches which span 26 of the 34 m of the Benot Ya'akov Formation at the site, including all of the archaeological layers. For the paleomagnetic study, the samples were subjected to a ten-step alternating field demagnetization to levels of 60 mT. Each sample reached a stable magnetic endpoint, usually before the third demagnetization step. After correction for the tilt of the beds, all of the samples in the upper 17 m of the sampled section had northward declinations and moderately steep, positive inclinations. Samples from the lower 9 m generally had southward declinations and moderately steep, negative inclinations. These directions imply that the magnetostratigraphy of the Gesher Benot Ya'aqov site consists of a reversed polarity zone overlain by a normal polarity zone. Based on the biostratigraphy and lithic assemblages at the site, we correlate the boundary between the polarity zones with the Matuyama/Brunhes boundary, dated at 780 ka. The mineral magnetic study demonstrated that the magnetic grain size did not change significantly during deposition of the sediment and that the intensity of the geomagnetic field was somewhat weaker during the reversed polarity interval than during the normal polarity interval. The uniformity of the magnetic grain size and the similarity of the intensity pattern to detailed records of the Matuyama/Brunhes transition at other sites, suggests that the 26-m section at the Gesher Benot Ya'aqov site represents somewhat less than 100–150 kyr. Because the lithic assemblage at the Gesher Benot Ya'aqov site is similar to assemblages found at sites of about the same age in East and North Africa, this result has considerable implications for estimates of rates of cultural diffusion.

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The Middle Paleolithic of Central Asia

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Central Asia is used here to designate the area stretching from the Zagros-Taurus Mountains in the West to southern Siberia (Altai) in the East, and from the Southern Ural foothills and the Irtysh River in the North to Northern India and Pakistan in the South. The Middle Paleolithic industries of the region form three distinct groups, each of which is confined to different, though partly overlapping, areas. The first group (northern and

central parts of Kazakhstan), though very vague as yet, may represent a continuation of the East European Middle Paleolithic with bifacially worked tools. The second one, which emerged at least as early as 1 mya, gravitates toward the eastern cultural zone (Pakistan, Northern India, parts of the former Soviet Central Asia), though during its duration of many hundreds of thousands of years its western borders fluctuated. The third group (the Zagros-Taurus, the northern foothills of Pamir and Tien Shan, Southern Siberia) comprises The Mousterian of Central Asia.

The Mousterian of Central Asia seems less “mosaic” than European Mousterian and can be defined as “ordinary” Mousterian in the sense that it lacks any unique characteristics and displays a rather classic and coherent set of artefacts and techniques reconstructed after these artefacts. No serious reasons are seen so far to subdivide it into any smaller units. Taking into account (1) the probability of relatively late ages of Central Asian Mousterian sites, (2) their association with the Neandertal type (at Shanidar and Teshik-Tash), (3) the total absence in the whole Central Asia of any clear precedent from which this industry could have evolved, and (4) the similarity of the Zagros-Taurus, Trans-Caspian, and Altai stone assemblages, it is possible to make a number of suggestions. First, it is possible that both Zagros and Transcaspian Mousterian sites were left by Neandertals moving from West Asia eastwards. Second, it could be that this movement was either an expansion resulting from successful adaptation (this would probably imply that all the available dates are too young, which is a possibility), or a forced retreat under the pressure of some other expanding population, e.g., modern humans. However, it will not be possible to test these suppositions until new and more reliable dates are obtained.

Current research on the Middle to Upper Paleolithic transition in Southern Germany

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In southern Germany, as in other parts of Europe, much current research has focused on documenting the transition from the Middle to Upper Paleolithic. Attempts have been made to improve our understanding of the diversity within late Middle Paleolithic assemblages and to pinpoint the timing of the arrival of the Aurignacian in the region. The work of Joachim Hahn in particular played a central role in this research.

Unlike other European regions, where leaf point assemblages are usually seen as the first phase of the Upper Paleolithic, *Blattspitzen* assemblages in Germany typically have been considered to belong to the last phase of the Middle Paleolithic. Finds from this period are known from several cave and open-air localities in Bavaria and Baden-Württemberg, but they appear to be less common than in neighboring regions of central Europe. Reliable dates for *Blattspitzen* assemblages are not yet available, but the existing evidence suggests that they date to between 45,000 and 35,000 b.p. *Blattspitzen* horizons lack the decorative objects that are well documented in the French Châtelperronian, and relatively little is known about the subsistence and settlement strategies of this period.

As new radiocarbon and thermoluminescence become available, the arrival of the Aurignacian has been pushed back; and it now looks like Upper Paleolithic groups were present in the region by 40,000 b.p. In Bavaria and Baden-Württemberg there is little

evidence for interstratification of late Middle Paleolithic and early Upper Paleolithic assemblages, and at Geißenklösterle, Vogelherd, Hohlenstein Stadel and Bocksteinhöhle a sterile zone separates Middle and Upper Paleolithic deposits. Much work is currently underway to understand the raw material economies and subsistence practices during the late Middle Paleolithic and Aurignacian. While Neanderthal remains have been found in Middle Paleolithic horizons and modern humans are associated with the Aurignacian, there are no hominid remains from the critical period around 40,000 b.p. We assume that interaction between archaic and modern humans must have occurred in the region, but too little is known about the period around 40,000 b.p. to adequately characterize this interaction or the timing of events along the frontier at which these hominids met. As excavations continue at sites with Aurignacian deposits including Geißenklösterle, and Hohle Fels, we anticipate new data and perhaps answers to these questions.

The personal ornaments from Arcy-sur-Cure (Yonne), France: technological and evolutionary perspectives

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The grotte du Renne at Arcy-sur-Cure is one of only two known sites with pierced objects attributed with some certainty to the Chatelperronian. The fact that the grotte de Renne ornaments, which remain largely unpublished, are associated with Neanderthal remains has placed them at the centre of debates concerning the symbolic capacities of Neandertals and an hypothesized relationship of acculturation between the Chatelperronians and the Aurignacians.

The authors review critically the available contextual and stratigraphic data for the grotte du Renne ornaments. They then report on their microscopic/technological analysis of the 38 personal ornaments from Chatelperronian levels X, IX and VIII and Aurignacian level VII. They show that while the chaîne opératoire for Chatelperronian ornaments is in some ways quite different from the classic SW French Aurignacian, it shares much with the Aurignacian/Early Upper Paleolithic of Belgium, Germany, the Czech Republic and European Russia. They emphasize that despite the impression in the literature, the grotte du Renne pierced objects considerably post-date the earliest personal ornaments in Europe, which are demonstrably not Chatelperronian. They conclude that pre-Chatelperronian dates for personal ornaments in non-Mousterian contexts in Central, Eastern and N.W. Europe support the notion of a relationship of acculturation between Early Upper Paleolithic and terminal Mousterian groups.

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The last Neanderthals: cultural variability and extinction

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Radiometric dates from Portugal and Southern Spain place the Mousterian–Aurignacian interface at ca. 28–30 ka B.P. In Cantabria and Northern Catalonia, the earliest Aurignacian is now dated at ca. 38 ka B.P. Thus, a stable frontier corresponding approximately to

the Ebro river valley probably separated Aurignacian modern humans from Mousterian Neanderthals for as much as 10,000 years. This pattern is in good accord with typological, paleoenvironmental and chronostratigraphic evidence.

Such a long coexistence without mutual acculturation forces a reappraisal of models that explain the extinction of Neanderthals as due to their biologically based intellectual inferiority. In the context of such models, the Chatelperronian and similar Upper Paleolithic cultural complexes have been considered as the result of "imitating, but not understanding, modern symbolical behavior". This imitation would be the inevitable outcome of the acculturation of Neanderthals brought about by a prolonged contact with Aurignacian moderns.

Due analysis of the data from the key site of Grotte du Renne (Arcy-sur-Cure, France) shows that Pre-Aurignacian Upper Paleolithic European technocomplexes, likely manufactured by Neanderthals, are an autochthonous development. Thus, the replacement of Neanderthals by anatomically modern humans should be looked at as a problem of contact between isolated populations with different, albeit largely parallel, cultural trajectories. In this case, as has often been documented in both the historical and the ethnographic records, the long-term outcome of contact was that one of those trajectories was truncated and the corresponding genetic lineage went extinct.

Current research in the Almonda karstic system (Tores Novas, Portugal), where Neanderthal remains from late Mousterian levels were recovered in 1997, promises to shed some light on the reasons behind the Ebro frontier pattern and its implications for the understanding of Neanderthal extinction.