NEANDERTHALS IN EUROPE

Proceedings of the International Conference, held in the Gallo-Roman Museum in Tongeren (September 17-19th 2004)

Directed by
Bart DEMARSIN & Marcel OTTE

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Collection éditée par

Marcel OTTE
Université de Liège
Service de Préhistoire
Place du XX Août 7, bât. A1
B-4000 Liège - Belgique
Tél.: ##32/4/366.53.41
Fax.: ##32/4/366.55.51
Email: prehist@ulg.ac.be
Web: http://www.ulg.ac.be/prehist/

ATVATVCA

Collection éditée par

Guido CREEMERS
Provinciaal Gallo-Romeins Museum
Wijngaardstraat 65
B-3700 Tongeren - België
Tél.: ##32/12/67.03.36
Fax.: ##32/12/67.03.33
Email: grm@limburg.be
Web: http://www.galloromeinsmuseum.be

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Reconstructed Neanderthal Man in the exhibition "Neanderthals in Europe" (Tongeren, October 25th 2003 - January 9th 2005).
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VOORWOORD
AVANT-PROPOS

Steve STEVAERT
Gouverneur van de Provincie Limburg

Van 25 oktober 2003 tot en met 9 januari 2005 vond in het Provinciaal Gallo-Romeins Museum van Tongeren de tentoonstelling "Neanderthalers in Europa" plaats. Uit de massale toevloed van bezoekers, meer dan 145.000 in totaal, bleek andermaal de enorme belangstelling voor de Neanderthaler bij een breed publiek van geïnteresseerden.

Aanleiding voor de tentoonstelling was het archeologisch onderzoek dat enkele jaren voordien van start was gegaan op de site Veldwezelt-Hezerwater (Lanaken, België). Archeologen van de Katholieke Universiteit Leuven legden daar tussen 1998 en 2003 de resten bloot van ten minste vijf verschillende kampplaatsen van Neanderthalers. De opgegraven sites zijn de oudste in Vlaanderen, de vindplaats is zonder meer de belangrijkste Neanderthalernederzetting die tot op heden in Vlaanderen werd opgegraven. De Provincie Limburg en het Provinciaal Gallo-Romeins Museum waren van meet af aan nauw bij het project betrokken en stonden ook jaarlijks in voor de organisatie van de succesvolle bezoekersdagen.

Met de tentoonstelling "Neanderthalers in Europa" werden de vondsten en de resultaten van het onderzoek in Veldwezelt-Hezerwater voor de eerste maal aan het publiek getoond. Net als vele andere sites die de afgelopen jaren zijn onderzocht in binnen- en buitenland, leverde dat een sterk gecorrigeerd beeld op van de Neanderthalers. Maar noodgedwongen bleef de tentoonstelling ook een verhaal met een open einde: ondanks langdurig en diepgaand onderzoek is de Neanderthaler nog altijd een wezen met heel wat mysterieuze facetten.

Het internationale colloquium "Neanderthals in Europe", dat plaatsvond van 17 tot en met 19 september 2004, was voor het Provinciaal Gallo-Romeins Museum de kers op de taart. Het museum wilde niet alleen de sterke wetenschappelijke funderingen van de tentoonstelling onderstrepen, maar ook een actieve rol spelen in het wetenschappelijk debat dat vandaag over de Neanderthaler gevoerd wordt. Het colloquium bleek een schot in de roos, met een ongekende publieke opkomst en een hoop vruchtbare discussies tot gevolg. Op vraag van de lezinggevers bundelden de Universiteit van Luik en de Provincie Limburg de krachten, een samenwerking die resulteerde in de publicatie van deze congresteksten.

L’exposition "L’homme de Neandertal en Europe" a eu lieu au Musée Gallo-Romain de Tongres du 25 octobre 2003 au 9 janvier 2005. L’affluence massive des visiteurs, plus de 145.000 au total, a montré une fois de plus l’énorme intérêt que suscite l’homme de Neandertal auprès du public.

Le point de départ de l’exposition était le projet de fouilles archéologiques lancé quelques années auparavant sur le site de Veldwezelt-Hezerwater (Lanaken, Belgique). Des archéologues de la Katholieke Universiteit Leuven avaient trouvé entre 1998 et 2003 les vestiges d’au moins cinq campements d’hommes de Neandertal. Ces sites d’excavation sont les plus anciens en Flandre et le site est tout simplement la plus importante colonie de Neandertal jamais découverte en Flandre. La Province du Limbourg et le Musée Gallo-Romain ont été d’emblée étroitement associés au projet et ont assuré aussi avec succès les journées annuelles des visiteurs.

Les découvertes et résultats de la recherche à Veldwezelt-Hezerwater ont été montrés pour la première fois au public dans le cadre de l’exposition "L’ homme de Neandertal en Europe". Tout comme quantité d’autres sites ayant fait l’objet de fouilles en Belgique et à l’étranger au cours des dernières années, celui-ci a permis de corriger nettement l’image que nous avions des hommes de Neandertal. Par la force des choses donc, l’exposition se termine elle aussi par des points de suspension: en dépit d’études minutieuses et approfondies dont il a fait l’objet, l’homme de Neandertal est loin d’avoir livré tous les secrets de sa riche personnalité.

Le colloque international "Neanderthals in Europe", qui a eu lieu du 17 au 19 septembre 2004, constituait un point d’orgue pour le Musée Gallo-Romain. Le musée voulait ainsi souligner les solides bases scientifiques de l’exposition, mais aussi jouer un rôle actif dans le débat des hommes de science sur l’homme de Neandertal. Le colloque connut un grand succès, avec une réaction du public sans précédent et une pléiade de discussions fructueuses à la clé. A la demande des conférenciers, l’Université de Liège et la Province du Limbourg ont fait cause commune pour publier un recueil de tous les textes de la conférence.

Wij willen uitdrukkelijk de Vlaamse Gemeenschap en de Eenheid Prehistorische Archeologie van de Katholieke Universiteit Leuven bedanken, zonder wiens inbreng de organisatie van dit colloquium niet was mogelijk geweest.

Nous voulons remercier tout particulièrement la Communauté Flamande et la Eenheid Prehistorische Archeolgie de la Katholieke Universiteit Leuven, car l'organisation de ce colloque n'aurait pas été possible sans leur apport.

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INTRODUCTION
INLEIDING

Bart DEMARSIN
Musée Gallo-Romain, Wijngaardstraat 65, B-3700 Tongeren. bdemarsin@limburg.be

De remarquables ossements furent découverts en 1856 dans une carrière des environs de Düsseldorf. Ils semblaient provenir d'une espèce humaine éteinte. Le site, le Neanderthal, donna son nom à ces hommes d'un autre âge. 150 ans plus tard, l'homme de Neandertal fait toujours autant rêver. Il est vrai que de nouvelles découvertes et de nouvelles méthodes de recherche ont considérablement modifié l'image que nous nous faisions de lui.

Mais les angles de vue nouveaux suscitent aussi des questions nouvelles. C'est la raison pour laquelle l'exposition "Neanderthals in Europe" avait prévu un large espace pour la discussion et le débat. D'où venait l'homme de Neandertal ? Quel était son environnement? Produisait-il de l'art? Quelle a été la cause de sa disparition? Le tableau qui en est dressé dans le cadre de l'exposition reste délibérément incomplet : en dépit d'études longues et minutieuses, l'homme de Neandertal a encore bien des facettes inconnues et mystérieuses. Mais la recherche ne s'arrête pas. Des scientifiques du monde entier tentent de reconstituer le puzzle que constitue la vie de l'homme de Neandertal. Et même si beaucoup de pièces du puzzle manquent, les résultats de leurs recherches sont remarquables. Non seulement on ne cesse de trouver des sites nouveaux, mais des sites connus et étudiés depuis longtemps font l'objet de nouvelles recherches avec des techniques modernes.

Avec le colloque international "Les hommes de Neandertal en Europe", le Musée Gallo-Romain voulait en premier lieu dresser un inventaire des résultats actuels de la recherche sur l'homme de Neandertal. Il voulait aussi inviter les scientifiques à échanger des idées et débattre entre eux, mais aussi avec un vaste public d'intéressés. L'homme de Neandertal a été le sujet principal de la première journée du colloque, la deuxième journée a été entièrement consacrée à son environnement naturel et son contexte social et culturel. La troisième et dernière journée du colloque a rassemblé les scientifiques et les visiteurs pour une visite de plusieurs remarquables sites du Neandertal en Belgique, dont le site de fouilles de Veldwezelt-Hezerwater et le site de grottes de Goyet, en Wallonie.

In 1856 kwamen in een steengroeve bij het Duitse Düsseldorf merkwaardige beenderen te voorschijn. Ze bleken afkomstig van een uitgestorven mensensoort. De vindplaats, het Neanderthal, gaf deze mensen hun naam. 150 jaar later spreekt de Neanderthaler nog steeds tot de verbeelding. Nieuwe ontdekkingen en moderne onderzoeksmethoden hebben het beeld dat ooit van de Neanderthaler werd opgehangen, danig bijgestuurd.

Nieuwe inzichten leidden ook tot nieuwe vragen. De tentoonstelling "Neanderthalers in Europa" liet dan ook heel wat ruimte open voor discussie en debat. Waar kwam de Neanderthaler vandaan? In welk milieu leefde hij? Produceerde hij kunst? Waaraan ging hij uiteindelijk ten onder? Het verhaal dat in de tentoonstelling geschetst werd, eindigde met een open einde: ondanks de langdurige en diepgaande onderzoeken die naar hem gevoerd zijn, heeft de Neanderthaler nog altijd heel wat onbekende en mysterieuze facetten. Maar het onderzoek staat niet stil. Wereldwijd trachten wetenschappers de puzzel van het leven van de Neanderthaler te vervolledigen. En ook al zijn heel wat puzzelstukjes voorgoed verloren, de resultaten zijn opmerkelijk. Niet alleen worden heel wat nieuwe sites ontdekt, ook reeds lang gekende en onderzochte sites worden opnieuw bestudeerd met hedendaagse onderzoekstechnieken.

Met het internationale colloquium "Neanderthals in Europe" wilde het Provinciaal Gallo-Romeins Museum in eerste instantie een overzicht brengen van de meest actuele onderzoeksresulaten met betrekking tot de Neanderthaler. Daarnaast wilde het de onderzoekers uitnodigen met elkaar, maar ook met een ruimer publiek van geïnteresseerden, ideeën uit te wisselen en in discussie te treden. Tijdens de eerste dag stond de Neanderthaler zelf centraal, de tweede dag stond volledig in teken van zijn natuurlijke omgeving en zijn sociale en culturele achtergrond. De derde en laatste dag brachten de onderzoekers samen met de andere deelnemers een bezoek aan een aantal opmerkelijke Neanderthalersites in België, waaronder de opgravingen in Veldwezelt-Hezerwater en de grotsite in het Waalse Goyet.

Nous ne pouvons que nous réjouir que les débats du colloque résultent en une publication car ils ont permis non seulement d'échanger quantité d'idées et de conclusions de recherches, mais aussi de nouer de nouveaux accords de collaboration entre scientifiques. Cette publication est pour nous une manière de mettre les fruits exceptionnels de ce colloque au service de la recherche future.

Dat de resultaten van het colloquium resulteren in een publicatie verheugt ons ten zeerste. Niet alleen werden heel wat ideeën en onderzoeksresultaten uitgewisseld, ook nieuwe samenwerkingsverbanden kwamen tijdens het colloquium tot stand. Met de publicatie willen we de uitzonderlijke output van het colloquium voor toekomstig onderzoek ter beschikking stellen.

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WHO WERE THE NEANDERTHALS?

Ian TATTERSALL
Division of Anthropology, American Museum of Natural History, New York NY 10024, USA.

Abstract: The Neanderthals are commonly thought of as a bizarre variant of our own species *Homo sapiens*, even by many who do not consider them to represent a "stage" in our own ancestry. But careful scrutiny of the record indicates otherwise. Both fossil and molecular evidence suggests that Neanderthals and modern humans last shared an ancestor more than 500 kyr ago, and the enlarging European hominid fossil record suggests that *Homo neanderthalensis* is actually the last surviving species of a fairly diverse endemic clade that flourished in the subcontinent between that time and about 27 kyr ago. For the scattering of fossils making up this record, including the crania from Steinheim, Reilingen, and the Sima de los Huesos, all show some but not all of the Neanderthal cranial hallmarks. For example, Steinheim possesses many of the typical Neanderthal features of the cranial rear and upper face, but lacks the puffy and retreating midface, while the best Sima cranium has Neanderthal-like supraorbital morphology and pterygoid tubercles in the lower jaw, but lacks the typical Neanderthal medial nasal projections, the ovoid coronal profile of the cranium, and Neanderthal features of the cranial rear such as the strongly undercut occipital torus. The resulting cluster of morphologies strongly supports the notion not only that *Homo neanderthalensis* was indeed a distinctive species, but that it emerged from a local adaptive radiation that occurred subsequent to the first successful implantation of hominids in Europe at some time between about 1.0 and 0.5 myr ago. The distinctiveness of the Neanderthals is further underlined by a new composite reconstruction of an entire Neanderthal skeleton recently made at the American Museum of Natural History. Combining elements from a half-dozen skeletons from almost as many countries, this new reconstruction contains sufficient continuity of elements from a single individual (La Ferrassie 1) to impart considerable confidence as to the reliability of its body proportions as well as its morphologies. And it shows that Neanderthals would have cut a very distinctive figure on the landscape, particularly with its narrow-topped and wide-bottomed rib-cage that tapers out below to match its wide, flaring pelvis with virtually no waist. As to lifestyles, while it is clear that at least in pre-contact (with Cro-Magnons) times the lives of Neanderthals were largely symbol-free, it is less obvious that the Neanderthals exploited a different range of food resources than that used by their clearly symbolic successors. Indeed it has been argued recently that the major shift in hunting-gathering subsistence strategies took place in the early Holocene, rather than in the "transition" between Middle and Upper Paleolithic ways of economic life. The Neanderthals were clearly ecological opportunists, successfully coping with a wide variety of environments through flexibility of behavioral response. Yet equally clearly they did not perceive and interact with the world around them as we *Homo sapiens* do today. We do the Neanderthals no favors by classifying them as *Homo sapiens neanderthalensis* simply because they had big brains. Instead, we should be trying to understand these unique hominids as the unique and separate evolutionary entity they undoubtedly were.

Introduction

Whether you believe that the first discovery that we *Homo sapiens* possess extinct fossil relatives took place in Belgium in 1829, or in Gibraltar before 1848, or in Germany in 1856, that discovery was of a Neanderthal fossil. And this historical fact has had profound consequences for our interpretation of the species *Homo neanderthalensis*, placing this distinctive hominid at front and center in portrayals of the hominid evolutionary drama. Of course, in the very earliest days of paleoanthropology, when there was no compelling reason to suspect diversity in human evolution, it made sense to look upon the Neanderthals as a variant or precursor of ourselves. But over the past century or more the growing human fossil record has made such scenarios increasingly difficult to sustain, as it becomes impossible to ignore the fact that this record contains a signal of systematic as well as moprhological diversity.

Certainly, as befits the species that is both behaviorally and anatomically the best-known among all known extinct human relatives, the Neanderthals must occupy a very special niche in our efforts to understand humanity's historical context and its place in Nature. These remarkable hominids do indeed constite a unique mirror that helps us discern just what it is that makes us unique. But given the emerging nature of the fossil record, this fact can no longer be deployed to justify the interpretation of the Neanderthals as a mere variant of our species, or alternatively as part of a single lineage that was bracketed at the far end of the timescale by "pre-Neanderthals" or "proto-Neanderthals", and at the near one by evolution or absorption into *Homo sapiens*. Yet such interpretations linger in a number of different guises, and the reason that they do so relates much less to the morphological facts of the matter than it does to the persistance of a deeply-rooted mindset. For the concept of a lineage of this kind is not based only on the received belief that Neanderthals need to be fitted somehow into the specific context of *Homo sapiens*. It has also flourished in the context of the fairly strictly linear notion of expected pattern in human evolution that became common wisdom in the second half of the twentieth century.

This perspective grew out of the wholesale capitulation of paleoanthropology to the gradualist notion of the evolutionary process that was espoused by the movement known as the Evolutionary Synthesis (see Tattersall 1995). Ultimately viewing evolutionary change as amounting to very little more than generation-by-generation change in gene frequencies within lineages, even in its least dogmatic forms the Synthesis suggested that *Homo neanderthalensis* was part of a single isolated or quasi-isolated European and western Asian lineage that somehow evolved directionally over a period of upwards of 500,000 years; and indeed, in his classic paper of 1950, the ornithologist Ernst Mayr, one of the the architects of the Synthesis and the one whose views were perhaps most influential among paleoanthropologists, concluded that the Neanderthals were no more than a "geographical race" of *Homo sapiens*. Still, in terms of general patterns of mammalian evolution this pattern would have been unusual indeed. Europe was virgin territory for hominids until a rather late date; and when a new type of mammal successfully enters an environment for the first time, what typically ensues is an adaptive radiation of new species, as the newcomers busily explore the new adaptive and ecological opportunities that are available to them.

The Phylogenetic Position of *Homo neanderthalensis*

Over the past several years my colleague Jeffrey Schwartz and I have been looking quite closely at the European and western Asian fossil records associated with the Neanderthals (see, e.g., Tattersall & Schwartz 2000). And because among the quite large array of hominid fossils known from Europe in the past several hundred thousand years there exist several forms that share some but not all of their features with the Neanderthals, we have concluded that in the fossil record of Pleistocene Europe we are indeed looking at a hominid adaptive radiation, rather than at a linear sequence that leads insensibly from a "primitive" ancestral form to the latest, "classic", Neanderthals. This is particularly evident because *Homo neanderthalensis* is highly apomorphic in numerous cranial features and is consequently a relatively easy morphological entity to define – remarkably, much easier than the differently autapomorphic *Homo sapiens* has turned out to be.

Fossil crania with full-blown ("classic") Neanderthal identity, all known from within the past 200,000 years or so, have brow ridges that roll back smoothly out of the orbital roofs and form a double arch over eye-sockets that have curiously cut-off lower middle corners as a result of major expansion of the maxillary sinuses. They also have a narrow lower face, a rather puffed-out but sharply laterally-retreating midface, and variably-developed "medial projections" just inside the lateral margins of the very large and broad nasal cavity (Schwartz & Tattersall 1996). In posterior view, the large but low braincase is squat and smoothly rounded at the sides, and at the back it bears a pitted suprainiac fossa in the midline of the occipital plane, which often projects in a "bun". Below the fossa there is a long and horizontal "occipital torus" that is defined beneath by a broad undercutting, but above only in the midline by the shallow and sometimes rather small suprainiac fossa. In the mandible are seen such features as a retromolar space, a sigmoid notch that is deepest posteriorly near the low-set condyle, a rather cut-off gonial angle, an elevation at the front of the anterior inferior margin of the corpus, and no formation in the midline of the external symphysis of the distinctive modern human chin (Schwartz & Tattersall 2000). Internally on the jaw there is a medial pterygoid tubercle; and among the teeth the molars are particularly distinctive, with relatively restricted and complex occlusal surfaces that are ringed by blunt crests.

Despite various claims to the contrary (e.g. Bermudez de Castro *et al*. 1997), it seems unlikely on morphological grounds that either of the earliest human fossil samples known from Europe, the 800 kyr-old Atapuerca Gran Dolina *Homo mauritanicus* fragments (see Hublin 2001; Schwartz & Tattersall in press) and the possibly even older Ceprano *Homo cepranensis* calvaria (Mallegni *et al*. 2003), represents a population that is ancestral to later European hominids. It is also hard to find apomophies that the specimens assigned by most authors to *Homo heidelbergensis* share with members of the Neanderthal group (and the extreme size of the intracranial sinuses in certain *Homo heidelbergensis* specimens, notably Petralona, tends to rule them out of the ancestry of the latter). It still seems most likely that the ancestry of both later *Homo sapiens* and *Homo neanderthalensis* lies somewhere within the mass of material from Eurasia and Africa that has been ascribed to *Homo heidelbergensis*; but specific links are still lacking, and the earliest European hominids that can be allied with the Neanderthals on the basis of clear cranial apomorphies are the 400 kyr-old Sima de los Huesos fossils from Atapuerca. These have been allocated by their describers (Arsuaga *et al*. 1997) to the species *Homo heidelbergensis*, but their possession of various cranial apomorphies seen also among Neanderthals contradicts this attribution, while at the same time they do not display the full Neanderthal apomorphy suite (see discussion below). The earliest claimants to fully Neanderthal status include some (but not all) of the Ehringsdorf fossils, probably over 200 kyr old, and the Swanscombe occipital, which may be even older; by the time of the approximately 175 kyr-old Biache partial cranium, Neanderthal morphology was apparently well-established, and non-Neanderthal hominid cranial morphologies are no longer found in Europe until the arrival of the Cro-Magnons some 40-35 kyr ago.

Various European fossil hominids show some, but not all, of the characteristics that typify Neanderthals. Thus, the famous cranium from the German site of Steinheim, perhaps about 225,000 years old, has Neanderthal features of the supraorbital and orbital areas. It also has a large nasal cavity that shows a hint of a medial projection, and it shows various other Neanderthal hallmarks that include long, horizontal parietomastoid and anterior lambdoid sutures and a (faint) suprainiac depression. However, this specimen also lacks the puffy and markedly retreating Neanderthal midface, and it is not usually considered to be a Neanderthal. Instead, among known forms, it appears to represent the "sister-taxon", the closest known relative, of the Neanderthals. Similar observations can be made of the partial braincase from the German site of Reilingen. This is at least 125,000 years old and perhaps as much as 225,000 years old, and it has several of the features that are found in both the Neanderthals and Steinheim. These include expanded petrosal pneumatization; a suprainiac depression; a horizontal occipital torus that is only fully delineated below; incomplete lateral ossification of the ectotympanic tube, and the rounded posterior profile of the braincase. On the basis of these similarities it is possible to interpret this specimen as belonging to a sister taxon to the one that includes both the Neanderthals and Steinheim.

Moving outwards, as already suggested the 400,000-plus-years-old hominids from Spain's Sima de los Huesos also have some but not all of the typical Neanderthal characters. Features that these fossils share with *Homo neanderthalensis* include: orbital and brow-ridge shape; a large nasal aperture that shows some forward extension of the frontal processes; a long, horizontal parietomastoid suture; and a pitted suprainiac depression. There are medial pterygoid tubercles in the lower jaw. However, the nasal fossa lacks a medial projection (instead, there is a clear conchal crest); the braincase rear profile shows much more vertical sides than in Neanderthals, together with a central peaking at the top; there is no well-undercut occipital torus; and the midface is not puffy and does not retreat sharply. Thus, while the possession of several "Neanderthal" apomorphies clearly excludes the Sima hominids from the species *Homo heidelbergensis* to which they were allocated by Arsuaga *et al*. (1997), they are equally clearly not Neanderthals, and nobody has ever claimed that they are. Again, it seems that these hominids are best interpreted as representing the sister group of those already mentioned.

It should be emphasized that the Neanderthal, Steinheim, Reilingen and Sima "morphs" I have just characterized are simply morphological groupings, and no claim is made that all of them necessarily represent distinct species in the biological sense – although some of them doubtless do. But what they do appear to provide evidence for is an *in situ* European hominid radiation. Certainly, the morphologies of these fossils – and others like them – do not form a neat transformation series that would suggest a linear pattern of evolution within a single Neanderthal lineage (even though the task of forcing them into such a structure is facilitated by generally poor dating). Instead, this apparent nesting of European hominids of the past 400,000 years or so can be interpreted as reflecting a major evolutionary exploration over this period of the ecological possibilities offered by the new lands of Europe. Rather than constituting the end-product of a single lineage that steadily evolved toward the morphology we see in the so-called "classic" Neanderthals of the last Ice Age in Western Europe, the distinctive *Homo neanderthalensis* actually formed part of a wider local radiation of hominids over this period. This signal in the European hominid fossil record of diversity rather than of linearity actually makes a great deal of sense given the wildly fluctuating environmental conditions that reigned in Ice Age Europe. For the climatic oscillations of the later Pleistocene evidently led to the frequent abandonment and recolonization by hominids of wide swaths of the subcontinent, even as the correlated fluctuations in sea levels played havoc with its geography. The emerging pattern of the European hominid fossil record suggests that *Homo neanderthalensis* was simply the most successful species, and the latest survivor, of an endemic European hominid radiation. And this, intriguingly, suggests that the Neanderthals may have done to their own closest relatives exactly what *Homo sapiens* would later do to them when, in the form of the Cro-Magnons, our own species arrived in Europe towards the end of the last Ice Age.

Neanderthals as an Individuated Species

Phylogenetically, then, the Neanderthals were simply members of an endemic hominid radiation in Europe with its roots perhaps half a million years ago. But exactly what kind of beings were they? As already noted, for historical reasons as well as because they had brains as large as ours, they have often been viewed in recent years simply as a bizarre variant of our own species, *Homo sapiens*. But they differed from us anatomically in numerous ways, and I have been convinced for decades now that they are to be understood properly only as an entirely independent evolutionary entity, that is to say, as their own species *Homo neanderthalensis* (see Tattersall 1986). I am convinced more than ever of this by the reconstruction of an entire Neanderthal skeleton recently completed by my American Museum of Natural History colleagues Gary Sawyer and Blaine Maley. Due to the fact that these hominids at least occasionally buried their dead, partial skeletons of quite a lot of Neanderthals are known. But all of them are very far from complete, and Sawyer and Maley had to combine casts of bones from half a dozen Neanderthal skeletons, from France, Israel, Belgium and Germany, to reconstruct the skeleton illustrated in figure 1.

Seeing the entire being in front of you like this is very different from looking at individual bones, or even at lists of characteristics in a monograph. And I must say I had a really visceral reaction when I first saw this skeleton fully assembled. Because, for the first time, I felt that I had truly *met* a Neanderthal. And, moreover, that I had met a creature truly unlike ourselves. Reviewing lists of differences between *Homo sapiens* and *Homo neanderthalensis* skeletal elements in a monograph, or even directly comparing the bones, lacks the *Gestalt* impact of a full-size reconstruction. This composite skeleton will be described in detail elsewhere (Sawyer & Maley in press), but even a superficial comparison (such as that shown in figure 2) between the composite Neanderthal and a modern individual of comparable height (approximately 164 cm) shows some remarkable differences in proportioning of the major body elements. In this connection it is important to note that we can have considerable confidence in the accuracy of the reconstructed body proportions because, in all major body areas, the reconstruction has continuity in elements from a single individual: the La Ferrassie 1 Neanderthal.

Figure 1. Front and side views of the composite Neanderthal skeleton reconstructed by G.J. Sawyer and Blaine Maley. Photograph by Denis Finnin, courtesy of the American Museum of Natural History.

Particularly striking are the extreme differences between the *Homo neanderthalensis* and *Homo sapiens* skeletons in the form of the thorax. The conical Neanderthal rib cage shows a dramatic upward tapering, from the the widely flaring waist area up to its narrow top; and in this characteristic it closely resembles the rib cages of both the "Lucy" (NME AL288-1, *Australopithecus afarensis*, ca. 3.2 Ma) and the "Turkana Boy" (KNM-WT 15000, *Homo ergaster*, ca. 1.6 Ma) specimens, the only even tolerably complete such specimens from earlier in the record. The broad inferior sweep of the rib cage in the Neanderthal is matched by the remarkable width of the broadly flaring ilia of its pelvis, and a similar conformation is found in the Lucy and Turkana Boy specimens (albeit attenuated in the latter by its immaturity). In contrast to what can thus apparently be regarded as the primitive hominid pelvic and thoracic proportions, the *Homo sapiens* skeleton seen in figure 2 appears strikingly derived, with its parallel-sided, barrel-shaped thorax and narrow pelvis. Taken together with the laundry-list of detailed osteological differences between Neanderthals and modern humans in the skull and the postcranial skeleton reviewed, among many others, by Stringer and Gamble (1995) and Tattersall & Schwartz (2000), the proportional differences just pointed out present an unassailable morphological case for distinguishing between the species *Homo neanderthalensis* and *Homo sapiens*. Indeed, in many other mammal groups species presenting morphological differences on this scale might well be classified in different genera without raising any eyebrows.

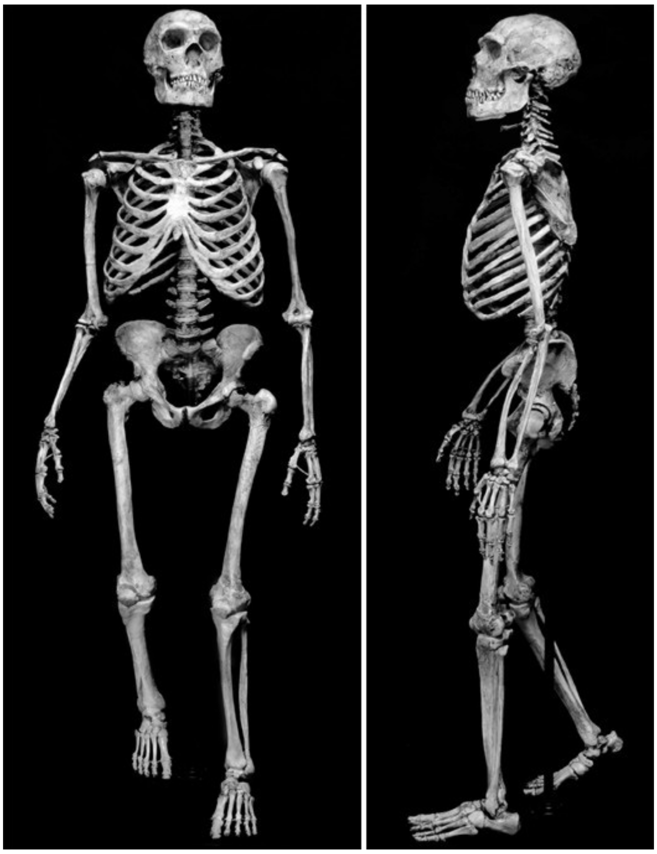

Figure 2. Comparative front views of the composite Neanderthal skeleton (left) and a modern *Homo sapiens* of the same stature. Photograph by Ken Mowbray.

Neanderthals on the Landscape

It is thus fairly certain that when the first Cro-Magnons arrived in Europe, some 40,000 years ago, they would have recognized in the Neanderthals creatures very different from themselves. How the two kinds of hominid would have interacted is material for a separate discussion, and I will just say here that I find it hardly credible that there was any biologically significant exchange of genes between the two populations. And this would, of course, be entirely unsurprising when one considers that both molecular and morphological evidence suggests that the two hominid lineages were probably separated by at least a half million years of independent evolution (Krings 1997; Tattersall & Schwartz 2000).

This message of biological distinctness is fully consistent with the behavioral one that I derive from looking at the archaeological record the Neanderthals left behind. Admittedly, from the economic point of view the picture is a bit murky. In Europe the Mousterian and Upper Paleolithic tool kits of the Neanderthals and early modern people are for the most part easily distinguishable; but this had not been not true of *Homo neanderthalensis* and *Homo sapiens* many millennia earlier in Israel, where both species are found in Mousterian associations. And Ofer Bar-Yosef (2004), among others, has recently argued that the evidence is equivocal for any major economic restructuring as the Mousterian gave way to the Upper Paleolithic. Instead, Bar-Yosef sees a truly innovative general change in extractive habits only in the very latest phases of the Old Stone Age. The implied basic similarity in the structure of Neanderthal and modern diets in Ice Age Europe is supported by analyses of food remains left by *Homo neanderthalensis* and *Homo sapiens* at late Pleistocene European habitation sites; these show, overall, a general similarity in composition (Stewart 2004). The few available stable-isotope and dental-wear studies of Neanderthals agree in suggesting that Neanderthal diets were generally rich in meat (see review by Drucker & Bocherens 2004); but detailed studies of animal food remains at Neanderthal sites suggest also that the strategies used by these hominids to obtain such resources varied substantially in space as well as in time (e.g., Stiner 1994). It thus seems eminently reasonable for Bar-Yosef (2004) to caution us that, whatever the hominid, later Pleistocene foraging strategies must have been largely governed by what was seasonally available in the local environment. The environments that the Neanderthals faced varied enormously, both locally and over time, and the animal and plant resources offered by these environments differed equally dramatically. Hence it seems entirely fair to conclude that Neanderthals were behaviorally opportunistic and highly flexible in the way in which they made their living, in a diversity of often extremely difficult environments.

Yet while in the beginning, at least, the overall economic portraits presented by the Neanderthals and the Cro-Magnons may not have differed too dramatically, it seems a reasonable inference that the Neanderthals were non-symbolic and non-linguistic, at least in the way in which we understand these things today (see discussion by Tattersall 2004). This is because, at least before the arrival of the Cro-Magnons in their European homeland, the very abundant material record of the Neanderthals contains nothing very compelling in the way of symbolic objects. In dramatic contrast, the record luxuriantly attests that the lives of the Cro-Magnons were, from the beginning, drenched in symbol. Socially and cognitively, here were two entirely different entities, despite some late hints that the Neanderthals, always facile imitators, might have picked up some behavioral traits from the invaders. And the cognitive contrast that the symbolic record suggests existed between the two hominid species strongly implies that, despite the fact that both necessarily exploited the same economic resources, the Neanderthals perceived, related to, and interacted with the world around them in ways that were very different from the Cro-Magnons' – and from our own.

So what does this mean for our understanding of the Neanderthals? It is no denigration of a tough, resourceful and behaviorally flexible hominid species to say that it did business differently from us, and it is clear that we are doing the Neanderthals no favors by classifying them as *Homo sapiens neanderthalensis* simply because they had big brains. We need to stop writing them off as a bizarre and by implication inferior version of ourselves, and to focus on understanding these remarkable hominids as the unique and separate evolutionary entity that they undoubtedly were. Which is something we can only do if we concede *Homo neanderthalensis* its own identity: an identity entirely separate and distinct from our own.

Acknowledgments

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THE EARLIEST RECORD OF HUMAN ACTIVITY IN NORTHERN EUROPE[1]

Simon A. PARFITT[1,2], **René W. BARENDREGT**[3], **Marzia BREDA**[4], **Ian CANDY**[5,6], **Matthew J. COLLINS**[7], **G. Russell COOPE**[6,8], **Paul DURBIDGE**[9], **Mike H. FIELD**[10], **Jonathan R. LEE**[6,11], **Adrian M. LISTER**[12], **Robert MUTCH**[9], **Kirsty E.H. PENKMAN**[7], **Richard C. PREECE**[13], **James ROSE**[6], **Christopher B. STRINGER**[2,6], **Robert SYMMONS**[2], **John E. WHITTAKER**[2], **John J. WYMER**[14] & **Anthony J. STUART**[12,15]

1. Institute of Archaeology, University College London, London WC1H 0PY, UK
2. Department of Palaeontology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK.
3. University of Lethbridge, Lethbridge, Alberta TK1 3M4, Canada.
4. Dipartimento di Geologia, Paleontologia e Geofisica, University of Padova, Via Giotto 1, I-35100 Padova.
5. Department of Geography, Loughborough University, Loughborough LE11 3TU, UK.
6. Department of Geography, Royal Holloway, University of London, Egham TW20 0EX, UK.
7. BioArch, Biology S Block, University of York, PO Box 373, York YO10 5YW, UK.
8. Department of Geography, Earth and Environmental Sciences, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK.
9. Lowestoft Museum, Oulton Broad, Lowestoft NR33 9JR, UK.
10. Church Cottage, Church Street, Fenny Compton, Warwickshire CV47 2YE, UK.
11. British Geological Survey, Keyworth, Nottingham NG12 5GG, UK.
12. Department of Biology, University College London, Gower Street, London WC1E 6BT, UK.
13. Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, UK.
14. 17 Duke Street, Bildeston, Ipswich IP7 7EW, UK.
15. University of Durham School of Biological and Biomedical Sciences, Durham DH1 3LE, UK. tony@megafauna.freeserve.co.uk

Abstract: the colonization of Eurasia by early humans is a key event after their spread out of Africa, but the nature, timing and ecological context of the earliest human occupation of northwest Europe is uncertain and has been the subject of intense debate (Dennell 2003). The southern Caucasus was occupied about 1.8 million years (Myr) ago (Gabunia 2000), whereas human remains from Atapuerca-TD6, Spain (more than 780 kyr ago) (Carbonell *et al*. 1995) and Ceprano, Italy (about 800 kyr ago) (Manzi 2004) show that early *Homo* had dispersed to the Mediterranean hinterland before the Brunhes–Matuyama magnetic polarity reversal (780 kyr ago). Until now, the earliest uncontested artefacts from northern Europe were much younger, suggesting that humans were unable to colonize northern latitudes until about 500 kyr ago (Gamble 1999; Dennell & Roebroeks 1996). Here we report flint artefacts from the Cromer Forest-bed Formation at Pakefield (52°N), Suffolk, UK, from an interglacial sequence yielding a diverse range of plant and animal fossils. Event and lithostratigraphy, palaeomagnetism, amino acid geochronology and biostratigraphy indicate that the artefacts date to the early part of the Brunhes Chron (about 700 kyr ago) and thus represent the earliest unequivocal evidence for human presence north of the Alps.

The Cromer Forest-bed Formation (CF-bF), exposed discontinuously for a distance of more than 80 km along the North Sea coast of eastern England, has long been famous for its early Middle Pleistocene fossils (Newton 1882; Reid 1882; Stuart 1996; Turner 1996; West 1980). Spectacular finds include many extinct large mammals, molluscs, beetles, remains of fruits, seeds and even trees from which the deposits get their name. Recent work on vertebrate and molluscan faunas has shown that the CF-bF is much more complex than previously realized and includes evidence for at least six distinct temperate phases between about 780 and 450 kyr ago (Preece 2001). The CF-bF sediments are primarily organic detritus muds and sands laid down within channels and on the floodplains of rivers, which drained central and eastern England before ice sheets invaded the area about 450 kyr ago (Rose *et al*. 2001). During this time, Britain was connected to what is now mainland Europe, East Anglia being located at the southwestern margin of a large coastal embayment around the subsiding North Sea basin. The flint artefacts found at Pakefield (52°25.9'N, 1°43.8'W) were recovered from river sediments, with a significant quartz and quartzite component, which formed the floodplain of the lower reaches of the erstwhile Bytham River that drained the English Midlands at this time (fig. 1) (Rose *et al*. 2001; Lee *et al*. in press).

Despite two centuries of investigation, no convincing artefacts have hitherto been found stratified within the CF-bF. However, several excavations in the recently re-exposed coastal sections of CF-bF (and associated deposits) between Pakefield and Kessingland (West 1980; Lee *et al*. in press; Blake 1890; Stuart & Lister 2001) resulted in the discovery of 32 worked flints (length more than 20 mm), including a simple flaked core, a crudely retouched flake and a quantity of waste flakes (fig. 2). These artefacts come from clear stratigraphical contexts and are associated with a wealth of evidence that allows a rare opportunity to reconstruct the environment

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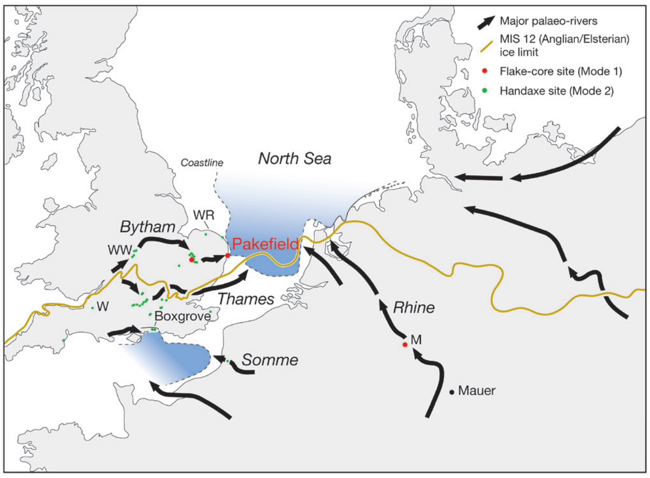

Figure 1. A reconstruction of the palaeogeography of northwest Europe during the early Middle Pleistocene (Turner 1996; Rose *et al*. 2001; Lee *et al*. in press; Wymer 1999; Roberts & Parfitt 1999; Gibbard 1988). All known Anglian/Elsterian and earlier archaeological sites are shown, and their concentration in southern England is highlighted. These sites can now be shown to provide a record of intermittent early human occupation of about 300 kyr duration. Human remains are known from Mauer and Boxgrove. M, Miesenheim I; W, Westbury-sub-Mendip; WR, West Runton; WW, Waverley Wood. For clarity, the names of rivers or geographical features are italicized and site names are in Roman font.

inhabited by the humans who made the tools. The artefacts, all in very sharp condition, are made of good quality black flint. Unworked surfaces, where present, are water-worn, indicating that the raw material might have been collected from the adjacent river channel. The assemblage lacks formal tools and is thus consistent with a Mode 1 technology (that is, flakes, pebble tools and choppers made with hard hammers (Wymer 1999), but this interpretation must remain provisional in view of the small sample size.

The artefacts came from four different contexts within an interglacial infill of a channel incised into Early Pleistocene marine sediments and overlain by a sequence of marine sands, glaciofluvial sediments and Lowestoft Till (fig. 3). The oldest artefact was found in the upper levels of the estuarine silts (fig. 3) containing marine and brackish-water ostracods, foraminifera and sparse marine mammals (including dolphin and walrus). All other artefacts were found in the CF-bF, which comprises the "Rootlet bed", "Unio-bed" and "laminated silts" (Lee *et al*. in press; Blake 1890; Stuart & Lister 2001). Two artefacts were found in overbank sediments with well-developed soil features including numerous fossil root-casts and pedogenic carbonate nodules ("Rootlet bed"). Most of the artefacts (n = 28) came from a lag gravel ("*Unio*-bed") at the base of the laminated silts that fill the channel

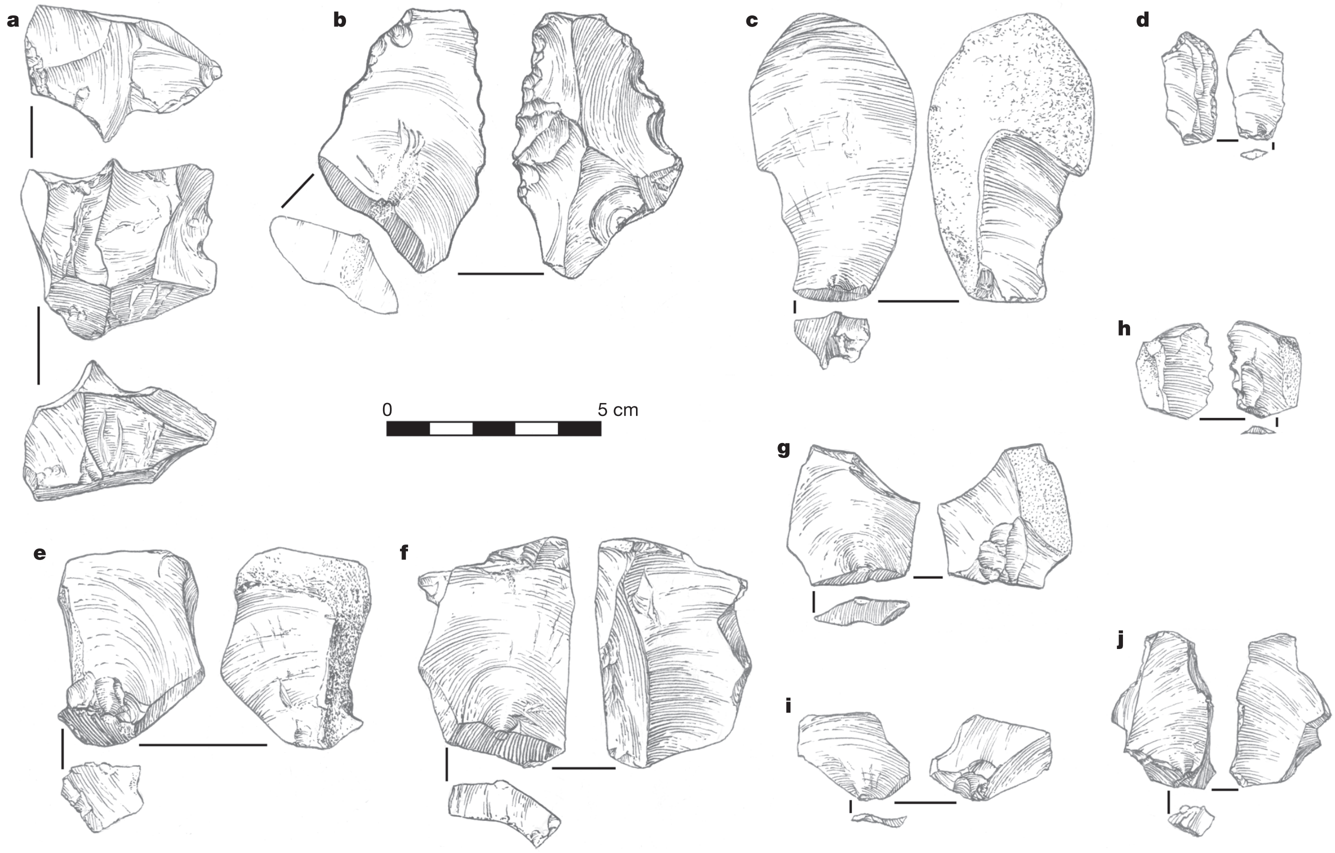

Figure 2. Lower Palaeolithic flint artefacts from the Cromer Forest-bed Formation at Pakefield. a, Core, partly alternate hard-hammer flaking, with several incipient cones of percussion on platforms. b, Retouched flake. c-j, Hard hammer-struck flakes, with previous removals on dorsal surface, often from the same direction. b, "Rootlet bed" (PaB); c, laminated silts (PaCii); a, d-j, "*Unio*-bed" (PaCi).

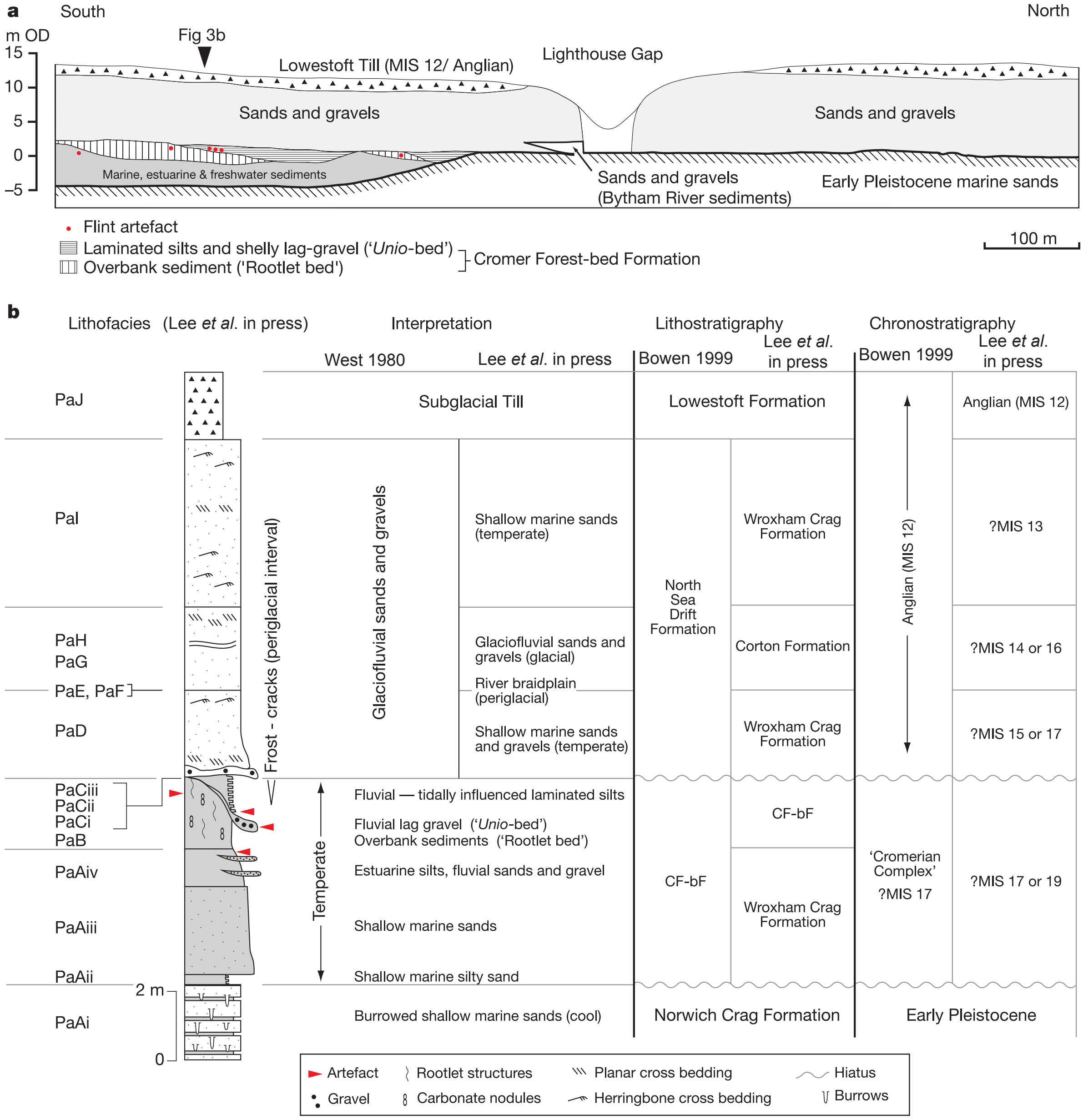

Figure 3. Stratigraphical context of the Pakefield artefacts. a, Coastal sections between Pakefield and Kessingland. b, Geological profile and interpretation.

cut into the overbank sediments, but a single flake (fig. 2c) was found in the laminated silts at the edge of the channel. Sediments overlying the channel infill were originally interpreted as glaciofluvial deposits attributed to the North Sea Drift Formation (Marine Isotope Stage (MIS) 12; fig. 3b), thus implying a long hiatus between the CF-bF and the glacial sequence. A new interpretation (Lee *et al*. in press) suggests that a more complete sequence is represented (fig. 3b) by the complex succession of marine sands, Bytham River sands and gravels, and glaciofluvial sands and gravels from the Happisburgh Glaciation, which are separated from the CF-bF by a periglacial interval indicated by the presence of frost-cracks. Another marine deposit overlies these sands and gravels and the whole sequence is capped by the Lowestoft Till Member, deposited by the Anglian Glaciation (West 1980), when ice sheets reached their maximum extent in Britain.

Fossils from sediments that contain the artefacts indicate that the local climate was significantly different from that of the present day in terms of temperature and seasonality of precipitation. Plant (*Trapa natans*, *Salvinia natans* and *Corema album*) and beetle (*Cybister lateralimarginalis*, *Oxytelus opacus* and *Valgus hemipterus*) remains include several thermophilous species no longer living in Britain, and the presence of *Hippopotamus* and frost-sensitive insects and plants implies warmer summers and mild winters. Mutual Climatic Range (MCR) (Atkinson *et al*. 1987) analysis of the beetle assemblage enables quantitative estimates to be made of the thermal climate at that time. These suggest that the mean temperature of the warmest month (July) was between 18 and 23°C and the mean temperature of the coldest months (January/February) was between -6 and +4°C. Pedogenic carbonate nodules in the "Rootlet bed" indicate an annual moisture deficit, whereas their isotopic composition reflects intense soil moisture evaporation during their formation (Candy *et al*. in press). The combination of warmer summer and winter temperatures together with a strongly seasonal precipitation regime is indicative of a warm, seasonally dry Mediterranean climate.

Both the insects and plants indicate the presence of marshy ground with extensive reedy vegetation and alder trees adjacent to a meandering river with shallow riffles and deeper pools. Oak woodland grew on drier ground with open grassland nearby. This mixture of habitats supported a variety of large browsing and grazing mammals dominated by *Mammuthus trogontherii*, *Stephanorhinus hundsheimensis*, *Megaloceros savini*, *M. dawkinsi* and *Bison* cf. *schoetensacki*, and their predators and scavengers (*Homotherium* sp., *Panthera leo*, *Canis lupus* (small) and *Crocuta crocuta*). The floodplain would have provided a resource-rich environment for early humans, with a range of plant and animal resources. An additional attraction, in an area where good quality flint would have been scarce, was the flint-rich river gravels, which provided the raw material for tool manufacture.

Pollen analysis indicates that the channel infill accumulated during an interglacial with regional vegetation dominated by broad-leaf woodland that included *Carpinus* (hornbeam) in its later part (West 1980). These sediments were originally correlated with those at the Cromerian stratotype at West Runton, Norfolk, 60 km to the north-west, on the basis of palynology (West 1980) and malacology (for example the presence of the extinct freshwater mollusc *Valvata goldfussiana* (Preece 2001). This suggestion is broadly supported by the extent of racemization and the pattern of amino acid decomposition in the intracrystalline fraction of *Bithynia* opercula. However, although these sites are close in age, several lines of evidence indicate that they are not exactly contemporary. West Runton lacks the important component of southern thermophile plants and beetles seen at Pakefield. Moreover, several large mammals, such as *Hippopotamus*, *Megaloceros dawkinsi* and *Palaeoloxodon antiquus* (the latter recorded only from unstratified material) known from Pakefield/Kessingland have never been found at West Runton, despite the much more extensive collections from that site (Stuart & Lister 2001). Furthermore, the occurrence at Pakefield of two vole species of the genus *Mimomys*, *M. savini* and *M.* aff. *pusillus* (fig. 4), of which only the former is known from West Runton, is also consistent with a difference in age. *M. pusillus* is known from the Early Pleistocene to its latest occurrence in the early Middle Pleistocene Ilynian Complex (European Russia) (Pevzner *et al*. 2001). As the latter is overlain by the Don Till (Donian), correlated with MIS 16, this suggests a minimum age for the Pakefield "*Unio*-bed".

This evidence indicates that sediments containing the artefacts belong to an interglacial in the early part of the "Cromerian Complex" (Turner 1996). This interpretation is supported by independent evidence derived from the lithostratigraphy. A maximum age is indicated by palaeomagnetic data from the laminated silts, which show normal polarity (Lee *et al*. in press), consistent with the early part of the Brunhes Chron. A minimum age is indicated by the overlying Lowestoft Till Member, conventionally thought to have been emplaced during MIS 12. The sediments between the CF-bF and the till have been traditionally interpreted as being of glaciofluvial origin, deposited during the Anglian Stage (West 1980; Wymer 1999). A longer chronology has recently been proposed on the basis of sedimentological evidence suggesting that the CF-bF may be separated from the MIS 12 till by two separate high sea-stands and two cold episodes (Lee *et al*. in press) (fig. 3b). By using the premise that temperate-climate marine deposits and cold-climate aggradations in the lower parts of large, temperate latitude rivers can be matched, respectively, to the peaks and troughs of orbitally tuned MIS cycles (Bassinot 1994), the archaeology can be dated to MIS 17 (about 680 kyr ago) at the very youngest. If evidence for ice-sheet extension across eastern England during MIS 16 is valid (Lee *et al*. 2004), then an additional temperate/cold cycle is required and the archaeology at Pakefield could be as old as the later part of MIS 19 (about 750 kyr ago).

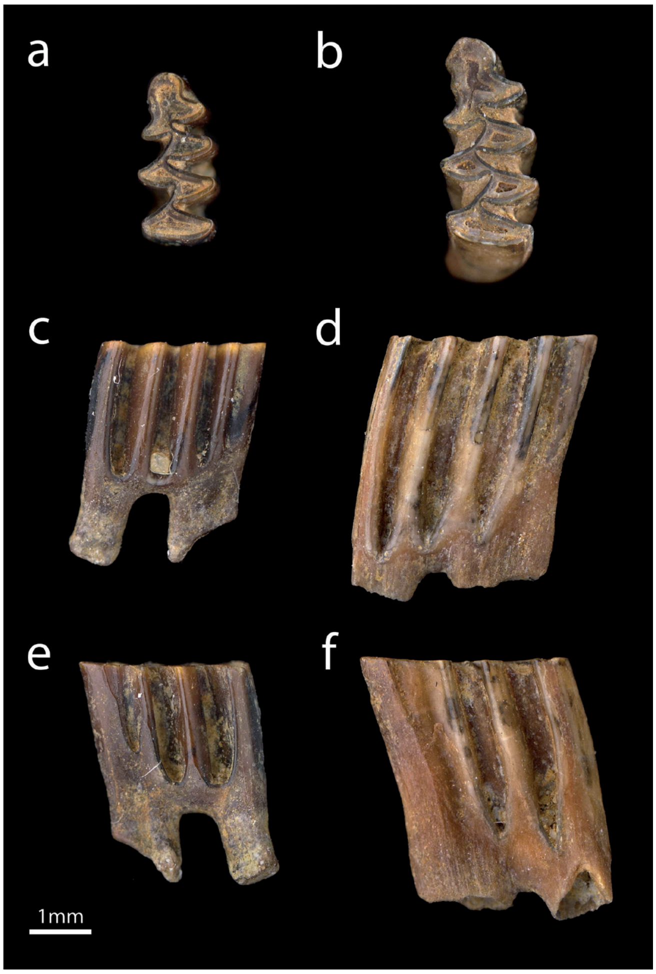

Figure 4. First lower molar of *Mimomys* aff. *pusillus* from Pakefield (a, c, e) (BMNH. M 63567, ex R. Mutch collection 1108.1, "*Unio*-bed") compared with that of *M. savini* (b, d, f) (BMNH M. 63568, ex R. Mutch collection 1242.2, "*Unio*-bed"). a, b) occlusal view; c, d) lingual view; e, f) labial view. Scale bar = 1 mm.

The oldest human fossils in northwest Europe are from Mauer (Dennell & Roebroeks 1996), Germany and Boxgrove (Roberts & Parfitt 1999), UK, where they are part of vertebrate assemblages that include the water vole *Arvicola terrestris cantiana*. All other northwestern European sites containing early Middle Pleistocene archaeology in association with rich small-mammal assemblages (for example, Miesenheim I in Germany, and Westbury- sub-Mendip and Waverley Wood in the UK) (Dennell & Roebroeks 1996; Wymer 1999; Bishop 1975), have similarly yielded *Arvicola* (with unrooted molars) rather than *Mimomys* (its ancestor with rooted molars). These early Middle Pleistocene archaeological sites with *Arvicola* have all been correlated with MIS 13, the basis for the belief in a short chronology for human occupation in this region (Dennell & Roebroeks 1996). The discovery at Pakefield of unequivocal artefacts in beds yielding *Mimomys* demonstrates a much longer human occupation of northwest Europe, pre-dating other evidence by as much as 200 kyr. There has been much discussion about what additional social, technological or physiological adaptations humans would have required to colonize northwest Europe compared with their occupation farther south (Gamble 1999; Roebroeks 2001). The Mediterranean climate reconstructed for the archaeological levels at Pakefield suggests that these pioneers were able to spread northwards in familiar climatic conditions, using their existing adaptations.

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THE WRONG QUESTION

Milford H. WOLPOFF
Paleoanthropology Laboratory, Department of Anthropology, University of Michigan, Ann Arbor, Michigan, USA 48109-1092. wolpoff@umich.edu

Abstract: it is hard to believe that opinions about any fossil sample could vary as wildly and completely as opinions about Neandertals and their place in human evolution (compare Wolpoff *et al.* 2004 & Tattersall 2002). The Neandertal sample is more than adequate, and evolutionary theory is the universally held explanatory principle, so there must be more to the story. Part of this is the role Neandertals have come to play in our culture, but even this post-modernist explanation will not suffice. The most compelling explanation of how Neandertal studies landed in so deep a quagmire is that in determining how different Neandertals were from the human condition, the wrong question was being asked.

Key Words: Neandertal, Human Ancestry, Evolution.

Pop Culture

Neandertal is the only word from paleoanthropology commonly found in dictionaries. This is not inconsequential for understanding how we interpret Neandertals; if calling a politician or policy "Neandertal" has meaning, once can imagine the meaning applied to the extinct folks with that name (fig. 1). Alley Oop may present a more benign implication of the "Neandertal" appellation, but the fact is that the word carries baggage from far more than the science involved in discoveries and interpretations of skeletal remains, for these folk have become a part of our culture (Trinkaus & Shipman 1993). Neandertal, moreover, is a *type* of human (Wolpoff & Caspari 1997), playing the role of "other" and used so we can define ourselves as different, and better (Stringer & Gamble 1998).

As European ancestors, the Neandertals' position rose and fell, not because of the advance of scientific discoveries as much as because of the spirit of the times. The first discoveries fit well into the developing evolutionary ideas in Darwin's time. They were the expected savages of the past that fit the needs of Huxley's model of biological evolution and Morgan's model of social evolution. But other discoveries just past the turn of the last century, culminating in Piltdown, seemed to suggest that modern humans were as ancient as or even earlier than Neandertals. It was easier to believe that humans were a degenerate Adam than a perfected ape (Wolpoff & Caspari 1997). Many of the myths about Neandertals had their beginning at this time. Hermann Klaatsch, a Berlin anatomist at the turn of the last century, reconstructed an idealized model of the Neandertal, based on the original faceless Feldhover skullcap, a mandible from Spy, and an isolated upper jaw fragment from Krapina. Pointing to it, he proclaimed (1923) "whenever a well preserved Neandertal skull is discovered, it is sure to look like my reconstruction". Klaatsch thereby originated the "common knowledge" that Neandertals were homogeneous, even before there were significant comparisons to be made.

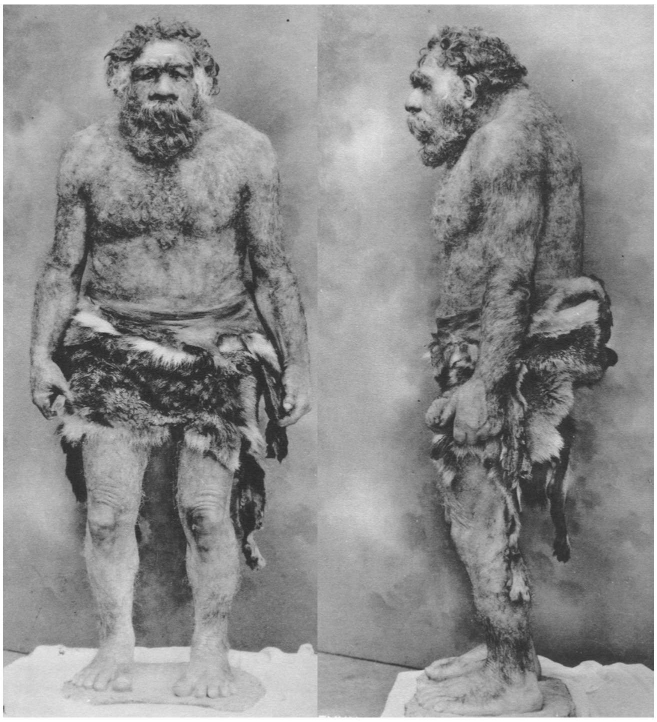


Figure 1. Field Museum of Chicago reconstruction of the old man from La Chapelle. This was in exhibit when this author was a child, and it seemed very impressive!

Klaatsch created another of the long-lasting Neandertal myths with his contention that Neandertals and modern people were contemporaries in Europe. He "found" them together when he was studying the Krapina remains, and he imagined there was a great battle for possession of the Krapina rock shelter (1923). In France he was involved in the discoveries at Le Moustier (a Neandertal youth and an infant) and Combe Capelle (a "modern" specimen) and claimed them to be contemporaries as well. However, his best evidence was from Krapina, where he mistakenly identified juvenile Neandertals as modern humans.

This was part of a concerted effort, especially in Western Europe and America, to remove Neandertals from any ancestral role in the evolution of living Europeans. However then, unlike now, a Neandertal ancestry could be acceptable *as long as it was not for Europeans*; for instance, Boule (1923) wrote: "Whereas the Neandertal man of Europe occupies the position of a type apart, ... which seems according to all the evidence to have vanished without issue, the little we know about this type in Asia shows it as included within a regular evolutionary sequence".

This changed to become a more inclusive rejection when its implicit racism was recognized by the anthropological community as it emerged from and fully rejected the racism of its past (Wolpoff & Caspari 1997). With the exception of a small continuous intellectual thread from scientists of Central and Eastern Europe, the Neandertals were regarded as extinct cousins for *all* humanity by many paleoanthropologists, even as evolutionists such as Dobzhansky and Mayr had come to treat them as a vanished human race, much as earlier Central European scientists such as Gorjanović-Kramberger had (see Radovčić 1988).

The changing scientific perspective is reflected in the many ways Neandertals are depicted in popular literature. For every story sympathetic to Neandertal humanity, as in Asimov’s (1959) "Ugly Little Boy", there are various renditions of their low evolutionary stage, lack of human or even primate intelligence, or other limitations (for instance Bisson (2005), recently published and exemplifying many similar interpretations of Neandertal stupidity). Neandertals are also often depicted as human-but-different; without language but telepathic (e.g. Golding 1963), or with very different temperaments and social arrangements as in the parallel Neandertal world described by Sawyer (2003a, 2003b, 2004). Yet Sawyer’s description of single-sex Neandertal groups doesn’t come from his imagination but from Soffer (1994): even the oddest and most fanciful ideas about Neandertals have a firm basis in paleoanthropological literature

Is it intellectually dead ideas about Neandertals or ideas about intellectually dead Neandertals?

Speth (2005) provides the best review ever of ideas about Neandertal oddness or ineptness, a required reading for any student of the subject. To provide a small taste of this supersized topic: Neandertal morphology shows they suffered from rickets (Ivanhoe 1970), iodine deficiency, dramatic changes in balances of thyroid hormones (Crockford 2003), acromegaly (Ivanhoe 1985) and iodine deficiency (Dobson 1998), and their gestation length was estimated at 11 months or more (Trinkaus 1984, but see Trinkaus & Tompkins 1990); in spite of the slow start Neandertals grew up quickly (Dean, Stringer, & Bromage 1986; Ramirez Rozzi Bermudez De Castro 2004) to be very strong, like the "Incredible Hulk". However, their strength gave them no advantage because Neandertal super-strength: "indicates an adaptation for endurance in prolonged locomotion over irregular terrain. … This locomotion included considerable irregular movement, rather than the more straight-line striding usually employed by recent humans … Their endurance- and strength-related locomotion was thus also poorly directed toward points in the landscape" (Trinkaus 1989:55).

Dare one call this “bumbling”?

Another explanation for their strength is that Neandertals are described as living a life with as much bone-breaking violence as rodeo riders (Berger & Trinkaus 1995), bringing to mind Henri-Martin’s (1923) claim that a Mousterian horse tooth from the Mousterian levels at La Quina had bit marks on its labial surface. At least one source of this violence presumably came from the Neandertal hunting technique of wrestling large mammals to the ground with their bare hands (Geist 1981).

Neandertal cultural activities, like their locomotion, have been described as "poorly directed", as Neandertals didn’t have the foresight to paint the walls of their caves, the ability to follow knapping rules and make good blades, the insight to invent (their Upper Paleolithic technology and culture is described as "borrowed" – the associations of Upper Paleolithic with Neandertals explained by the possibility that the Neandertals were kept as pets), and their grave goods were actually floor sweepings.

Now, one might think that these various depictions and reconstructions would provide clear evidence of evolution, for they could show how and why modern humans might easily have evolved from the Neandertal condition, for obviously advantageous reasons. But no, they combine to provide an overwhelming case for *denying* evolution by rejecting a Neandertal ancestry, initially because Klaatch’s claim of modern populations contemporary with Neandertals, and later because modern populations were thought to precede Neandertals (although this is only relevant to interpreting their evolutionary position if it is assumed Neandertals are a distinct lineage – which happens to be the conclusion drawn from this particular argument). It is as Brace (1964) once quipped about a different Neandertal question; the foundation shifted, but the superstructure remained the same. Apart from the science, this is a logical consequence of treating Neandertals as a type.

Yet we might ask whether the Neandertal contemporaries are actually *modern* humans? Even though they are widely described as modern humans in the secondary literature, the primary sources are more careful. And well they should be, because it is difficult to square the anatomy of some of the "early modern" specimens with the distribution of features in recent or living human populations, broad and varying as this distribution is. For instance the Skhul 2 female (fig. 2) has a frontal with a true supraorbital torus that projects significantly in front of the frontal squama and extends evenly across the middle of the face (including a very broad innerorbital area), only thinning slightly over its most lateral aspect. No recent or living women have a similar upper facial morphology. Sex determination in this individual (McCown & Keith 1939) is uncontested, but her anatomy would be quite exceptional even if "she" were "he".

White and colleagues describe the Herto BOU-VP-16/1 cranium (2003) as part of a population that is "on the verge of anatomical modernity but not yet fully modern" (p. 745). Their multivariate analysis supports this interpretation, placing Herto between modern and Neandertal distributions. This is a description that equally well pertains to subsequent Late Pleistocene African samples at Klasies (Churchill *et al*. 1996; Lam *et al*. 1996; Smith 1992; Wolpoff & Caspari 1996), and Jebel Irhoud (Bräuer 1992). Studying penecontemporary remains from a region very close to Africa, McCown & Keith (1939) regarded the Skhul specimens as a population intermediate between Neandertals and living humans, and the observation (inference) of interbreeding undermines the interpretation of Neandertals as a "type" of hominid, because types to not describe variation within species.

So here is the rub. These "early modern" Neandertal penecontemporaries are not really modern because they differ in meaningful ways from living populations. Well, Neandertals *also* differ in some ways from living populations. Why wouldn't we conclude that for Late Pleistocene populations, differing in some ways from living populations *by itself* is not sufficient to exclude a population from the ancestry of living populations? After all, isn't that difference what evolution is supposed to explain?

The wrong question

So how different are Neandertals? Are they significantly different from living Europeans? This is the issue that most Neandertal studies address, and many of them evidence that significant difference is indeed the case. Such studies have a great antiquity in paleoanthropology's history and were critiqued by Weidenreich more than a half-century ago (1943:44): "It almost became a sport of a certain group of authors to search for the skeletal parts of Neandertal Man for peculiarities which could be claimed as 'specialization', thereby proving the deviating course this form has taken in evolution. … There is not one single peculiarity which has not been taken by some author to represent a unilateral specialization".

The most significant developments in the half-century since Weidenreich wrote these words were not as much in new discoveries as in new approaches to the problem. These were made possible by the continuing evolution of high speed computing. Stringer's (1974, 1978) pioneering early work provides an example (fig. 3).

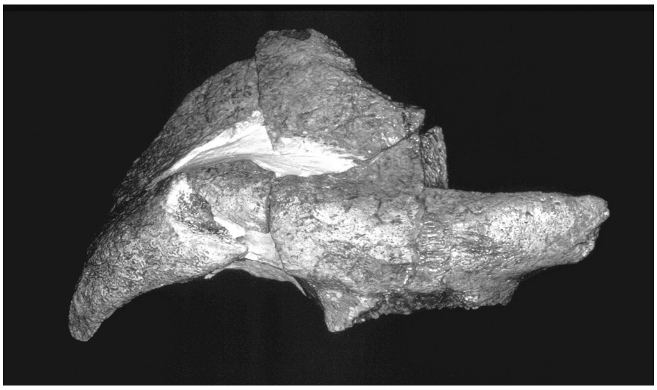


Figure 2. Skhul 2 female frontal bone. The vertical thickness and anterior projection of the true supraorbital torus in this "early modern human" woman is, to the best knowledge of this author, unknown in the women of any living population.

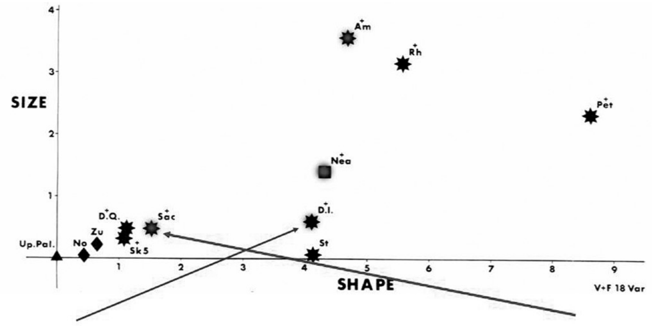


Figure 3. In this figure (modified from Stringer (1978, fig. 17), a number of complete Later Pleistocene crania are compared with Upper Paleolithic Europeans with a Penrose "size and shape" analysis of 18 vault and face measurements. Living peoples such as Norse (No) and Zulu (Zu) are shown to be the most similar to these late Pleisotcene Europeans. The most archaic specimens such as Petralona (Pet) and Kabwe (Rh) are furthest from the European Upper Paleolithic, and the Neandertals (Am=Amud; Sac=Saccopastore 1) are more distant than the several recent populations, although not as distant as the most archaic specimens. D.I. is Djebel Irhoud 1, D.Q. is Qafzeh 6, Sk 5 is Skhul 5, and St is Steinheim. Note that Saccopastore is closer to the European Upper Paleolithic than Djebel Irhoud is.

In this application of multivariate analysis Stringer (1978) demonstrated that modern populations were most similar to the Upper Paleolithic Europeans, and assumed this meant they were most closely related. Neandertals were more distant, and archaic specimens such as Steinheim, Petralona, and Kabwe were found to be more distant yet. Multivariate distance thereby tracked distance of relationship, according to Stringer and many other authors following. This implied to many paleoanthropologists that the European Upper Paleolithic sample had a recent last common ancestor (LCA) with other recent or living groups from Europe and other continents, that the LCA with Neandertals was more ancient, and the LCA with the archaic humans of the Middle Pleistocene even more ancient yet. Neandertals, in this interpretation, were not the ancestors of later Europeans.

While Stringer was one of the earliest to ask this question, and he has continued to do so throughout his career, he has hardly been alone. To cite a much more recent example (but again, hardly a unique one), Havarti (2003) used a generalized procrustes analysis for 17 craniofacial landmarks to examine the differences between humans, chimpanzees, and Neandertal fossils, and analyzed the coordinate configurations of the specimens with principal components. The chimpanzees (*Pan troglodytes* and *P. paniscus*) were clearly separated from each other, and the Neandertals were distinguished from the moderns. This study and a second one (Havarti *et al*. 2004) drew a taxonomic conclusion: Neandertals are more different from modern humans than the closely related chimpanzee species are from each other, and more different than gorilla subspecies. The comparison to chimpanzee species is flawed for several reasons (Ahern *et al*. 2005) and it is the subspecies comparison that is perhaps more relevant. However, the pairwise comparisons of gorilla subspecies and of Europeans from the Mousterian and Upper Paleolithic (fig. 4) do not differ significantly (Havarti *et al.* 2004) even though the difference between the comparisons is exacerbated by the fact that the gorilla comparisons are between mixed-sex samples, while the humans compare a mixed-sex Upper Paleolithic sample with a Neandertal sample that is all male. This result is compatible with genetic comparisons. The ancient DNA variation for Neandertals diverges less from modern humans than chimpanzee subspecies differ from each other (Hawks & Wolpoff 2001).

Yet, like the Stringer example, there is a more fundamental problem with this result – it addresses the wrong question, since surely everybody recognizes that Neandertals are not modern humans.

The right question

These Neandertal analyses can be interpreted quite differently if the right question is asked: instead of questioning how similar Neandertal groups are to recent or modern populations, the *evolutionary* question is *whether Neandertals are among the ancestors of living Europeans.* Similarity is not always a direct reflection of ancestry; if it was, there would be no need for the study of phylogenetics.

There are several ways in which Neandertals may have contributed to the ancestry of the later Europeans:

- through direct descent, with differences between Neandertal folk and later Europeans due to changing selection;
- through mixture in Europe, as populations entering Europe during the interstadials encountered natives;
- through mixture, as European Neandertals dispersing to other regions during stadials contributed to ancestry of ancestral populations evolving outside of Europe (for instance, as in western Asia).

This could be thought of as a genetic or anatomical issue. Genetics addresses it because if all living humans descended from a very small population that lived recently in Africa, none of them descended from Neandertals. On the other hand, if the size of the ancestral human population was not especially small in the Late Pleistocene, Neandertals very well could have been among the ancestors of living populations. Genetic studies in living people can give us important information about the past history of population size as long as we can be sure the genes we study are neural, meaning that natural selection does not play a role in their variation. With neutrality, we can assume that only mutations produce variation in the genes, and only genetic drift, a consequence of small populations, can reduce variation. The amount of variation lost depends only on how small past population size was, and so with the assumption of a known, constant mutation rate we can make estimates of past population size. But the genetic issues are more complex than often supposed. Population subdivision (population structure) significantly effects the estimation of past population size (census size), but not nearly as greatly as the increasing evidence that natural selection plays a large role in our genetic evolution (Bustamante *et al*. 2005; Clark *et al*. 2003; Gillespie 2001; Kamal *et al*. 2006; Wang *et al*. 2006; Wildman *et al* 2003).

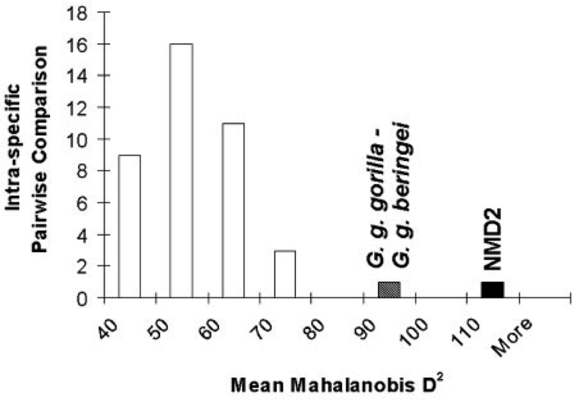


Figure 4. Harvati *et al.* (2004, fig. 2a) show that the pairwise comparison of craniofacial; measurements for Neandertals and Upper Paleolithic Europeans is of greater magnitude than the pairwise comparison of the two gorilla subspecies. However, the difference between the two comparisons is not significant, and this is in spite of the fact that the Upper Paleolithic European sample has males and females while the Neandertal specimens are only male, artificially increasing the difference between the two.

There is one clear and testable way in which Neandertals would not be expected to be among the ancestors of living Europeans: if they were a different species. This is a hypothesis of ancestry, with predictions and consequences that can be examined. Stringer's (1978) data inadvertently address this. If Neandertals are a separate lineage, with its own evolutionary tendencies and its unique evolutionary fate, we can expect that Neandertals are more different from living humans than the LCA of Neandertals and living humans is (fig. 5). This is because there is more evolutionary change between Neandertals, the LCA, and living humans than there is between Neandertals and the LCA alone.

This raises the question of common ancestry. Estimating the age of a LCA for a lineage division that this author actually does not believe took place is a risky business. However, many paleoanthropologists accept Krings and colleagues original (1997) divergence estimate of about 600 kyr based

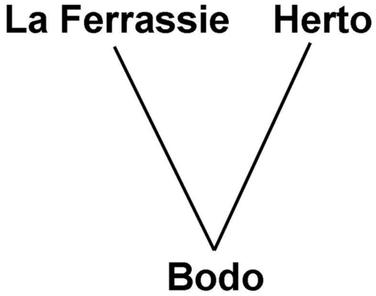


Figure 5. Relations expected from phylogeny of a distinct Neandertal clade. Saccopastore should be far more distant from modern populations than Djebel Irhoud is, in fact Neandertals should be the most distant of all the comparisons. Instead, it is Kabwe and Petralona, much closer to the presumed LCA, that is most distant from the modern populations, and Saccopastore is closer than Djebel Irhoud. Stringer has never questioned the validity of his methods and for more than 30 years he has interpreted the results of this and other studies to mean that Neandertals became extinct with little or no influence on modern populations, because they differ from them. But if we accept this study and others like it, they actually show the opposite. If the Neandertals are more like modern populations than are specimens closer to the LCA of the Neandertals and the modern populations, Neandertals cannot have been a distinct lineage.

on mitochondrial evolution, followed by his error range determination of 317 kyr to 741 kyr (Krings *et al*. 1999). These are supported by/(compatible with) estimates by Hublin (1998) of a bottleneck on the Neandertal lineage at about 480-425 kyr, and those who accept a "*Homo heidelbegensis*" ancestry for the Neandertal species place divergence even further back in time. These divergence estimates would make Bodo a quite credible LCA, and Kabwe and Petralona too late for this, and instead quite credibly on African and European lineages respectively.

Examining figure 17 from Stringer's 1978 publication, we can see (fig. 3) that a Neandertal, Saccopastore, is actually more like modern Europeans (and other modern humans) than Kabwe or Petralona are, even though these two are closer to the LCA. Saccopastore is even more similar to Djebel Irhoud, equally unexpected under a divergence hypothesis. If Neandertals were a separate lineage *we would expect Saccopastore to be least like these samples* (fig. 5). The Neandertal mean Stringer determined (Nea) is clearly more like the moderns than Petralona or Kabwe. Stringer's data, addressing the right question, reject the hypothesis that Neandertals are a distinct lineage.

How we may examine the hypothesis of Neandertal ancestry

Considering the question of Neandertal ancestry anatomically, we may address three aspects:

- Can all Neandertals be distinguished from contemporary non-Neandertals?
- Is there a unique Neandertal lineage with its own evolutionary tendencies?
- Do post-Neandertal Europeans retain Neandertal features?

Can all Neandertals be distinguished from contemporary non-Neandertals?

One place where there are Neandertals and penecontemporary non-Neandertals is in Western Asia. Amud and Tabun may well span the entire range for this sample (Tabun earliest, Amud latest). Arranged in order reflecting the seriation of virtually any feature, the two Neandertals never stand out at the extreme. figure 6 shows lateral views of the crania arranged by forehead flattening; Qafzeh 5 has the most extreme expression of this feature. This mixture of the two samples was reported and detailed by McCown & Keith (1939) and is well known. For instance, in their systematic analysis of Amud's postcranial remains, Endo & Kimura (1970) systematically compared the features of the fragmentary Amud skeleton to European Neandertals and Skhul 4. They found Amud intermediate, but, in their words, slightly closer to Skhul in the comparisons. Examining their data shows that the preponderance of closest postcranial resemblances are between the two Levantines, when only unique similarities are examined. To wit:

- 24 characters link Amud with Skhul 4 but do not appear in European Neandertals;
- 14 characters link Amud with European Neandertals but do not appear in Skhul 4;
- 8 characters link Skhul 4 with European Neandertals but do not appear in Amud.

In a more formal way to approach this question, Kramer and colleagues (2001) employed a cladistic analysis to examine the Levant cranial sample for anatomical clusters. The hypothesis of taxonomic distinction for the Neandertals predicts that they should cluster together if derived features are examined. The most complete Levantine cranial specimens were employed in these analyses in order to maximize trait coverage across all regions of the skull. The Levantine Neandertals are represented by Amud and Tabun, while the "moderns" include Skhul 4, 5 and 9, and Qafzeh 3, 6, and 9. Males and females are represented in both samples. ER 3733 was used as an outgroup to define character states for the 12 nonmetric features examined (there were no missing data). The three cladistic analyses were performed using PAUP. Because of the limited size of the data sets, PAUP was able to complete exhaustive searches for all possible trees for each analysis.

Using the same characters, this approach was first applied to the sequential samples of European Neandertals and early Upper Paleolithic crania, basically to see if it worked with the low level taxonomic distinctions involved. Figure 7 depicts one of the seven most parsimonious trees reported by Kramer and colleagues. Of the nearly 1000 trees, ranging in length from 19 to 29 steps, evaluated by PAUP, the seven most parsimonious cladograms all displayed a Neandertal clade distinct from an Upper Paleolithic human clade. This result is similar to those reported above; early Upper Paleolithic folk are not Neandertals.

With this success, over 10,000 trees were constructed from the Levantine sample using PAUP, ranging in length from 26

Figure 6. The 9 most complete adult Levant crania, shown in lateral views to the same approximate size and reversed when necessary to face in the same direction. From the upper left corner, naming each row left to right, the specimens are: Qafzeh 3, Skhul 4 (a cast of the Mario Cech reconstruction), Qafzeh 9, Skhul 9, Qafzeh 6, Skhul 5, Tabun 1, Amud 1, Qafzeh V. Qafzeh specimens 3 and 5 are at the extremes for forehead rounding, occipital angulation, supraorbital prominence, mastoid size, and a number of other features. This illustrates what the PAUP analysis (fig. 8) shows: the Levant hominids do not form two distinct anatomical clusters, Neandertals and "moderns".

to 35 steps. Of the 17 most parsimonious trees (length=26), Kramer and colleagues note that not one revealed a "Neandertal" clade of Tabun and Amud distinct from the early moderns from Skhul and Qafzeh (the majority consensus tree is shown in figure 8). In addition, of the next 24 most parsimonious cladograms (length=23), only two grouped Tabun and Amud to the exclusion of the Skhul/Qafzeh remains. These results cannot be due to the inability of PAUP to distinguish Neandertal from modern human morphology. Kramer and colleagues interpreted them as a failure to reject the null hypothesis that these specimens all belong to a single species. They certainly show that all Neandertals cannot be distinguished from contemporary non-Neandertals.

Is there a unique Neandertal lineage with its own evolutionary tendencies?

There are many ways to approach this question, but an excellent unexpected opportunity to examine it came with the discovery of the Herto cranium (BOU-VP-16/1), a large and robust Ethiopian male about 165 kyr old (White *et al*. 2003). In fact, Herto was specifically used by the authors to address questions about both the origin of modern humans and the fate of the Neandertals.

The Herto specimens were said to "exclud[e] Neandertals from a significant contribution to the ancestry of modern humans" (White *et al*. 2003) because they look more like modern humans than Neandertals do. This interpretation of the Herto taxonomy starts with an implicit assumption about whether modern humans are a distinct entity and that Neandertals fall on a different lineage. For it to be a valid interpretation of phylogeny there would have to be a monophyletic group composed of Herto and all recent and living humans, but excluding Neandertals and their European ancestors (and by inference also excluding Middle Pleistocene Asians). Otherwise, the contributions of Neandertals to later Europeans could not be addressed by examining the character states in penecontemporary or older populations in Africa.

So, Herto provides the basis of a test for the hypothesis of a separate Neandertal lineage, because if this hypothesis is

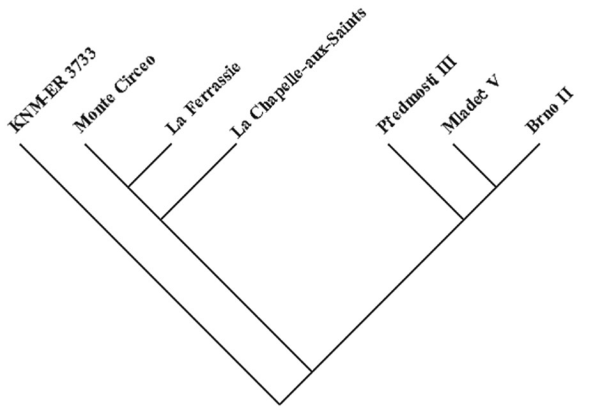


Figure 7. Comparison of European Neandertal males and earlier Upper Paleolithic males. One of the seven most parsimonious cladograms (length=19) shown here, generated by PAUP, demonstrating that "Classic" western European Neandertal males are all distinguished from succeeding Earlier Upper Paleolithic males using the anatomical criteria and approach also applied to the Levant sample (fig. 8). In fact, all seven of the shortest trees placed these Neandertals on a clade distinct from that occupied by the earlier Upper Paleolithic males. This verifies the accuracy of the approach used to ask whether the same Neandertal vs. "modern" division can be shown in the Levant hominids.

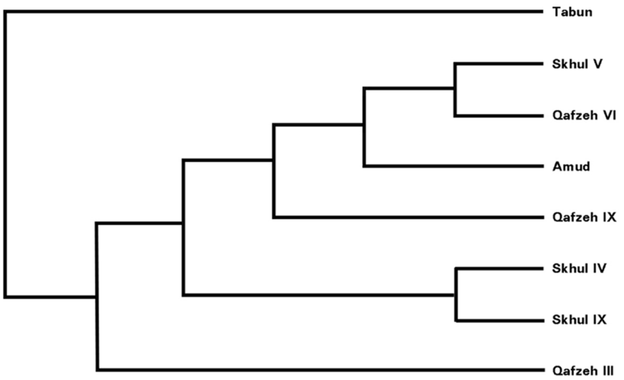


Figure 8. Levantine "Neandertals" and Levantine "early modern humans". The 50% consensus tree for the 17 most parsimonious cladograms (length=26) generated by PAUP is shown here. Tabun and Amud (the "Neandertals") do not cluster apart from the "early moderns" from Skhul/Qafzeh. None of the 7 shortest trees displayed a Tabun/Amud clade separate from that of Skhul/Qafzeh. By themselves, the Skhul individuals run the gamut from most plesiomorphic (Skhul 4) to most derived (Skhul 5).

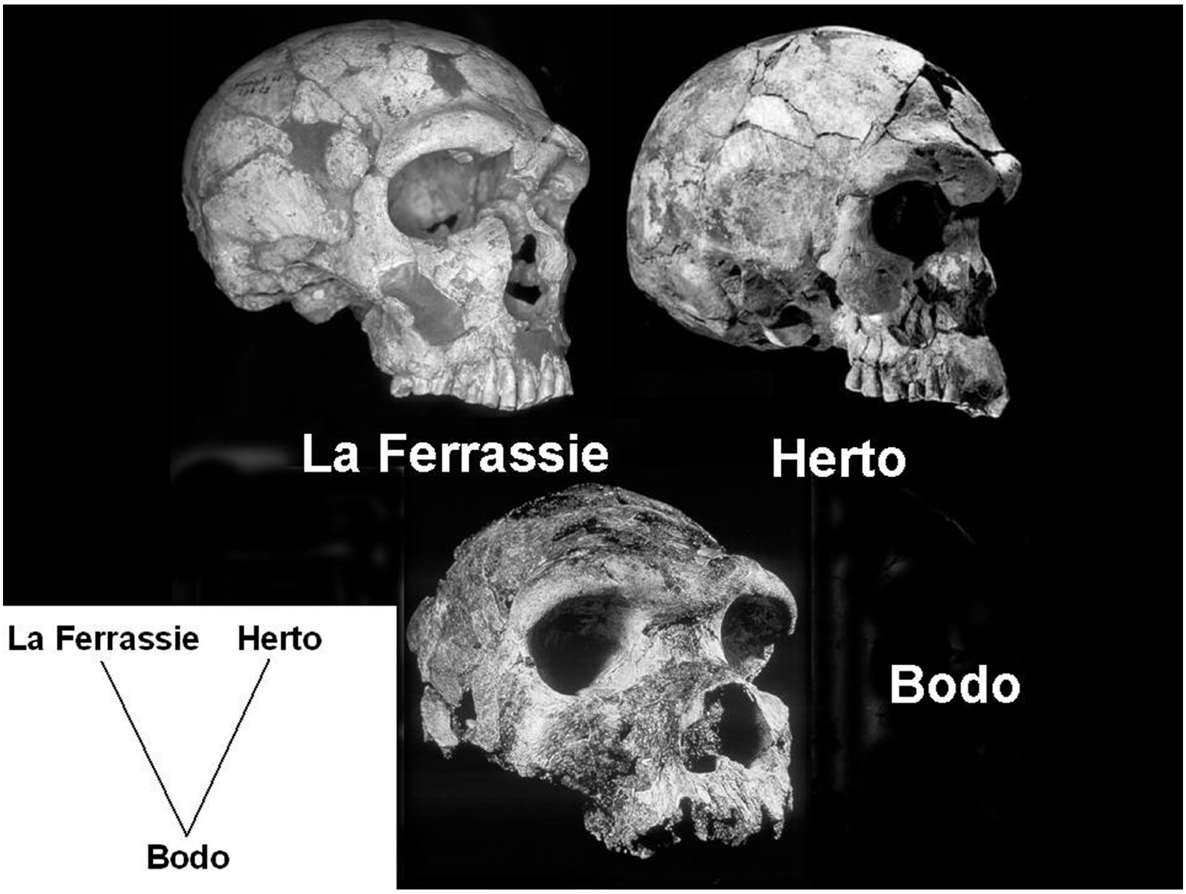


Figure 9. The question of a unique Neandertal lineage is addressed by comparisons with the Herto cranium (adapted from White *et al*. 2003), a specimen widely considered an ancestor of living humans. If there is a unique Neandertal lineage, it should increasingly separate from this human linage over time, and we would expect Herto to be more different from La Ferrassie than either differs from their LCA, perhaps Bodo or something like it (Bodo is a credible LCA because if one believes Neandertals are a separate lineage, one might also believe the mtDNA based estimate of 600-700 kyr for the separation). It appears that La Ferrassie is more similar to Herto than the LCA, which either requires an explanation of parallel evolution, or far more probably means that there was reoccurring gene flow (sensu Templeton (2005) between the populations. This indicates they are not on separate lineages (see fig. 12 for a more formal assessment).

valid, we can expect the Neandertal line to become more and more different from the Neandertal/human LCA. This prediction is the same as that discussed above over the issue of how to interpret Stringer's work in an evolutionary context. Herto should differ from the LCA, but differ even more from the Neandertals that evolved from it, presumably as part of a separate lineage (fig. 9).

To examine this prediction, it is reasonable to use a measure of phenetic similarity (Wolpoff & Lee 2001). A more formal phylogenetic approach is problematic because the closeness of relationship of the putative lineages assures that no phylogenetic hypothesis could be adequately tested with the information available to us (Hawks 2004). It is also problematic because the Herto variables that can be compared are limited to those reported in Nature. One author of the Herto paper describes the Nature publications as "announcements" (White 2003), but the information published in this difficult to get into high impact journal is often the only source of data for years if not decades, and thereby is the basis for scientific discussion. This is neither an isolated opinion nor a minor inconvenience - some museums now consider publication in *Nature* and *Science* insufficient for access to the specimens they possess. Finally, a phylogenetic approach is difficult because while Bodo, by morphology and by age, provides a reasonable idea of what a LCA for the lineages could be like, not enough of the vault preserved for a valid systematic comparisons, and these are even more circumscribed by the small number of measurements and observations published for both Bodo and Herto.

Working with Sang-Hee Lee, we developed a phenetic approach to the question of similarity (Wolpoff & Lee 2001) that was based on the comparison of all available homologous measurements between pairs of specimens. The dispersion of the data around a linear regression through these points, which we call STET (fig. 10), is a measure of similarity that takes both size and shape into account (Lee & Wolpoff 2005). STET values clearly and unambiguously distinguish variation within species (pairs of specimens within the same species) from the higher magnitudes of STET values for pairs of specimens from different species (fig. 11).

A serration of STET values can be used to test the hypothesis of lineage difference (Lee & Wolpoff 2006), because if Neandertals are a distinct lineage, they should be more different from Herto than a earlier member of the European lineage such as Petralona is (fig. 9). This is not the case (fig. 12). Neandertals are more similar to Herto than Neandertal ancestors are.

The large, robust Herto male cranium affords the first opportunity to compare the Europeans to an African specimen of Neandertal age clearly related to modern populations, and evaluate whether the Europeans fit the model of a distinct line, evolving in a different direction, without confusing the evaluation with issues of size and robustness. These comparisons quite clearly show the Europeans are *not* evolving in a different direction from the rest of humanity. Whatever the causes of Neandertal variation, and there are sure to be many, lineage distinction does not seem to be one of them.

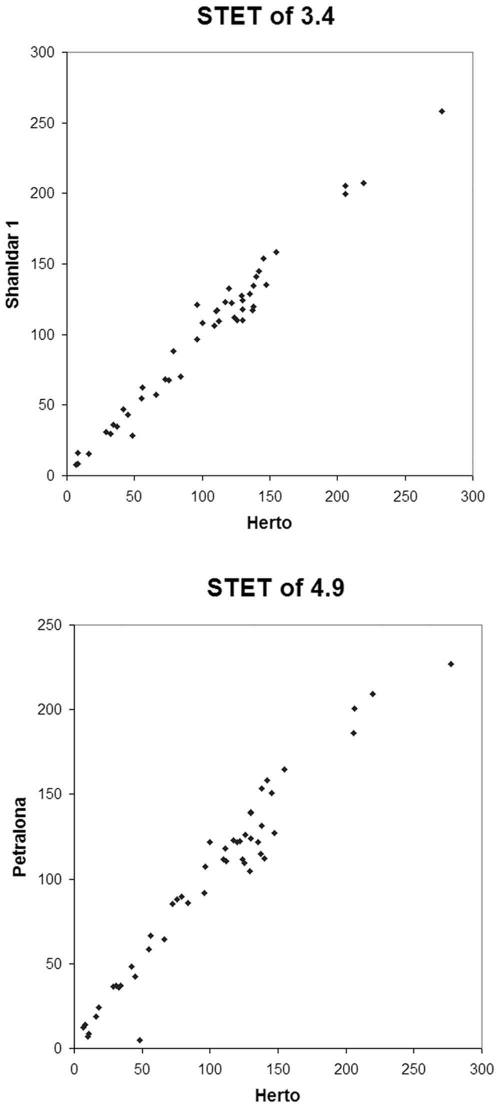


Figure 10. STET values determined from bivariate plots of Herto (BOU-VP-16/1) and two specimens from the European deme: Petralona (earlier) and Shanidar 1 (later). If there is a European deme that is reproductively isolated from the African deme, we would expect divergence to increase for its more recent members. This is not the case.

Do post-Neandertal Europeans retain Neandertal features?

Some Neandertal features certainly appear to persist until modern times in Europe (fig. 13), where for the most part they comprise part of the set of characteristics used to identify Europeans in a forensic context (Gill & Gilbert 1990). The earliest post Neandertal European crania are from the Romanian site of Peştera cu Oase (Trinkaus 2005; Trinkaus *et al*. 2003) and the Moravian site of Mladeč (Wild *et al*. 2005). While the former is not yet fully published, the later remains are well analyzed (Frayer 1986; Jelínek 1983; Jelínek *et al*. 2006; Wolpoff *et al*. 2001). Some of the features that identify the Mladeč males as Europeans are among those shared

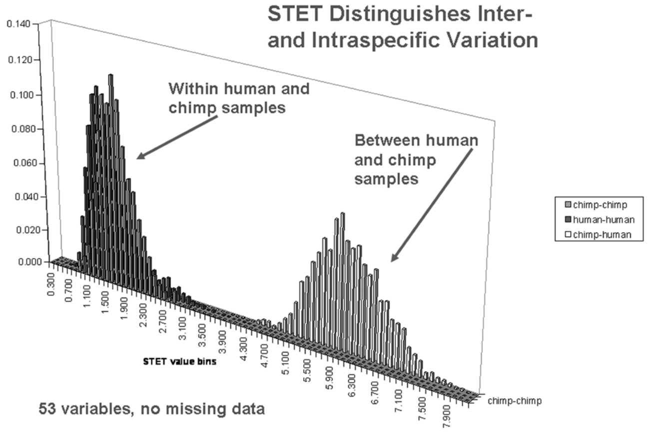
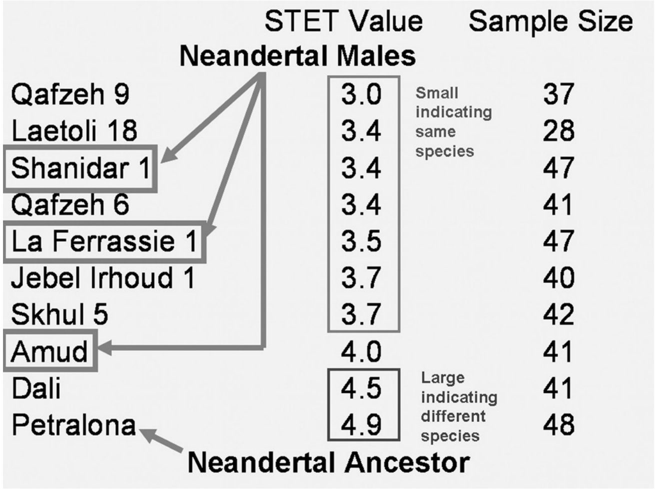


Figure 11. STET values for interspecies and intraspecies comparisons of chimpanzee and human samples, courtesy of Sang-Hee Lee.



Neandertal Males

	STET Value		Sample Size
Qafzeh 9	3.0	Small indicating same species	37
Laetoli 18	3.4		28
Shanidar 1	3.4		47
Qafzeh 6	3.4		41
La Ferrassie 1	3.5		47
Jebel Irhoud 1	3.7		40
Skhul 5	3.7		42
Amud	4.0		41
Dali	4.5	Large indicating different species	41
Petralona	4.9		48

Neandertal Ancestor

Figure 12. STET values for Herto compared with Neandertals and a Neandertal ancestor, Petralona. All specimens in this comparison are males.

with Neandertals, and there are other common Neandertal features in these remains (Frayer 1992). For instance, the small mastoid process of Mladeč 5 and elliptical suprainiac fossa on Mladeč 6 exemplify anatomy said to be unique in the Neandertals (Hublin 1998), but clearly are not uniquely Neandertal because they are found in these post Neandertal Europeans. The issue of uniqueness would only be important in the context of a separate Neandertal lineage.

Wolpoff and colleagues (2001) examined the question of what the Neandertal features in these earliest modern Moravians reveals about their ancestry; in particular, could the hypothesis of a half Neandertal-half Skhul/Qafzeh ancestry be rejected? They calculated the pairwise differences between each of the two Mladeč crania and the most complete Neandertal and Skhul/Qafzeh crania. These comparisons were based on observations for 30 non-metric traits (the non-metric traits are specified in the figures titles and are unrelated to the concocted "observations" analyzed by Bräuer & Broeg (1998)). The results of the pairwise comparisons are shown in figures 14 and 15.

Pairwise difference analysis is applied to DNA sequence data to investigate the closeness of relationship that a single ancient individual has to samples of living humans from different regions of the world (Krings *et al*. 1997). In these genetic analyses, the number of nucleotide differences between all possible pairs of individual DNA sequences is counted, and the results are presented as the frequency distribution of the number of differences. The assumptions are that each difference represents a mutation and that individuals who share fewer pairwise differences are more closely related because fewer mutations separate them. An equivalent assumption underlies all phenetic clustering techniques, where similarity is assumed to reflect relationship. Such procedures consider individuals who cluster more closely to be more closely related to each other. They do not necessarily assume a full independence of the traits; just as independence cannot be assumed for nucleotide differences in the non-recombining mtDNA molecule (see also Harvati and colleagues (2004), who use the same technique). The required assumption is that traits more closely linked are randomly distributed throughout the data set. The procedure is conservative, in that the absence of data for a specimen is considered the absence of difference. Missing data in our comparative samples are not randomly distributed. The Skhul/Qafzeh crania have more missing data than the Neandertals do. This means that in this specific analysis, the results will be weighed to show more similarities with the Skhul/Qafzeh remains.

The number of differences between Mladeč 5 and 6 and each of the others was tallied, and the figures aligned the specimens in order of increasing difference. The average pairwise difference between Mladeč 5 and the Neandertal sample (fig. 14) is 14.8, and between it and the Skhul/Qafzeh sample is 14.0, virtually the same. For Mladeč 6 (fig. 15) the corresponding comparisons are 7.8 and 11.6 differences, so this Aurignacian European is closer to the Neandertal sample. A Sample Runs Test was used to examine whether the ordering of Neandertal and Skhul/Qafzeh crania, based on the number of pairwise differences from the Mladeč crania, is random (the null hypothesis). Randomness in the order of pairwise similarities cannot be rejected by these data; the pairwise comparisons fail to reject the equal ancestry hypothesis, and thereby disprove the notion that the Mladeč crania are uniquely related to Skhul/Qafzeh.

This non-metric analysis is limited by the small sample sizes and ignorance of the underlying variance/covariance matrices for the data. The significance tests we used above are the ones we believe are valid for the metric and non-metric comparisons we could make. These limitations affect the resolution of our analysis, but it is clear that we have failed to disprove the hypothesis of equal ancestry for the Mladeč male crania. This fact, and the persistence of some Neandertal features in Europe until recent, even modern times, combines to show that Europeans retain Neandertal features. Of course, it is also true that some Neandertal features have spreads to other populations, and many European features show descent from other populations, and/or are the consequences of natural selection. These are the consequences of the breeding structure of human populations (Lasker & Crews 1996; Moore 1994).

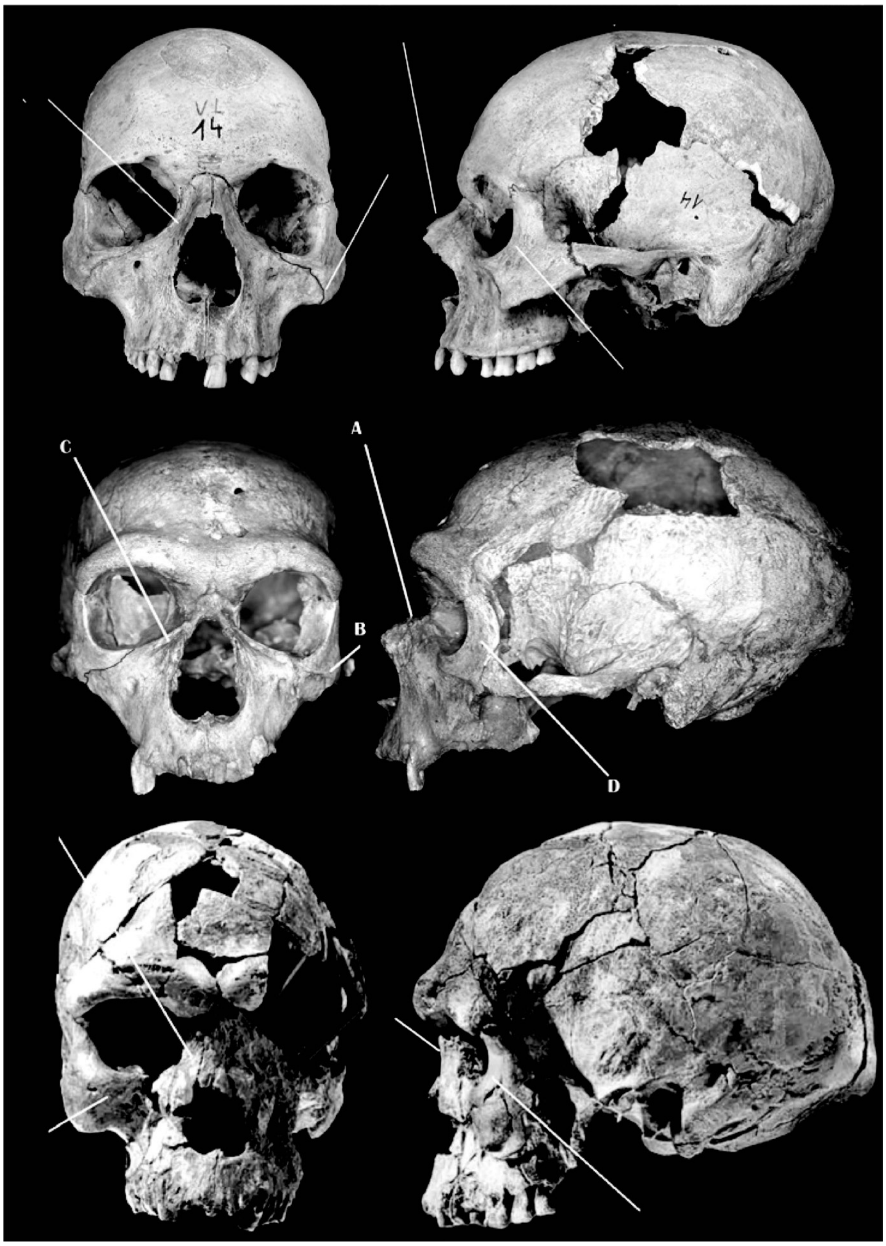


Figure 13. Some distinctive Neandertal features remain common in Europe today. Features showing sufficient geographic variation to be useful in forensic analysis are often found in the midface (Gill & Gilbert 1990). Here, four features of the midface in La Chapelle (center) are compared with similar anatomy in the modern specimen above, a Copper Age male from a 8-10 century Croatian site - Lijeva Bara (Vukovar, Croatia) - shown above, and contrasting anatomy in the Herto Ethiopian below (from White *et al*. 2003). Crania are shown to the same approximate size. European regional characteristics illustrated are:

A: the high nasal angle defined by the slope of the lofty nasal bridge as it rises up between the orbits and incorporates the frontal processes of the maxillae as well as the nasal bones themselves (not preserved in La Chapelle, the view shows the nasal process of the maxilla);
B: the course of the zygomaxillary suture (enhanced) that turns inward at its most inferior aspect;
C: the maxillary expansion at the lateral nasal borders, resulting in a “pinching” of the region so that these borders are laterally oriented;
D: the lateral orientation of the zygomatic bone.

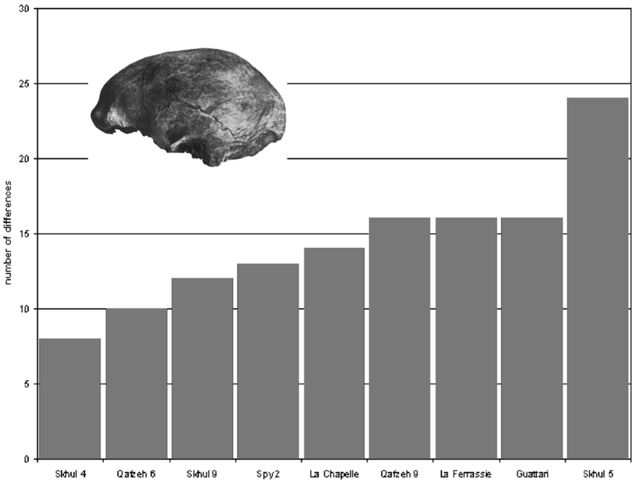


Figure 14. Pairwise differences between Mladeč 5 and the most complete Neandertal and Skhul/Qafzeh males. 30 non-metric traits are used in this analysis: "teardrop" shape (seen from top), cranial rear rounded (seen from back), occipital bun, asterionic parietal thickness (>9 mm), lambdoidal occipital thickness (>8 mm), vertical occipital face short, sagittal groove along vault posterior, occipital plane long (>60 mm), suprainiac fossa of elliptical form, paramastoid crest prominent, occipitomastoid crest prominent, broad occiput (>120 mm), retromastoid process prominent, nuchal torus extends across occiput, mastoid-supramastoid crests well separated, mastoid process projects minimally, glenoid articular surface flattened, supraglenoid gutter long, external auditory meatus leans forward, mastoid tubercle, glabellar depression, frontonasal suture arched, supraorbital center dips downward, broad frontal (>125 mm), central frontal boss, frontal long (gl-br>113), frontal keel, anterior temporal fossa border angled, lateral supraorbital central thinning, medial height of supraorbital large (>19 mm).

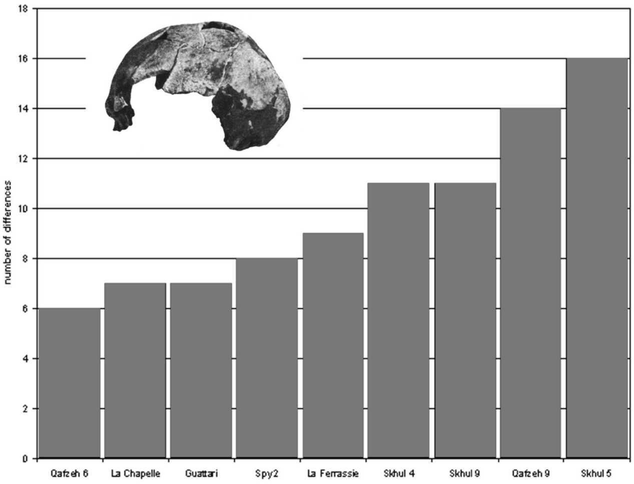


Figure 15. Pairwise differences between Mladeč 6 and the most complete Neandertal and Skhul/Qafzeh males. 22 non-metric traits are used in this analysis, less than the number for Mladeč 5 because the vault is less complete: "teardrop" shape (seen from top), cranial rear rounded (seen from back), occipital bun, asterionic parietal thickness (>9 mm), vertical occipital face short, sagittal groove along vault posterior, occipital plane long (>60 mm), suprainiac fossa elliptical, paramastoid crest prominent, broad occiput (>120 mm), retromastoid process prominent, nuchal torus extends across occiput, mastoid-supramastoid crests well separated, glenoid articular surface flattened, glabellar depression, frontonasal suture arched, supraorbital center dips downward, broad frontal (>125 mm), central frontal boss, frontal long (gl-br>113), frontal keel, medial height of supraorbital large (>19 mm).

Neandertal species, clade, or hybrid

Whether Neandertals are regarded as a species, clade, or hybrid population, such an interpretation would reflect an essentialist view of variation where distinct types mix. Yet, Neandertals need not be any of these but still could be different: Neandertals are not necessarily a type of human. Without question, Neandertals reflect geographic variation, and the fact is that geographic variation regularly evolves and persists within species, without the necessity of reproductive isolation (Bossart & Prowell 1998; Laporte & Charlesworth 2002; Pannell & Charlesworth 1999; Ptak & Przeworski 2002; Templeton 1998; Templeton *et al*. 1995; Wijsman & Cavalli-Sforza 1984; Wilkinson-Herbots 1998).

Variation can arise from differences in selection acting on adaptive traits, isolation by distance and unequal reciprocal gene flow in the absence of selection, and clinal distributions created by balances of gene flow (mostly from the center to the edges of the human range) and selection. It probably cannot be repeated too often that gene flow refers to the movements of genes, which may or may not involve the movements of peoples (Lasker & Crews 1996), but in either case gene flow is reciprocal and requires interbreeding between people from different groups, which is varyingly been called mixture, admixture, assimilation, or hybridization (as in the case of the so-called "love child"), depending on how different the author regards the mixing populations. One cannot overestimates the effects of restricted gene flow because of isolation by distance (Eller 1999; Hanson 1966; Templeton 1997, 2002; Wright 1943).

Yet, it is the fact of human mixture itself that continues to be unexpected and surprising. Consider Sládek and colleagues' (2002) analysis of the Šala frontal bone. Even though they conclude it is most similar to the Skhul frontals, it does not occur to these authors that this similarity could reflect recurrent gene flow between Europe and Western Asia. For many authors, it seems that gene flow, if it happened at all, only happened at the time Neandertals disappeared and therefore played a role in their disappearance. Before this time, the underlying assumption is one of Neandertal isolation and separation; how else could Neandertals have evolved their distinct features? This is a powerful argument, even standing as an explanation for cases when the features turn out not to be distinct. But the world view that differences must evolve under isolation flies in the face of modern evolutionary biology that considers the role of population structure in creating diversity within widespread species.

If there was mixture between Neandertals and other populations, it was at this time when changing selection associated with climatic change and emerging (or entering) cultural innovations were important causes of evolutionary change (d'Errico 2003; Zilhão 2001). It might be that selection within Neandertal populations promoted key adaptations introduced by the new populations, but it would also be the case that Neandertal cold adaptations would be of significant selective advantage to populations adapted to other climates. We would expect gene flow to be multidimensional, and this makes the populations more similar to each other. This process has been likened to the Tasmanian situation, but it is quite different. Population replacement, intermixture, and swamping in Tasmania took 150 years, the interactions in Europe were over a period estimated as 40 times as long (Mellars 2006). It is unreasonable to suppose the same mechanisms were at work.

Conclusions

It often seems as though the Neandertal issues will never be resolved, but I do not believe this will be the case. One promising direction is to ask the right question and not the wrong question about their relationship to us. While Neandertals are clearly different from living populations, more different than living populations are from each other (wrong question), the best available evidence is that Neandertals are among the ancestors of living populations, and that some of their features remain, especially but not uniquely in Europe (right question).

Acknowledgements

I am deeply grateful to Demarsin Bart and the Gallo-Romeins Museum in Tongeren for inviting me to the "Neandertals in Europe" Congress, held in Tongeren, Belgium, and arranging funding for my visit and presentation. I thank the curators of the Neandertal and other Late Pleistocene European fossils reported in this paper, for permission to study the remains in their care.

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THE DATING OF NEANDERTHAL SITES

Nick DEBENHAM

Quaternary TL Surveys, 19 Leonard Avenue, Nottingham NG5 2LW, U.K. n.debenham@qtls.globalnet.co.uk

Abstract: This paper begins with a review of the range of techniques which are available for the absolute dating of sites of Neanderthal age. Descriptions are given of the types of material that are commonly dated, and the circumstances in which it is useful to measure their ages. Some of the difficulties that are faced by dating laboratories are then explained, with consideration of the different types of uncertainties that are inherent in date measurements. It is emphasised that no dating technique is invariably accurate, and that a comparative dating study, involving several methods, is the most reliable means of determining the age of an archaeological event.

Key Words: Uranium series dating, thermoluminescence dating, error analysis.

Absolute Dating Techniques

The techniques for dating archaeological materials can be divided into two classes: those which produce absolute dates and those which give relative ages. Absolute dating methods yield results directly in terms of calendar years. The principal techniques of absolute dating which are useful for Neanderthal sites include uranium series disequilibrium dating, thermoluminescence (or TL) and electron spin resonance (or ESR) dating. Contrasting with these, relative dating methods provide floating chronologies, which require a procedure of calibration before their findings can be presented as calendar dates. Measurement techniques that require calibration include radiocarbon dating and amino acid racemisation. While relative dating methods are valuable in a large number of cases, it is clear that calibrated results cannot be more precise or reliable than the absolute dates against which they are calibrated.

Uranium series dating has been most commonly used to date speleothems, and has found wide application in dating stalagmitic floors in cave sites. The TL technique is also applicable to dating stalagmites, but is also used to date the heating of flint and stone by fire, and the deposition of sedimentary material. The ESR method is closely related to TL, but has been applied mainly to dating teeth.

Uranium series dating of stalagmite

Uranium series dating makes use of the radioactive decay of U-234 into the isotope Th-230, which itself is unstable with a half-life of 75,000 years (Ivanovich & Harmon 1982). When stalagmites are newly formed, they incorporate small amounts of uranium, but much lower concentrations of thorium. The subsequent slow increase of Th-230, from decay of the uranium, provides a measure of the stalagmite's age. This technique can date speleothems up to 350,000 years old, at which age Th-230 is close to equilibrium with other isotopes of the uranium series.

In many archaeological cave sites, in situ stalagmitic floors provide easily identifiable marker horizons. These floors indicate an interval of time between the emplacement of the underlying sedimentary unit and the deposition of the overlying unit. It is often difficult to measure the ages of cave deposits directly, but the stalagmitic floors can be dated with relative ease, and often provide a reliable chronology of the emplacements.

TL dating of stalagmite

The TL dating method can be applied to various geological materials (Aitken 1985). It makes use of the property of many crystalline materials to record the amount of radiation dose to which they have been exposed. Figure 1 shows a thin slice cut from a portion of stalagmite, which is being heated at a rate of 2.5°C per second. It has reached a temperature of 275°C, where there is a maximum in the intensity of the luminescence which is being emitted from the slice. This is the phenomenon of thermoluminescence, or TL. The spatial pattern of the TL has been made visible for photography with the aid of an image intensifier tube (Walton & Debenham 1980, 1982). It shows bands of varying TL intensity which correspond to different growth layers in the stalagmite.

The phenomenon of TL can be used to date the stalagmite because the intensity of the emitted TL is related to the

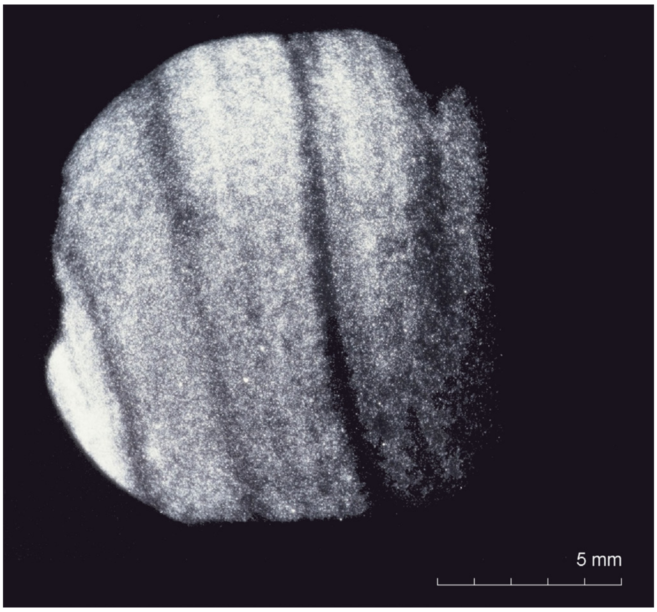

Figure 1. TL emissions from a thin slice cut from a stalagmite. The slice is undergoing heating at a rate of 2.5°C per second and has reached a temperature of 275°C. The spatial pattern of the TL was photographed using an image intensifier tube (Walton & Debenham 1980, 1982). The bands of varying TL intensity coincide with growth layers in the stalagmite.

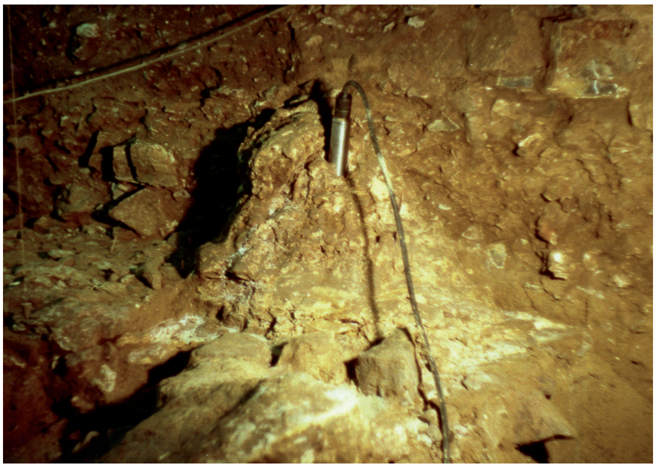

Figure 2. Measurement of gamma radiation intensity inside a large stalagmitic boss using a portable spectrometer. The stalagmite has been drilled with a coring machine, and a sample for TL dating has been obtained from the core. The detector of the spectrometer occupies the same position as the TL sample, and is recording gamma rays emanating from the stalagmite and underlying sediment.

total radiation dose that the calcite has received since it was formed. It is therefore possible to measure this quantity of radiation by means of TL observations. If both the total amount of radiation absorbed and the rate at which the dose was delivered are known, then the age of the stalagmite can be calculated.

Radiation is naturally present in all environments in the form of alpha, beta and gamma rays from radioactive elements, and also as cosmic radiation. Figure 2 shows a measurement of gamma radiation in La Grotte Scladina, Sclayn. A large stalagmitic boss has been drilled with a coring machine, and a sample has been taken from the core for TL examination. A gamma radiation detector has been placed in the hole, so that it occupies the same position as the TL sample. Gamma rays have a maximum range of approximately 30 cm, and the detector is recording the number and energies of gammas which are reaching it from other parts of the stalagmitic boss and from the underlying sediment. The detector is also counting the number of cosmic rays passing through the stalagmite.

Alpha and beta radiations are both short-range radiations. Their intensities can be determined in the laboratory from measurements of the stalagmite's radioactivity. When all the components of the radiation dose-rate have been measured, its total value can be combined with the TL measurement of the absorbed dose to yield the age of the stalagmite.

TL dating of heated flint and stone

The TL dating procedure for flint is similar to that for dating stalagmite (Valladas 1992). The main difference is that the flint needs to have been heated in antiquity in order that its age can be measured. In fact, the TL date refers to the heating of the flint, and a temperature of 400°C or more is necessary to make the date measurement possible. It is sometimes difficult to decide whether the heating was caused by human agency or by natural fire, but it is certain that, in order for the flint to reach a high temperature, it must have been lying on the surface of the ground. It follows that, at sites where flint débitage has been rapidly buried, the information provided by TL dating relates directly to the archaeological event.

The useful age range of the TL technique for dating flint extends from a few millennia to several hundred millennia. The method is well suited to dating Neanderthal sites, since they fall within the central part of this age range. It is equally applicable in both caves and open air sites. The technique has been especially useful in many parts of northern Europe where thick loessic deposits provide ideal conditions for dating heated flint.

TL dating of sediment

The general procedure for TL dating sediment is similar to that used for stalagmite and flint. However, in this case, the event that is dated is the exposure of the sediment grains to daylight (Debenham 1985). The necessary light exposure can only occur if the sediment is transported in a dispersed state over some distance. Thus, the TL method is well suited to dating loess depositions, but can also be applied to fluvial and colluvial sediments. In addition, it is found to be useful for dating buried palaeosols. In this case, the continual cycling of material to the surface by bioturbation, over a long period of soil formation, results in the entire volume of the soil receiving an exposure to light.

Date Information

The information that the archaeologist receives from the dating laboratory is summarised by two numbers. The first is the "age" of the dated event. This should be understood as the central value of the age range which is indicated by the date measurement. The age is of most value to the archaeologist when it is presented in absolute units, i.e. in calendar years. The second number gives the half-width of the measured age range, often referred to as the "error". Adding these two numbers gives the upper limit of the age range, and subtracting them gives the lower limit. The meaning conveyed by the two numbers is that there is a 68% probability that the actual date of the event lies between the upper and lower limits of the age range. It should be noted, however, that radiocarbon laboratories normally quote date limits which correspond to a probability of 95%.

Using this information, it is theoretically possible to estimate the likelihood that, for instance, one site predates another. Alternatively, the archaeologist may want to compare the date information for the human occupation with other measurements attached to environmental and climatic data. For these purposes, it is important that the age range indicated by the date measurement should be as realistic as possible. The question therefore arises: Do the error limits express all the uncertainties which affect the date measurement?

Sources of uncertainty

Three categories of uncertainties can be distinguished. The first category includes all uncertainties attached to measurements made in the laboratory or in the field. Scientists feel entirely confident about handling this type of uncertainty, and have well-established techniques for quantifying them. For this reason, measurement uncertainties are always included in the error limits which are attached to date information.

The second category includes uncertainties which are less easily quantified. In all dating procedures, there are complicating factors which adversely affect the measurement of the true age. In uranium series dating, attempts are often made to estimate the effect of the Th-230 which was already present in the speleothem at its formation, and to correct the measured dates accordingly. In TL dating, consideration must be given to how radiation levels may have varied in the past, and to the effect of such changes on the calculated date. All of these corrections carry an additional uncertainty which should be included in the error limits of the final date.

There is a third category of uncertainties which dating laboratories are unable to quantify, and which therefore are never expressed in the error limits of the age. These uncertainties result from failures of the basic assumptions on which the dating method rests.

Basic assumptions

It is worth remembering that dating laboratories do not measure time directly. Instead, they measure such things as isotopic ratios and intensities of luminescence. Time is an inference which is drawn from these measurements, based on assumptions about the initial state of the measured system, and the manner in which the system has evolved from its initial state. It follows that technical advances in our ability to measure isotopic ratios or signal intensities do not automatically lead to improvements in dating accuracy.

The basic assumptions differ among the dating methods. In uranium series dating, and also in radiocarbon dating, it is assumed that the sample has behaved as a perfect time capsule throughout its history; in other words, that it has been completely sealed from its environment. This supposition requires that there has been no movement of the relevant isotopes into or out of the sample.

In TL dating, various assumptions are taken depending on the material under examination. In the dating of heated flint, it is assumed that the sample was not reheated at a time significantly later than its use. In the case of stalagmite, there is the possibility of the material undergoing recrystallisation after its initial formation. If this has happened, the TL date may refer to the recrystallisation, rather than to the original formation of the sample. The dating of sediment is based on the assumption that the material was fully exposed to light at the time of its deposition. However, some mechanisms of deposition do not allow an adequate exposure, and the TL date will then refer to an earlier transportation of the material.

In all the above cases, it is not possible to detect failures of the basic assumptions directly, or to quantify the uncertainties that they transfer to the date measurement. However, this does not mean that it is impossible to reach a more realistic understanding of the uncertainties attached to date information. Fortunately, a way forward is suggested by the fact that, while all dating techniques are subject to unquantifiable uncertainties, they are not affected in the same way by the various circumstances that cause the errors. The methods can, in varying degrees, be regarded as independent of each other. To the extent that the errors are uncorrelated, comparisons between the results of different dating techniques will reveal the hidden uncertainties that affect them.

Comparative Dating Studies

It may be argued that, since all absolute dating techniques involve radioactivity in the natural environment, their results cannot be regarded as independent measurements. However, a distinction can be drawn between techniques which involve the observation of one particular isotopic ratio, such as uranium series and radiocarbon dating, and those which rely on the presence of a diverse ensemble of radioactive elements, such as TL and ESR. The dating of a stalagmitic floor can be taken as an example. Uranium series dating of the stalagmite is affected if the sample gains or loses uranium or thorium. In contrast to this, the TL date of the same stalagmite would be influenced by a net movement of all the radioactive nuclides into or out of the stalagmite and its surrounding sediments. In practice, it is unlikely that a given geochemical alteration would affect both dating methods in the same way. To a large extent, therefore, the two methods can be considered to be independent of each other. As a corollary, it is clear that, if uranium series and TL dating are in agreement on the age of a given stalagmite, greater reliability can be attached to the measurements.

One site which exemplifies the coordinated use of several dating techniques is Pontnewydd Cave in Wales (Green 1984; Aldhouse-Green 2005). More than eighty samples from this site have been dated; heated flint has been dated by TL, stalagmitic material was measured by both TL and uranium series techniques, several teeth were dated by ESR, and some bone was also dated by uranium series. The assessment of these data has also involved stratigraphic, faunal and climatic information. The result of this exercise has been twofold; firstly, a chronology has been determined for the human occupation and cave development which is more robust than one based on a single method of dating; and secondly, much knowledge has been gained about how the various dating techniques perform in particular circumstances.

Conclusions

It should be emphasised that the production of date measurements is an essentially impossible scientific task, because much of the information required to produce the date is inaccessible to measurement. As a result, all dating techniques are prone to unquantifiable uncertainties, and none can be considered to be invariably reliable. The best response to this situation is to apply the fullest range of dating methods to each archaeological context. By comparing all the results, hidden uncertainties in the different methods can be revealed. When date measurements from several sources are compared, not only does the archaeologist gain a more accurate view of the age of the site, but the dating specialists also learn more about the limitations of their measurements.

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THE PHYSICAL ENVIRONMENT DURING THE LATER QUATERNARY IN MID-WESTERN EUROPE

Frans GULLENTOPS
Lab. Prehistorie, Redingenstraat 16, B-3000 Leuven. Frans.Gullentops@geo.kuleuven.ac.be

After the findings of Schmerling and Boucher de Perthes some fifty years of consternation followed on the mysterious environment in which Early Man lived in Mid-Western Europe. The proof of a succession of glaciations in the Alps by Penck and Brückner brought the happy solution of periglacial climates with permafrost alternating with warm interglacials. And Milankovitch found an explanation of these cycles and at the same time a securing chronological framework.

After mid-century patient description and analysis of profiles in different environments made it clear that is was not that simple. The application of advanced sedimentology, pedology and most important palynology revealed important trends and oscillations in the warm and cold phases. Correlations became more and more hazardous. Then sediment cores in the ocean floors showed that these oscillations were systematic and world wide. Detail and understanding grew with the stupendous analysis of thick ice masses, tending to establish a universal oscillation curve. Most important is that the cores of sediment and ice deliver a continuous record. On the contrary our profiles on land register sedimentation on some moments, depending on the environment, and are stable on others and eventually weather and are submitted to erosion on others. Hiatuses represent in general much more time than the sediments. Nevertheless the stratigrapher will try at the end to make a correlation of his layers with the continuously refined general curve and present an elaborated chronological statement. It is understandable that for prehistorians this time conclusion is most important, but for other scientists, and for many prehistorians also, the understanding of the local environment at that moment has even more appeal. We review some environments.

A preliminary remark concerns the general insolation. The Milankovich parameters change de mean temperature not drastically. And the use of qualifications as arctic and polar for our pleistocene environment are very misleading. Never existed in mid-western Europe conditions were snow melted only during two month a year like Spitsbergen now. Nor had prehistoric man to cope with 6 month of winter darkness like Inuits now.

Variations of geographical parameters are responsible for considerably enhancing the primary change. Displacement of the winding Gulf Stream to the south is of prime importance. Continentality increased due to the retreat of the ocean on the shelf, more especially the diminished cold North Sea with icebergs. Further modulation through changing pressure systems: oceanic air to feed the ice masses and katabathic extremely cold and dry air flowing from them. It is evident that even more than now the Loire must have been a striking limit with the deep tempering ocean then also close by.

Permafrost has been the trade-mark of the periglacial climate. However it has been exceptional. Imagine the yearly thawing producing a soaked mud over the permafrost which would flow above 2-3° of slope. Flanders with its soft Cenozoïc strata would have been really flat. Certainly it happened, but for short periods. We know it best from the last Weichselian glacial.

The last forest soil of the Rocourt-complex ends with a taiga which is abruptly killed off. Lumps of the well preserved humus horizon are floated down-slope and only preserved in depressions. Above 1-2° of slope we never found it. The completely leached E-horizon of the taiga soil is washed in pipes of melting soil-ice lenses. Deep ice-cracks mm-thin are filled with humic inluvium from the soil top. It is a very cold spell with permafrost because deep seasonal frost can not saturate the topsoil due to the yearly drainage of it. It was very short because no important ice features or cryoturbations developed. We estimate the duration of this permafrost tundra at a millennium.

The last layer of the next Hesbaye Member is a thin humic horizon with a few shells, 14C-dated at 28.000 BP. It is immediately followed by hugh cryoturbations and massive ice wedges of tundra polygons. The whole landscape is activated, also by the thermokarst at its close; on slopes erosion by solifluction is such that never any Hesbaye sediments were observed and that all traces of the earlier interglacial soil are eroded. The permafrost is followed by a strong deflation time and by a characteristic humic soil, twice 14C dated at

21.400 BP. This allows to estimate that this most imported permafrost tundra lasted around 4 millennia. It corresponds to the beginning of MIS2. The grèzes littés of the Côte de Meuse register this permafrost, but the Upper Rhine Graben seems devoid of it, as are the lowlands south of the Loire. The natural wine limit? To stress the importance of these 4.000 years we must realise that this was enough for the Wurm Glaciers to flow out of the Alps and the Weichsel Ice to reach over the Baltic.

The humic soil is followed by the massive arrival of the Brabant loess and at its base are found straight cracks >6m deep, only 3-4cm wide above, filed with this loess. They were dry frost cracks filled with the powdery dust. Summer thawing produced only slow creep responsible for the typical plications, tongues, of the soil horizon. This permafrost which may have lasted only a few centuries was certainly less cold than the preceding. Indeed frost penetration in winter was helped by the absence of snow cover due to the extreme continental conditions. And in summer insolation was reduced considerably by the dust storms brought in by the katabathic winds.

Did the Younger Dryas refrigeration reach permafrost conditions, as some advocate? We never observed morphological activity needing permafrost and are not convinced that the "pingo’s" of the Ardennes summits need it. But certainly conditions came close in this last cold pulse.

The three permafrost phases of the last glaciation total about six years and take approximately 1/10 of the time. Furthermore the three are very different and without modern equivalent. The first may come close to climatic conditions of Tirol at 2500m, the second of the wetter French Alps at 2600m, for the third the Gobi is too lovely.

The next most classic periglacial environment is the aeolian: deflation and accumulation. Deflation areas need to be vegetation free. Apart from focal sources, as dry falling river-beds, this needs harsh conditions. Late and short snow free areas will tend to stay too wet; in dry continental spells with maximal katabathic winds will deflation be dominant. Pebble floors are abundant in the cover-sand area, but penetrate only in the northern loess area at the base of the Kesselt suite. Further south local deflation is shown by strings of lyophylised chalk granules. Its total importance is shown by the huge amounts of sand and silt blown to the south.

Accumulation of sand has two distinct facies. The pure aeolian sand has a homogenous appearance because the transporting winds tend towards the same velocity. Grain thick coarser laminae show local deflation. The mineralogy of this Wildert cover-sand shows its allochtonous, so distant provenance. It is coeval with the Brabant loess. The other facies is more stratified, with silt laminae, structures like adhesion ripples and activity of sheet-wash. The designation niveo-eolian stresses the influence of melting snow cover. These St.-Lenaarts Sands fill depressions and are interspersed with humic and peaty horizons. These episodes occur between the first two permafrost tundras. Rivers, even small ones, play an important role as the saltation jumps are too short to pass them. The sand is incorporated in the river charge and either evacuated or blown out of the braid-plains down-stream in typical wind walls. This results in a very compartimented landscape in which rivers form the limit of aeolian sediment types.

In the dry second half of the Younger Dryas aeolian activity was again dominant. Local deflation by south-western winds blew up parabolic dunes which indicates that enough vegetation, including birch, subsisted to counteract a very different aeolian activity.

Loess sedimentation presents the same differentiation. The lower Hesbaye loess is dominantly layered and greyish brown. It often fills erosion gullies and is then rich in washed-in shells and can have a very high content of worm-pearls. Micro-erosion is rare so loess-wash is suggested by snow melt waters on still frozen surface. In general this loess is patchy, fills depressions and contains strings of material washed or crept in from the hill tops: sand, fossils, pebbles.

The Brabant loess is very different: yellowish and powdery suggesting lyophilised complete dehydration of the grain films; strong carbonate content, never dissolved with perfect micro-foraminifera; rare phantoms of stratification in a mantle draping the relief, only absent on exposed hill tops. In the type area is devoid of shells or pearls and seems azoic, the classic interpretation of a loess-steppe being too friendly.

A third loess environment is the Lafelt loess probably blown out of the Warthe outwash plains at the end of MIS6. It occurs as an 8m thick body preserved on the Kesselt plateau. The loess has the composition of the Brabant loess but is now completely layered in mm-thin laminae deformed in continuous tufur structures. This suggests a snow-cover whose melt water could trickle off without any sign of erosion. Some kind of low vegetation like mosses seems necessary. In it occur at least four whitish horizons 10-15cm thick underlain by an ochrous band with a reticular pattern. In the top centimetres occur loess shells, while the leached horizon has many thin worm canals and their pearls. This abundant live needs a vegetation, with lots of lichen as the leaching without complete decalcification is interpreted as due to lichenic acids. No permafrost existed and the ice-wedges are from superposed tundra polygons about 100 Ka later. We interpreted these short rhythms as due to some non-astronomic forcing. They may be safely seen as Dansgaard-Oeschger events.

Snow has been already mentioned many times but it is worth special consideration. We recall its direct effects in nivation benches s known in the Ardennes and its fundamental role in the explanation of asymmetric valleys. And in the resulting sediments, grèzes littés, produced by night frosts at the rim of declining snow banks and evacuated down-slope by the melt waters. Snow modulated climate varieties as now in the D-climats. Early snow will hamper frost penetration into the soil; thick snow will insulate for permafrost, refresh spring and shorten the growing season.

One might surmise that in humid cycles half the precipitation falls as snow; it would be measured in meters. It melts in a short time, hastened and increased by rain. This leads to high run-off, which in the low order watersheds has even a diurnal rhythm. The work of the ensuing sheetfloods will depend on the cohaesion of the soil and the density of the vegetation. Cryopediments developed rapidly on loose sands or frost-sensible rocks. And rivers reached their maximal transport capacity. When measured by the work achieved snow must be considered as the most important factor in the periglacial environment.

Stability phases leading to surface weathering and soil formation have been shown to represent very short episodes. This does not mean that beyond these vegetation was lacking. In Hesbaye times valley filling contain so often organic layers that they have been called Peaty Loams. The same is true for sandy rivers in which numerous debris horizons occur. All these layers contain masses of thin twigs from Ericaceae and prostrate willows, with enrolled leafs. Armeria and numerous mosses are common. These layers are not related to climatic optima but represent sedimentological hasards of channels and swamps in which these light debris could be floated. They show that vegetation was always present, but low and adapted to the snow cover.

In strong contrast is the short Bölling/Alleröd oscillation which reached forest stage and the best formed soil. In fact it is the real beginning of the Post-glacial and prehistoric man has experienced it that way.

The long lasting interglacial reached forest climax and consequent soil development. The greatest surprise were the findings of Woillard that the last interglacial consisted in fact of the succession of three nearly identical vegetation developments. This allowed to understand a lot of problems in the corresponding Rocourt Soil. Prehistorians should be well aware that for obscure reasons the Eemian is mostly limited to the oldest of these phases and base their understanding on the divisions of MIS5. The begin of periglacial conditions coincides with the important marker produced by the enstatite volcanic eruption, begin of MIS5/a.

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A BIOSTRATIGRAPHYCAL BASE FOR DATING PALAEOLITHIC SITES

Thijs VAN KOLFSCHOTEN
Faculty of Archaeology, Leiden University, P.O. box 9515, NL-2300 RA Leiden.

Abstract: The age of Palaeolithic sites is often a matter of debate. Absolute dating is problematic for the older records with an age beyond the limit of radiocarbon dating (>50 ka) and hence, other methods have to be applied. A classical method is the use of biostratigraphical data, using knowledge of the changes in flora and fauna that are caused by the evolution, extinction and migration or dispersal of species. The Quaternary larger and smaller mammal records are subdivided into a number of biozones that form a biostratigraphical framework that is widely applied among Quaternary continental stratigraphers. The Quaternary biozonation, described in this paper, plays an important role in Palaeolithic research.

Keywords: Quaternary, Palaeolithic, mammalian biostratigraphy.

Introduction

One of the most debated questions in Palaeolithic research is the age; the age of a site, the age of the hominin dispersal into Europe or the extinction of, for instance, Neanderthals. There are different ways to solve questions about the age. Apart from physical methods such as ^{14}C dating it is often also possible to make us of the accompanying mammal fossils. The presence of a certain species, its evolutionary stage, or (although restricted) the absence of a species, can be used for dating deposits- not absolute age-estimation but an indication of a relative age. In other words, dating in the sense of: older than, or younger than or about the same age. In other words to make use of the classical, widely used method biostratigraphy i.e. the science of dating and correlating rocks and sediments using animal and plant fossils. The fact that during the Quaternary the continental flora and fauna almost constantly changed means that biostratigraphy for dating provides a good basis for correlation of stratigraphic sequences or events at one locality to those at another locality e.g. for correlation between Eastern and Western Europe or between Europe and Asia. However, biostratigraphy is a relative dating method and must be independently calibrated with numerical dating methods before numerical ages can be assigned to biostratigraphic zones or events.

The rapid and continuous climatic changes during the Quaternary induced major changes in environmental conditions and available habitats. This is particularly the case in higher latitudes or in areas such as the western part of the North European plain, where the conditions are less diverse, in comparison to mountainous areas such as Central Italy or the Balkan Peninsula. The forest vegetation, which dominated the flora of North-western Europe during interglacial phases, disappeared during the cold stages and was replaced by the so-called Mammoth Steppe- treeless vegetation types which are "analogous but not necessarily identical in plant-composition to present-day tundra, steppe and alpine meadows" (Guthrie & Kolfschoten 2000). The climatic changes that characterise the Quaternary affected the composition of the flora and fauna in three major ways: a) the evolution of species; b) the extinction of species, and c) the dispersal or migration of species.

The evolution of species

The evolution of species is a natural phenomenon that is observed throughout geological history. Natural selection is the basis for evolution and it can take place if: a) there are more offspring than can grow to adulthood; b) there will be a struggle for survival among individuals; c) in sexually reproducing species, no two individuals are identical and variation is rampant; d) much of this variation is inheritable. From this, one can infer that in a world of stable populations where each individual must struggle to survive, those with the "best" characteristics will be more likely to survive, and those desirable traits will be passed to their offspring; and that these advantageous characteristics are inherited by following generations, becoming dominant among the population through time. This is natural selection that leads to the evolution of species that is observed in the Quaternary fossil record.

Many different species show evolutionary changes during the past 2.6 Ma. However, there are also species with a long stratigraphical range that have hardly evolved or have not evolved at all. This applies to nearly all plant species but also to molluscs, insects, amphibians and reptiles. Among the Quaternary mammals there are species that do not show clear evolutionary changes such as the Chiroptera or bats. Another example is the Pygmy Shrew *Sorex minutus*, a species that only shows some fluctuations in size during the past 2.6 Ma. The Pygmy Shrew is widespread in Europe and lives under different climatic conditions. It inhabits areas with good ground cover although it is uncommon in woodland. The Pleistocene climatic and inherent environmental changes influenced the geographical distribution of the species but hardly affected the morphology of the dentition and the skeleton of the species. Therefore the fossil record of the species does not show a clear evolution. This applies also to a number of forest dwellers such as the Wood Mouse *Apodemus sylvaticus*, squirrels (e.g. the Red Squirrel *Sciurus vulgaris*) and glirids (e.g. the garden Dormouse *Eliomys quercinus* and the Common Dormouse *Muscardinus avellanarius*).

Fortunately, there are a large number of species that clearly have evolved even in such a relative short period as the Quaternary. The evolution is in some cases rather rapid, in others rather slow, and not all the evolutionary changes occur in the same period of time. Some species mainly evolved during the Early Pleistocene whereas others show clear changes during a later phase of the Quaternary. Remarkably many mammalian species e.g. mammoths, rhinoceros, and different voles, show comparable evolutionary changes. A general feature in the evolution is:

1) the increase in the height of the crown of the (pre)molars,
2) the increase of complexity of the enamel pattern of the (pre)molars.

Both features are related to the adaptation to more abrasive nutrition. The deterioration of climate led to the reduction of woodland vegetation and an expansion of a more open habitat with a dominance of grasses. For many herbivores this implies a change to more abrasive food.

Change in size is another feature that can be observed in a number of Quaternary species. Pleistocene wolverines of the genus *Gulo* show a remarkable increase in size during the Middle Pleistocene (Kolfschoten 2001). The same, though less extensive, can be seen in wolves (Bonifay 1971). Horses, on the other hand, increased in size during the early part of the Middle Pleistocene but reduced in size from the later part of the Middle Pleistocene onwards. Changes in size are generally not unidirectional and are therefore not a good feature for biostratigraphical purposes. Therefore changes in size can only be used in combination with other data.

Mammoth evolution

Among the species that show clear evolution during the Quaternary and are, hence, biostratigraphically relevant, are the mammoths belonging to the lineage *Mammuthus rumanus - Mammuthus meridionalis - Mammuthus trogontherii - Mammuthus primigenius*. Mammoth evolution began in Africa and during the late Pliocene mammoths migrated to Eurasia. The late Pliocene and Pleistocene fossil record indicates that the Eurasian mammoth underwent very significant changes: a shortening and heightening of the cranium and mandible, an increase in the relative height of the molars, an increase in the number of plates and thinning of the dental enamel (Lister *et al*. 2005). The earliest representatives of the European mammoth *Mammuthus rumanus* from the interval 3.5-2.5 Ma are characterised by upper M^3 molars with 8-10 plates, a hypsodonty index (i.e. the height of the crow divided by the width x 100) of about 120 and an average thickness of the enamel of about 3.8 mm. The upper M^3 of the most advanced representative of the mammoth lineage *Mammuthus primigenius* has 20-28 plates, an average hypsodonty index of about 200 and enamel with a thickness that ranges between 1.0 and 2.5 mm with an mean of about 1.6 mm.

Previously it was assumed that the transformation within the *Mammuthus rumanus - Mammuthus meridionalis - Mammuthus trogontherii - Mammuthus primigenius* lineage was gradual and more or less simultaneous across the species' range. However, recent investigations of the geographical variation across the whole of northern Eurasia indicated a more complex model (Lister *et al*. 2005). The transition between *Mammuthus rumanus* and *Mammuthus meridionalis* is still poorly known; the number of late Pliocene fossil remains is too limited. The Early - and early Middle Pleistocene *Mammuthus meridionalis* is better known. The species was widely dispersed in Eurasia and migrated to America during the Early Pleistocene. The European fossil record indicates that the species hardly evolved despite the fact that it occurred in the region for almost 2 Ma. In eastern Asia, probably in China, however, *Mammuthus meridionalis* evolved into *Mammuthuis trogontherii* in the interval 2.0-2.5 Ma. *Mammuthus trogontherii* expanded its original range and spread to NE Siberia by 1.2 Ma and towards Europe around 1 Ma. In NE Siberia *Mammuthus trogontherii* began a transformation into *Mammuthus primigenius* as early as 700 ka. The European population of *Mammuthus trogontherii* also hardly evolved and only shows a reduction of size in the interval between 1 Ma and 200 ka. *Mammuthus primigenius*, with its origin in NE Siberia, invaded Europe during the late Middle Pleistocene about 200 ka ago.

The evolution of voles

Rodents are well represented in the present-day fauna; nearly 40% of all living mammalian species are rodents. They represent a huge variety of animals including for example beavers, squirrels, marmots, hamsters, rats, mice, voles, lemmings, dormice and porcupines. Voles are a rather recent branch of diminutive grazers in rodent evolutionary history. They arose from the hamster lineage during the late Pliocene and have been very successful in Quaternary, with about 100 extant species. The evolution of the voles shows radiations leading to a number of different lineages. All these lineages show in principle the same type of evolution.

The first change that can be observed is an increase in height of the crown. The brachiodont molars developed into hypsodont molars with high enamel-free areas or dentine tracts. The increase of crown height led to a delay in the formation of

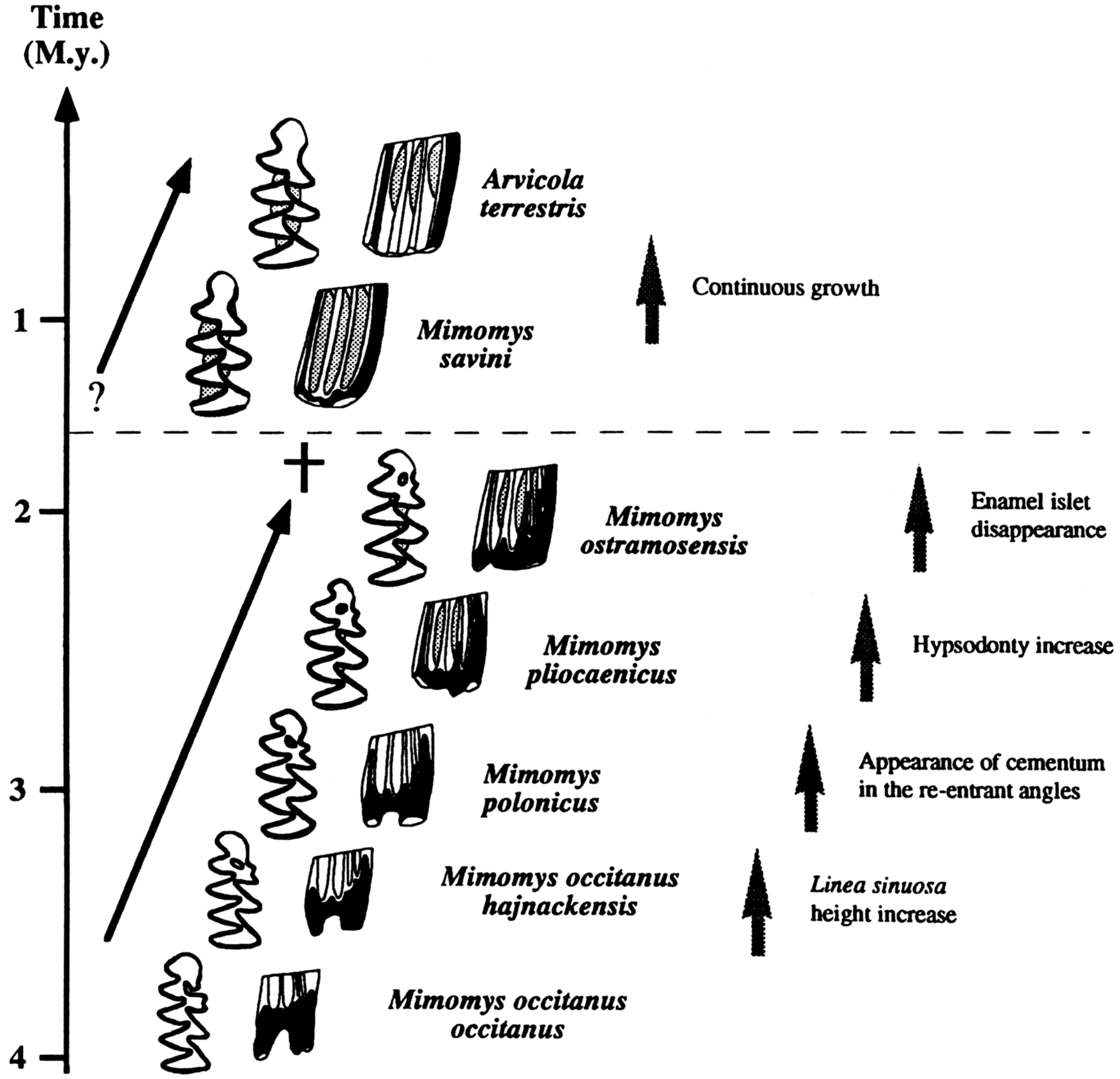

Figure 1. Phyletic gradualism in the *Mimomys occitanus – M. ostramosensis* lineage, showing the major evolutionary trends: increased hypsodonty related to a higher linea sinuosa; appearance of cementum in the re-entrant angles, and disappearance of the enamel islet. Continuous only occurs between *Mimomys savini* and Arvicola terrestris *cantiana.* From: Neraudeau *et al.* 1995.

roots, an evolutionary trend that finally results in voles that have molars without roots (fig. 1). A second feature that can be observed in the evolution of voles is the development of crown cement in a number of the lineages, crown cement that occurs in the re-entrant angles of the hypsodont molars. In addition, different lineages show an increase in the length of the posterior upper molar (M^3) and the anterior lower molar (M_1), an increase that parallels the increase of complexity of the posterior (M^3) or anterior (M_1) lobe of both molars.

Another general feature that can be observed in different lineages is change in the differentiation of the thickness of the enamel. The occlusal surface of the molars of voles shows a number of dentine fields covered with enamel at the outer side. The anterior enamel edge of the salient angles of the lower molars is concave and the posterior convex. The concave edges first occlude during the longitudinal movement of mastication; they are the so-called leading edges. The convex edges are the trailing edges. In a large number of living species the enamel of the trailing edges is much thinner than that of the leading edges. The opposite can be observed in many more primitive species. The transition from having trailing edges that are thicker to one in which the leading edges are relatively thicker is called the evolution in the differentiation in the thickness of the enamel.

The evolutionary changes described above did not occur simultaneously in the different lineages or within the lineages in the same region. The evolution of voles is a complicated story, studied by a large number of palaeontologists. Because of the geographically wide range of the species, their often dominant occurrence in the Quaternary fossil record and the extremely quick evolution that can be observed in a number of lineages, voles are extremely important for Quaternary continental stratigraphy. In particular for Eurasia the *Mimomys savini - Arvicola terrestris* lineage is important for the subdivision of the Middle and Late Pleistocene. *Mimomys savini*, a vole with rooted molars, is the ancestor of the living water vole *Arvicola terrestris*. The species occurred in European faunas during the late Early and the early Middle Pleistocene. The transition of populations of water voles with rooted molars to populations with more hypsodont, unrooted molars referred to the genus *Arvicola* (fig. 2), took place during the first half of the Middle Pleistocene. This transition seems to be well established since populations with a small percentage of rooted molars are known from several localities in Germany, Italy, the Czech Republic and Russia. The genus *Arvicola* clearly shows a gradual evolution in the differentiation in the thickness of the enamel since its appearance during the early Middle Pleistocene. Enamel differentiation appears to be an important marker to indicate the evolutionary stage of *Arvicola* and hence the relative age of the fossil record.

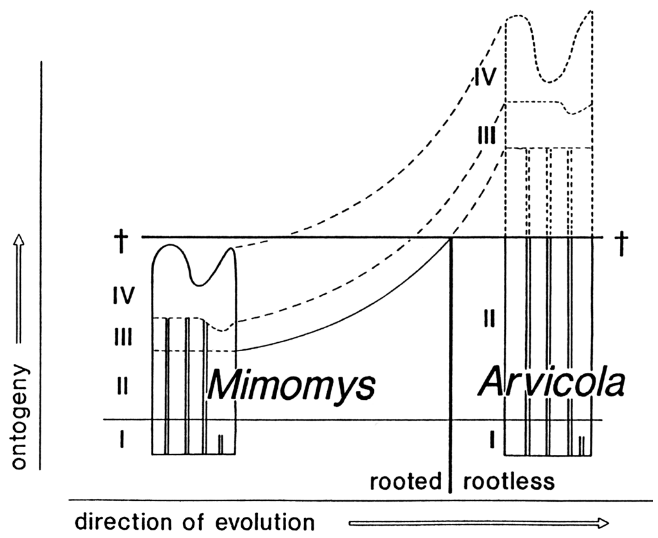

Figure 2. Model of the evolutionary transition from rooted molars in *Mimomys* to unrooted molars in *Arvicola* in terms of the heterochronous shift of ontogenetic phases I-IV Koenigswald W. von & Kolfschoten T. van (1996).

The *Microtus (Allophaiomys) - Microtus (Microtus)* lineage is important for the biozonation of the later part of the Early Pleistocene. The molars of that well-known lineage already lack roots. They first of all show changes in the differentiation of the thickness of the enamel and later, near the end of the Early Pleistocene, there was a huge radiation that led to a number of different lineages such as the *Microtus (Stenocranius) hintoni – M.* (*St.*) *gregaloides - M.* (*St.*) *gregalis* lineage. For the early part of the Quaternary one of the important lineages is the *Mimomys occitanus* - *Mimomys hajnackensis – Mimomys polonicus – Mimomys pliocaenicus – Mimomys ostramosensis* lineage (Neraudeau *et al*. 1995).

Extinction

The extinction of species is also biostratigraphically important. Several examples demonstrate the global or local extinction of species. Well known are the Late Pleistocene – early Holocene extinctions of mainly larger mammals that can be observed in almost every continent. In Eurasia, species such as *Ursus spelaeus, Mammuthus primigenius, Coelodonta antiquitatis, Equus hydruntinus* and *Megaloceros giganteus* disappeared at the end of the Late Pleistocene or the beginning of the Holocene. Extinction in the smaller mammal fauna of Eurasia can be observed in Middle Pleistocene faunas. Species such as *Drepanosorex savini, Talpa minor* and *Trogontherium cuvieri* are relicts from the Early Pleistocene that became extinct during the Middle Pleistocene.

Extinction is often preceded by a strong reduction of the geographical range of a species and a retreat to a refugial area. The Late Pleistocene European rhinoceros species *Stephanorhinus kirchbergensis* and *Stephanorhinus hemitoechus* show a progressive southward contraction of their geographical range preceding their extinction before the Late Glacial Maximum (Stuart 1993; Stuart *et al.* 2004; Stuart 2005).

Migration and dispersal of species

The migration of mammal species is certainly the major factor in the changes of composition of the Quaternary faunas in a specific region. These migrations are primarily caused by the alternation of the available habitats due to the changes in climate and environment (Kolfschoten 1995). Eurasian cold stage faunas from the last and penultimate glacial period are characteristic and rather well known; species such as *Dicrostonyx gulielmi, Lemmus lemmus, Mammuthus primigenius, Coelodonta antiquitatis* and *Rangifer tarandus* expanded their range southwards and occur together with species which prefer a more steppic environment such as ground squirrels (*Spermophilus undulates*) and hamsters (*Cricetulus migratorius* and *Cricetus cricetus*) that expanded their geographical range north- and westwards.

A rise in temperature led to more distinct steppic conditions in the lower latitudes. These steppic conditions resulted in the increase of the relative number of steppe elements. Lemmings and other cold stage indicators withdrew northwards and species such as the steppe lemming *Lagurus lagurus* migrated westward and invaded Northwestern Europe. A rise in temperature was followed in certain areas such as the North European plain by an increase of oceanic influences. That resulted in a climate, which induced a re-establishment of forests with thermophilous broad-leaved and coniferous trees and the return of forest dwellers such as glirids (*Eliomys quercinus, Muscardinus avellanarius*), wild boar (*Sus scrofa*), and cervids (*Cervus (Dama) dama* and *Capreolus capreolus*) (Kolfschoten 1992).

This general picture of alternating species, more or less the same species that "come and go", is applicable to the late Middle and Late Pleistocene and may also be applicable to the earlier cold stages. However, one can distinguish a migration of species that is more or less independent of, and not only the result of climatic change. The contemporary migration of a number of species characterizes the so-called major dispersal events. In addition there are also incidental immigrations of single species. The woolly rhinoceros *Coelodonta antiquitatis*, for example, had its origin in Asia and invaded Europe during the Middle Pleistocene, together with other cold stage faunal elements. Since its appearance, the species became a permanent element of the European cold stage faunas. The straight-tusk elephant *Elephas (P.) antiquus* invaded North Western Europe for the first time during the early Middle Pleistocene and occurred during every subsequent interglacial period until the Holocene. *Hippopotamus amphibius* also invaded Europe during the early Middle Pleistocene, most probably during the same warm phase in which *Elephas (P.) antiquus* appeared. However, *Hippopotamus* did not return until the Late Pleistocene (Eemian), after its withdrawal at the end of the early Middle Pleistocene.

Another aspect is the migration and dispersal at subspecies level: the migration and dispersal of populations to areas which were inhabited by the same species. Tracing these migrations demands significant morphological differences between the "new" population and the "old" one, as is the case between the Late Saalian and Eemian *Arvicola terrestris* populations of Northwestern Europe. The gradual change in differentiation of the enamel (fig. 3) was interrupted and showed an important fluctuation at the Saalian-Eemian transition. An explanation of this feature is the invasion of less derived populations. *Arvicola terrestris* disappeared from the northern areas which were covered by inland ice and along the edge of the inland ice shield during the Late Saalian. The re-colonisation of that area took place through the invasion of less advanced populations which survived in areas located more to the south- (east). The presence of more primitive features in southern populations during the Pleistocene is very plausible since it has been demonstrated that the living *Arvicola* populations also show a strong morphological cline in the development of the enamel differentiation. In this aspect the southern populations are much more primitive than the northern populations (Kolfschoten 1992).

Biostratigraphical subdivision of the Quaternary

The changes in the Quaternary mammalian fossil record described above form the basis for a biostratigraphical subdivision of the Quaternary (fig. 4). The extensive and well investigated Quaternary mammalian fossil record allows us to divide the record into clusters and to establish a biostratigraphical subdivision or zonation of the Quaternary period. Each biostratigraphical unit or biozone is characterised by a distinct faunal assemblage. A number of mammal biozonations have been established by different authors. However, many of these zonations are not defined in accordance with the official guide to stratigraphic nomenclature, and the terminology used by some authors is confusing. Furthermore, the application of several biozonations is geographically restricted. Two different biozonations are widely used in Quaternary biostratigraphy: the first one is based on the changes in the Eurasian larger

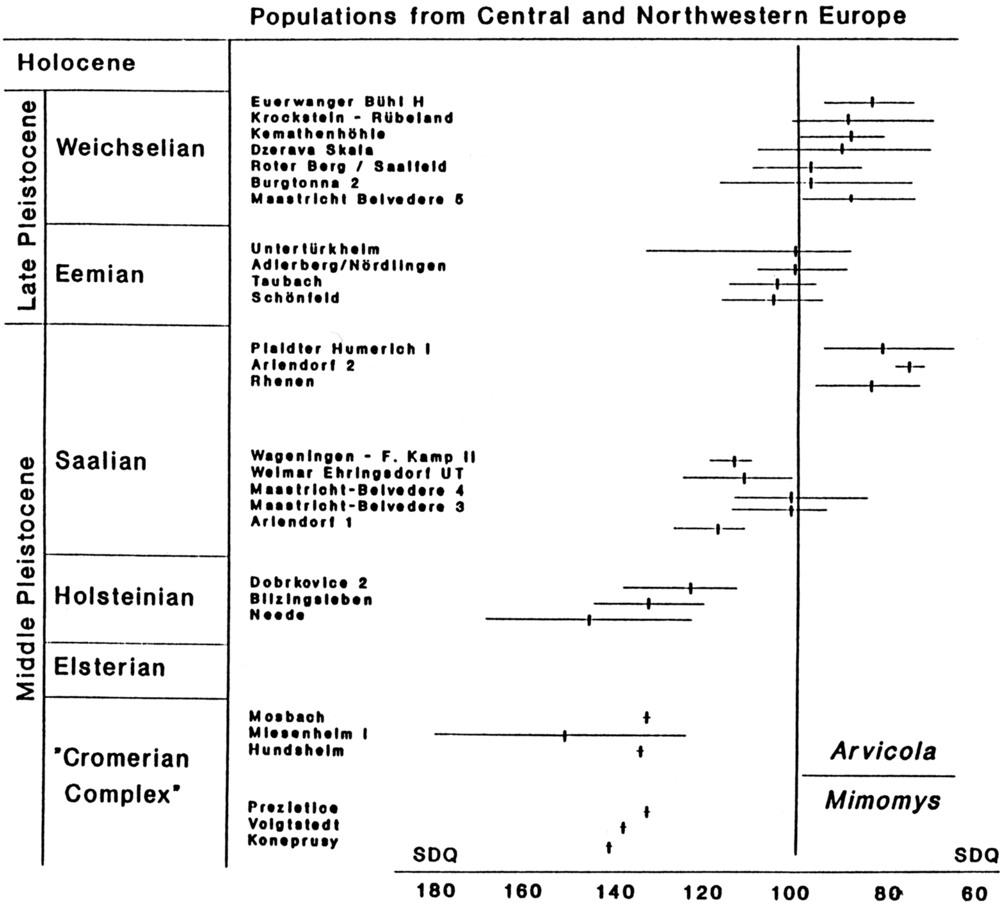

Figure 3. The range and mean of the enamel thickness quotient (SDQ) of a number of Middle and Late Pleistocene populations of *Arvicola* from Central and Northwestern Europe. From: Koenigswald W. von & Kolfschoten T. van (1996).

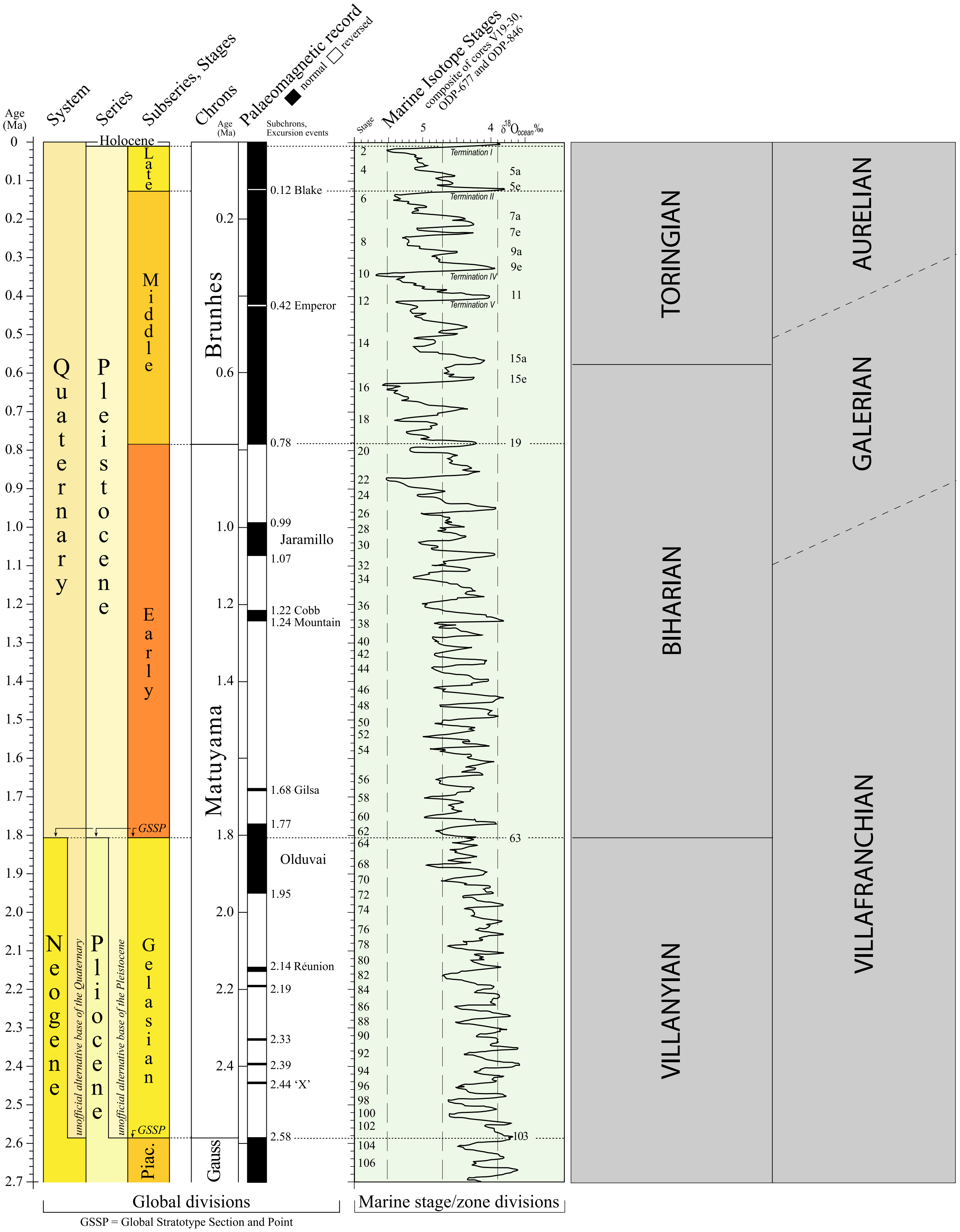

Figure 4. A correlation of chronostratigraphical subdivisions of geological time, spanning the last 2.7 million years with the applied biozonations.

mammal faunal community and the second one is based on the evolution in the smaller mammal assemblages. The co-existence of two different biozonations, one for the larger and one for the smaller mammalian record, is purely historical and is the result of specialisation within the community of mammalian palaeontologists.

Larger mammal biozonation

The widely adapted larger mammal biozonation is mainly based on the Italian fossil record and was established by Azzaroli and co-workers (Azzaroli *et al*. 1988). The Quaternary larger mammal faunas are divided into three main units: Villafranchian faunas, Galerian faunas and Aurelian faunas. The term Aurelian, indicating "modern mammal association" whereas the Galerian faunas are "becoming modern in appearance" (Sardella *et al.* 1998) is not often used. The Villafranchian is divided into an early, middle and late Villafranchian with the transitions marked by major events. The "*Leptobos*" event, indicating the appearance of species of the genus *Leptobos* in the Italian mammal faunas, marks the beginning of the Villafranchian. The first occurrence of *Mammuthus meridionalis* and *Equus*, the so-called elephant-*Equus* event, marks the transition of the early to middle Villafranchian and the appearance of *Canis etruscus*, the "Wolf" event, the middle to late Villafranchian transition. The "end-Villafranchian" dispersal event was originally described as a total faunal turnover, with massive extinctions and replacements marking the transition to the Galerian. However, it appears that the original definition of the boundary between the Villafranchian and the Galerian is unsatisfactory since the duration of the total faunal turnover took altogether about 0.5 Ma.

The Villafranchian starts well before the Quaternary with the oldest Villafranchian faunas having an age of about 3.3 Ma. The elephant-*Equus* event has an age of 2.8 – 2.9 Ma and the "Wolf" event an age of 2.2 – 2,3 Ma. The stratigraphical position and age of the Villafranchian – Galerian transition is still problematic. Some authors put the transition at an age of about 1.1 - 1.2 Ma, whereas others put the beginning of the Galerian close to the Brunhes/Matuyama boundary with an age of 0.78 Ma.

Smaller mammal biozonation

The smaller mammal biozonation that is widely used as a standard for the Early and Middle Pleistocene of Eurasia, is mainly a modified version of the Hungarian biozonation established by Kretzoi (1965). In this subdivision, three biozones are recognized for the Pleistocene period in the literature often erroneously referred to as "stages": Villányian, Biharian and Toringian. The Villányian faunas can be recognized by the dominance of voles of the genus *Mimomys* and the absence (or the occurrence in only a very low percentage) of voles of the genus *Microtus*. The Biharian faunas are characterised by a dominance of *Microtus* co-occurring with *Mimomys*. The Biharian biozone is also divided into two substages: Lower and Upper Biharian. The disappearance of the subgenus *Microtus (Allophaiomys)* marks the transition from the Lower to the Upper Biharian. The Toringian biozone can be recognized by the *Arvicola* - *Microtus* assemblages. *Mimomys* is missing in Toringian faunas.

The numerical ages of boundaries of the biozones and hence, the age ranges of the biozones is still a matter of debate. The Villányian started well before the beginning of the Quaternary at about 3.6 – 3.7 Ma ago. One of the most important abrupt changes in the smaller mammalian fauna took place during the transition of the Villányian to the Biharian biozone. Until recently the major faunal "turnover", in particular the reconstruction of the vole community, and the expansion of rootless voles characterised by the appearance of *Microtus (Allophaiomys)* (a group of voles, easily recognisable and well represented in the fossil record of the Northern Hemisphere), was dated just after the Olduvai Event. This transition formed one of the strong 'continental' arguments to put the Plio-Pleistocene boundary near the top of the Olduvai. New data, however, indicate that the age of this faunal "turnover" is questionable. Tesakov (2004) argues that this faunal 'turnover' took place long before the Olduvai Event and he dates the transition between 2.1 and 2.2 Ma. The transition between the Lower and the Upper Biharian is rather well dated with most authors agreeing that *Microtus (Allophaiomys)* disappeared during or just before the Jaramillo palaeomagnetic Subchron. The Biharian – Toringian transition is studied in great detail because the age of this transition is very important for dating the earliest Palaeolithic sites in Europe. The first occurrence of the genus *Arvicola,* marks the beginning of the Toringian, dates around 0.5 Ma ago (Kolfschoten 1992; Koenigswald and Kolfschoten 1996).

Additional biozonations

The biozonations described above are mainly used by Eurasian continental biostratigraphers, often next to regional zonations applicable in the area of investigation. There is no elaborated widely applicable biozonation of the continental floral record despite the fact that the impact of Quaternary climate changes on the floral composition in most regions is huge and the stratigraphical range of many species is very fragmented and/or restricted. Floral species hardly show any evolution during the Quaternary and also the number of extinctions is restricted. On the other hand, they are very valuable for identifying climate changes through changes in species composition.

In the marine realm there are a number of micropalaeontological zonations (Gibbard and Kolfschoten 2004; Lourens *et al.* 2004). Biozonations have been established for the fossil record of different microfossils: planktonic foraminifera, calcareous nannofossils, diatoms, radiolaria and dinoflagellates. The planktonic foraminifera biozonation and the calcareous nannoplankton biozonation are the major tools for subdividing marine sediments. The application of the other fossils is generally restricted to areas with specific conditions.

The application in Palaeolithic research

A biozonation dividing the Quaternary in periods of 0.5 Ma or even more is of restricted utility in Palaeolithic research. This is in particular the case for early Quaternary deposits. The use of biostratigraphy is less relevant in younger deposits because the biozonation is too coarse for the detailed information one is looking for. The stratigraphical setting of Middle and Late Pleistocene strata in many cases allows correlation to regional stages such as the widely adapted North West European Stages. Furthermore, there is a tendency to use the Marine Isotope Stages as a timescale for continental finds, in spite of the very restricted number of direct correlations between continental and marine zonations.

Using mammalian biozonation to indicate the age of Palaeolithic sites results only in very rough indication.

The statement that the Palaeolithic remains from Dmanisi (Georgia) have a Villafranchian age based on the larger mammal remains suggests there we are dealing with very old finds. The fact is that the mammalian biozonation of the Quaternary is too coarse for Palaeolithic research. To get more detailed information, one should use our knowledge of the fauna evolution within the different zones. The late Biharian faunas can put in a biostratigraphical order using our knowledge about the evolutionary tread in the *Microtus (Stenocranius) hintoni*/*Microtus (Stenocranius) gregaloides*/ *Microtus (Stenocranius) gregalis* lineage (Kolfschoten & Markova 2005).

The Biharian – Toringian transition plays a role in the "short chronology" debate. Roebroeks and van Kolfschoten (1994) launched the short chronology hypothesis and argued that all the undisputed Palaeolithic sites in Europe have a Toringian age, i.e. the related mammalian faunas are characterised by the occurrence of voles of the genus *Arvicola* and the absence of *Mimomys savini*. Shortly after, Palaeolithic remains (including human remains) were discovered in a "*Mimomys*" context in Atapuerca (Spain). The occurrence of *Mimomys* and representatives of the *Microtus (microtus)* guild indicate a late Biharian age. The number of Biharian Palaeolithic sites is however, restricted.

To put the European Toringian Palaeolithic in the right stratigraphical order The evolutionary changes in the genus *Arvicola* during the past 500 Ka, observed in many different areas in Europe and by different authors, is used. The *Arvicola* molars from Maastricht-Belvédère and Schöningen 13-11-4 differ in the relative thickness of the enamel and hence differ in ages. The *Arvicola* molars indicate that the remains from Schöningen 13-11-4 are older than the main Maastricht-Belvédère fauna (M-B 4). The evolution level of the *Arvicola* molars is one of the most important age indicator. Other factors eg. the occurrence or absence of species (smaller as well as larger mammal species) are taken into account to determine the (relative) age of a site. Palaeolithic researchers in Europa use a more detailed "biozonation". There is no problem to apply this detailed "biozonation" in a geographically restricted area. For long distance correlation of sites one should be aware of the fact that geographical gradients might play an important role.

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NEANDERTHALS IN THEIR LANDSCAPE

Jürgen RICHTER
Inst. für Ur- und Frühgeschichte, University of Cologne. j.richter@uni-koeln.de

Abstract: The physical and cultural remnants of Neanderthals have been found within a large variety of environmental contexts, and, obviously, there was no *Neanderthal standard environment.* Despite the fact that Neanderthals are widely regarded as having anatomically adapted to survive under cold climatic conditions, we must probably accept them as *potentially ubiquist hominids*. Through 100.000 years of Neanderthal (in strict sense) existence, between 130.000 and 30.000 years B.P., their environment changed several times under the influence of major climatic oscillations. A variety of different landscapes all over Europe and the Near East was inhabited and used by Neanderthals.

Environment versus landscape

Definitions of the term "landscape" include both the natural background (environment) and the human aspect of the part of the earth surface which is inhabited and used by men. At any given time, and all over the world, groups of humans developed specific manners of adaptive systems designed to address specific types of environments. Adaptive processes involve various options, decisions based on knowledge and experience, and opinions regarding particular environments. The geographic and cognitive nature of landscape is mirrored by definitions such as: "A particular part of the earth surface specifically conditioned by co-action of prevailing geofactors, including human action and, as attested by its specific appearance ("Erscheinungsbild"), differing from adjoining regions" (translated from Encarta 2002, German edition). Landscape does not only mean the natural environment which prevails around humans, but it includes the individual and cultural perception of the environment by the humans themselves. Thus, a conceptual model of landscape has to include the environment (animals, plants, climate, surface, watershed) and, at the same time, human perception functioning as a filter between environment and human adaptive systems (fig. 1).

Consequently, the present paper focuses on the environment of Neanderthals, the human perception of the environment, and some examples of adaptive systems.

The environment of Neanderthals 130.000-30.000 B.P.

During the long time of their existence, from 130.000 to 30.000 years ago, Neanderthals underwent several fundamental climatic alterations. Not only did they live in interglacial forests, they also inhabited interstadial steppe environments. Moreover, Neanderthals lived in a vast area throughout western Eurasia, stretching from the Near East to the British Isles, and from the Iberian Peninsula to Central Asia. At certain times, they were able to survive in the lowlands of the northern European plain, as well as in the high mountain regions of the Alps.

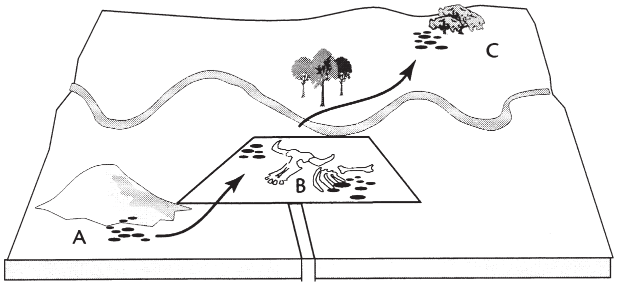

Figure 1. Cultural repertoire model. B (excavated area) can be understood as time window within an annual cycle of hunter-gatherer mobility. The cultural repertoire (optional assemblage of all artefacts which can possibly be made by a given human group) is dispersed over an annual territory. The excavated assemblage (B) represents a part of the cultural repertoire. Site A (workshop site) had been occupied prior to B. Some artefacts found at B had been imported from A. Some artefacts were later exported from B (hunting and butchering site) to C (short term camp site; - from Uthmeier 2004b:77).

Neanderthal populations survived several climatic cycles, such as the Eemian Interglacial (MIS 5e), the beginning of early Weichselian glacial cooling, interrupted by two long ameliorations (5c and 5a), the first glacial maximum (MIS 4) with an early, a moderate, and a late extreme phase, and which depopulated most of what is now central Europe, and the following long, unstable but still moderate, early Interpleniglacial (early MIS 3) with at least three interstadials (Oerel, Glinde, Moershoofd). During the second part of the MIS 3 interpleniglacial, the climate became considerably harsher. The climatic deterioration might have played a role in Neanderthal extinction. The Hengelo interstadial saw the beginning of the Aurignacian, and after some authors, the occurrence of modern humans in Europe. The oldest physical remnants of modern man, from Oase Cave in Romania, are dated to the following cold phase, between the Hengelo and the Denekamp interstadial. If dating of the last Neanderthals from Andalusia and Croatia at around 30.000 B.P. is correct, the Denekamp interstadial was the time of Neanderthal extinction. From 26.000 to 18.000 B.P. Central Europe was almost completely depopulated and the Weichselian glaciers reached their maximum extension. After the second maximum of the Weichselian glaciation (early MIS 2) *Homo sapiens sapiens* became the only hominid to settle on Earth. During periods of climatic deterioration, particularly under the harsh conditions of both glacial maxima of the last glaciation (MIS 4 and MIS 2), human habitat must have been restricted to the southern and southwestern parts of Europe. The rhythms of expansion and retreat of Neanderthal populations are not yet fully understood. Changing modes of adaptation, migration and repeated regional extinction must have played a major role within large-scale Neanderthal population cycles. In order to understand these mechanisms, a micro-scale approach proves advantageous, for it can provide case studies of Neanderthal land-use patterns and seasonal mobility within particular territories and landscapes.

Neanderthal land use patterns display a great variety of modes, which is particularly obvious when interglacial (MIS 5e) and glacial (f.e. MIS 3) case studies are compared:

- During the last interglacial or Eemian Interglacial, the climate was periodically warmer and more humid than today. Deciduous forests covered most of Central Europe. Elephant and rhino, red deer, forest bison and wild pig were among the human prey. Hippo lived as far north as England. While the climate was comfortable to humans, their population size was probably smaller in forests than in open landscapes. As Neanderthal nutrition was mainly based on meat, they were particularly dependent on the availability of larger mammals that could be hunted. In forest environments, however, the ungulate biomass tended to be smaller than in steppe environments, because the proportion of grass vegetation was lower. Animals were not concentrated in large herds but rather dispersed over large areas (Standwild).

- During the interpleniglacial (MIS 3), the climate was drier and amplitudes of temperature increased, with long, cool winters and shorter, hot summers. Open landscapes of the mammoth steppe zone covered most of Europe. Human nutrition was mainly based on the exploitation of ungulates such as horse, reindeer and bison, which occurred in large herds migrating between summer and winter habitats.

Europe during the last interglacial

The last interglacial or Eemian Interglacial, from 126.000 to 115.000 B.P., saw warm and humid climatic conditions in Europe similar to those of the present time, or even a little more favourable (overview: Van Kolfschoten & Gibbard 2000). Thus, archaeological sites from the last interglacial allow us to observe the behaviour of middle Palaeolithic humans under similar climatic conditions and in, potentially, comparable environments as currently prevailing.

Eemian archaeological sites are rare in Europe (fig. 2), and a recent comprehensive study lists only 30 sites for central Europe (Wenzel 1998:3). For western Europe (cf. Monnier *et al*. 2002) the situation is even worse, and the British Isles are even completely void of any human traces dated to the last interglacial. Very few sites in eastern Europe are tentatively attributed to the Eemian, most of the claimed Eemian ages still being highly questionable (Chabai *et al*. 2004:425). On the other hand, Eemian human occupation might have stretched as far north as Finland and as Far East as Siberia, as new finds from the Yenisei area indicate (Chlachula *et al*. 2003). Several Neanderthal remains have been uncovered from Eemian contexts in central Europe. Eemian early Neanderthals have been found at Krapina (670 Fragments), Saccopastore (adult female and adult male), Ganovce (brain cast) and Taubach (12-14 years old child).

Given the short duration of the Eemian, of only 11.000 years or 0.5% of the Quaternary, there are still more sites than one might expect, especially in Central Germany and in Slovakia, where many travertine sites are concentrated with excellent preservation of organic matter. Eemian archaeological sites are mostly preserved in travertine and caves, and more rarely in Lake Basins, river and beach deposits and volcanic deposits (Wenzel 1998:3).

125.000 years ago, climatic amelioration came very rapidly. The Greenland GRIP ice core seemed to indicate some short, cold interruptions of the interglacial climate, but to the contrary, terrestrial pollen records from more than 100

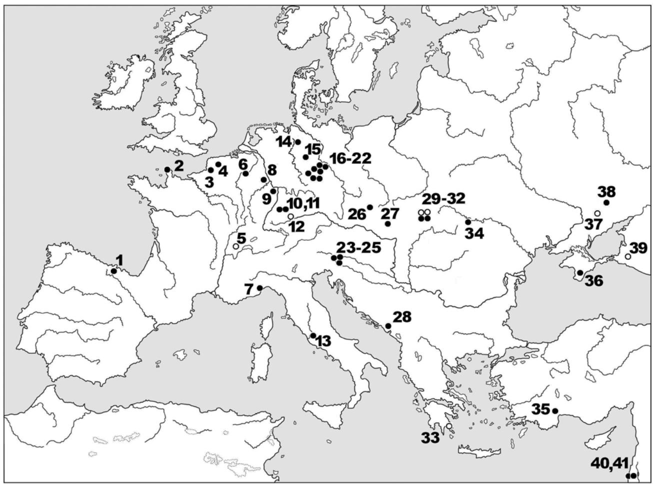

Figure 2. Last Interglacial (MIS 5e and 5d) sites in Europe.

localities in northern central Europe argues for relatively stable climatic conditions during the last interglacial (Kühl & Litt 2003).

A simultaneous drop in steppe landscapes and a rise in forested landscapes in central Europe characterised the vegetation at the beginning of the Eemian interglacial. When the Eemian period began at about 125.000 B.P., the polar ice caps had already reached their minimum extension, such contrasting the early Holocene (Shackleton *et al*. 2003). Birches dominated (pollen stage E1), followed by pine-birch (pollen stage E2), pine-oak-mixed forest (pollen stage E3), oak-mixed forest-hazel (pollen stage E4a) and hazel-yew-linden tree (pollen stage E4b), stage E4 representing the climatic optimum in central Europe, when the Helicigona banatica mollusc fauna appeared north of the Alps. The second part of the interglacial displays a dominance of hornbeam (pollen stage E5), hornbeam-spruce (pollen stage E6a), pine-fir-spruce (pollen stage 6b) and finally pine forest (pollen stage E7).

The terrestrial chronology of the Eemian has recently been compared with data from deep sea foraminifers, and it is now clear that the Eemian began about 5 ka later than MIS 5e and stretched about 5 ka into the cooler stage MIS 5d (Arslanov *et al*. 2002). The new chronology can now be used to integrate vegetation, radiometric and stratigraphic data from Eemian archaeological sites in Europe (fig. 3). Two chronological stages are now visible:

Early and Middle Eemian: travertine and lakeside locales with birch forests, birch-and-coniferous forests and deciduous forests. Humans preferably exploited Megafauna like rhino and elephant. Homogeneous, Mousterian lithic assemblages with scrapers and denticulated pieces were common. Lithic production was mostly based on Levallois concepts. Generally, denticulate artefact assemblages tend to occur under mild and temperate climatic conditions (in France during MIS 5 and 3; see Rolland 2001:558) and are connected with processing of wood and plants, and possibly bone. Rolland also suggests profligate raw material exploitation with opportunistic, less selective procurement, mostly from local sources.

Late Eemian and early post-Eemian: cave and riverside locales, and one volcano locale with more open environments. Bovines (Kulna, Wallertheim), horse and red deer (Tönchesberg, Sesselfelsgrotte and Southern France) were hunted. Lithic artefacts were very heterogeneous and indicate probably different regional traditions: “Taubachian” (microlithic) assemblages (Sesselfelsgrotte U-A08 and U-A07 and Kulna 11) were roughly contemporary to assemblages with different kinds of blades and backed pieces, extraordinary for this time (Tönchesberg, Wallertheim). Bifacial technology was very rare in western and central Europe but very important in the Crimea (Kabazi II, unit V-VI). At this time, the use of bifaces obviously coincided with the extension of open landscapes and of the Mammoth steppe. By contrast, inhabitants of forested landscapes preferred unifacial tools.

Taubach does not belong to the Taubachian (Weissmüller 1995:225).

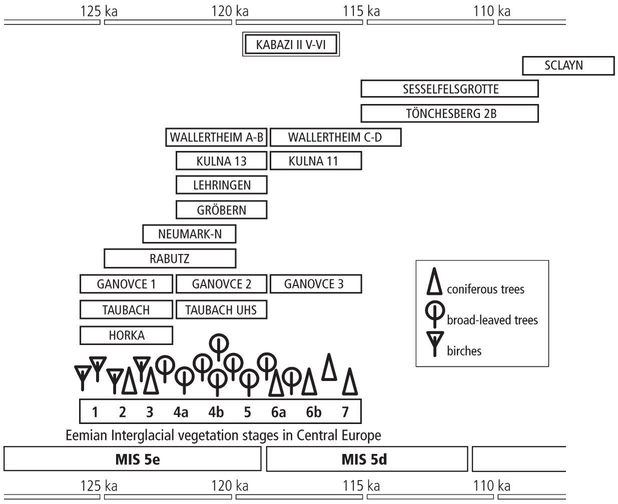

Figure 3. Last Interglacial and early Weichselian Glacial sites compared to the Eemian vegetation record. Early and middle Eemian (MIS 5e) sites are strongly related to springs, lakes and watercourses and display broad spectrum hunting prey.

Early and mid-Eemian hunting, trapping, scavenging at lake-sides and springs

The carrying capacity for ungulate biomass is lower in densely forested landscapes than in open landscapes, and the large herds of steppe animals like mammoth, woolly rhino, reindeer and horse disappeared. As ungulate-hunting prey decreased during the Eemian, a parallel decrease of human population was often assumed. Population density of Palaeolithic humans, however, might have been so low in relation to ungulate biomass, that a possible decrease in available prey might not have had any effect on human nutrition.

Aurochs and red deer were well adapted to woodlands and required hunting strategies focused on multi-species exploitation of single animals of relatively moderate mobility. Moreover, forest elephant and forest rhino kept large areas free of dense forests and facilitated grazing by other species such as horse and giant deer.

Most surprisingly, humans often exploited elephant and rhino, as many archaeological sites show (fig. 4). It is not clear weather elephants were hunted, trapped or just scavenged.

At the famous site of Lehringen in Germany, an elephant skeleton was buried at a lake-side together with a 2,4 m long wooden spear and 27 stone artefacts of Levallois character (Wenzel 1998:194). Whether humans actually hunted the animal or just killed it when already trapped in the swamp, remains open to discussion. It was certainly butchered, as is equally attested for an elephant skeleton found at Gröbern, again at a lake-side, and again along with 27 artefacts of Levallois production (Mania 2000; Wenzel 1998:202). The nearby Neumark-Nord site, formerly dated to MIS 7 and recently redated to the first half of the Eemian interglacial (Böttger *et al*. 2005), yielded several in-situ butchery zones. Elephant (*Palaeoloxodon antiquus*), forest rhino

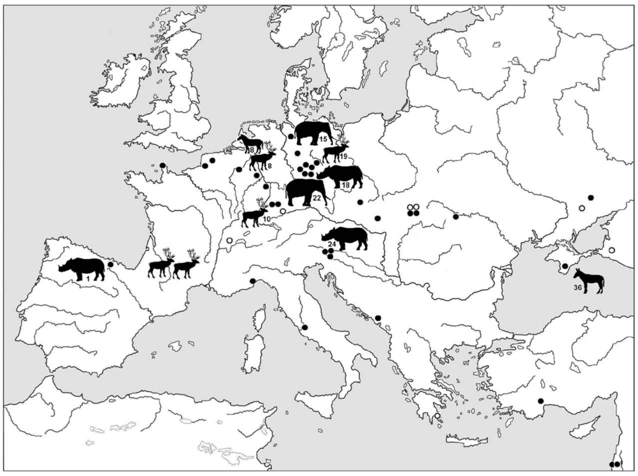

Figure 4. Principal hunting prey for selected last Interglacial sites in Europe (Richter 2005). Megafauna comes mostly from MIS 5e sites (for site numbers compare fig. 2).

(*Dicerorhinus kirchbergensis*) and aurochs (*Bos primigenius*) were exploited by humans, and abundant stone artefacts from discoid and Levallois concepts were found along with their bones (Mania 2000:27). Lehringen, Gröbern and Neumark-Nord have all a similar ecological setting in common, with butchery of Megafauna near small lakes.

Another important group of interglacial sites occurs near springs, and travertine deposits usually conserved the embedded archaeological remnants very well. Several sites in northern Germany (Veltheim-Steinmühle), central Germany (Taubach, Burgtonna), southwest Germany (Stuttgart), and Slovakia (Ganovce, Horka-Ondrej etc.) can be assigned to this group. All of these, together with the lake-side group, belong to the first half of the Eemian, except Ganovce, layer 3, a possibly later occurrence, which is famous due to a travertine cast of an early Neanderthal brain found in this layer. At Taubach, the age profile of forest rhino and bear connected with abundant cut-marks argue for hunting or trapping of these dangerous animals. The minimum count of individuals at Taubach was 76 rhinos and 52 bears (Wenzel 1998:231). Large numbers of rhinos have also been found in El Castillo Cave, layer 24 (steppe rhinos) and, along with aurochs and beaver, at Krapina Cave (Wenzel 1998:232). At Ganovce, forest elephant was again found along with forest rhino, but taphonomic analysis is yet lacking.

Late Eemian and early post-Eemian herd hunting

Less spectacular, but probably more important as a daily source of meat, were *cervidae*, such as red deer, and bovines such as aurochs. Red deer served as primary prey in Eemian southern France (Boyle 1998) and was possibly exploited at Rabutz (along with rhino and aurochs), and certainly at Stuttgart-Untertürkheim and Tönchesberg 2B (Wenzel 1998:232).

Tönchesberg 2B, on top of a middle Rhine volcano, belongs to a later phase with steppe elements, dating to the beginning of MIS 5d (Conard 1992), which explains the exploitation of two horses along with the mentioned three red deer. At the same time (MIS 5d), a minimum number of 59 Bison priscus were hunted at Wallertheim (Rheinhessen; Gaudzinski 1992), thus attesting specialised, mono-specific hunting which is so far absent from the MIS 5e sites, and obviously occurred only from MIS 5d onwards when the climate changed towards glacial conditions.

The comparably late occurrence, at the end of the Eemian, of mono-specific hunting, coincides well with the evidence from Kabazi II, where *Equus hydruntinus* was repeatedly and exclusively hunted, and some *cervidae*, bovids and rhinos were possibly scavenged (Richter 2005).

Fish, shells and vegetables

As a general opinion, the beginning of the present interglacial or Holocene, with its supposed decrease in ungulate biomass, led to "broad spectrum adaptation" of subsistence. Meat from hunted animals was now increasingly accomplished by other kinds of diet. Among recent hunter-gatherers, particularly in the Southern Hemisphere, plant diets supply often more than half of the daily caloric demand of humans. If vegetables play a major role in nutrition, humans must obtain additional protein from animals. Molluscs and shells, rich in proteins, can cover such nutritional gaps, given that mainly proteins are needed, because molluscs add very little to the caloric budget. Reciprocally, the exploitation of molluscs makes much sense if the remaining part of the diet relies on plants. Exclusive subsistence on molluscs is impossible for humans, except for short periods when other sources of nutrition are scarce.

For the last decade of research, such reasoning about a possible broad spectrum adaptation of Neanderthals seemed meaningless, because isotope analysis of Neanderthal bones had repeatedly showed them as pure carnivores, comparable to wolf and hyena (Bocherens & Billiou 1998:324). This holds not only for Neanderthals in cold and dry climates, as attested for the 40/45.000 years old Neanderthal remains from Marillac/Charente (France), but also for Neanderthals in moderate climates. Such evidence comes from an individual from Sclayn (Belgium), layer 4, which is attributed to MIS 5c, a moderate interstadial (Brörup) of the Early Weichselian about 100.000 years ago (Bocherens & Billiou 1998:316). Nevertheless, isotope data from MIS 5e/5d Eemian Neanderthals are still lacking, thus encouraging speculation about interglacial Neanderthal diet.

Possible evidence of plant diets (Wenzel 1998:230) are burnt nuts (*Corylus avellana*) from Rabutz, and from the second-last interglacial at Ehringsdorf, burnt fruits from the linden (*Tilia*) as well as Kornel cherry (*Cornus mas*).

Use of molluscs is highly probable at Eemian seashore sites such as Balzi Rossi and Elaea. The large site of Saint-Germain-des-Vaux is best explained as a campsite especially devoted to the exploitation of marine resources. It is, by the way, the only Eemian settlement site in central and western Europe which has yielded zones of activity such as hearths, pits, areas of lithic production etc. (Cliquet 1994; Monnier *et al*. 2002). Of course, some of the travertine (f.e. Taubach) lake-side sites (f.e. Lehringen) have delivered fish remnants, but there is no proof for human exploitation.

The *Erscheinungsbild* of Eemian landscapes

Compared to early Holocene subsistence patterns in Europe, the Eemian evidence is essentially different. "Broad spectrum" subsistence played only a minor role, and animal exploitation concentrated, during the earlier Eemian period, on a few species of Megafauna. At the beginning of the Holocene, elephants and rhinos were already extinct, medium-sized ungulates such as red deer or small mammals such as hare were hunted. Fishing and the collecting of vegetables played an important role. By contrast, Eemian Europeans were obviously an "affluent society" which survived comfortably on selected large animals. An exploitation of animals prevailed which was essentially prime-dominated (Gaudzinski 2002). Whereas rhino and elephant dominated the earlier Eemian period, medium-sized ungulates like red deer and horse seem to have gained more importance during the second part of the Eemian.

The supposed reduction of ungulate biomass under forest conditions had obviously no impact on human survival rates. Possibly, Eemian human population density was so low that it never reached critical hunter-prey-relations.

Eemian life concentrated around small lakes and springs (fig. 5) where people waited for incoming animals. Ambush hunting was probably common. Scavenging might have been easy, especially for rhino. More than one third of male Sumatra rhinos, close relatives of the Eemian rhinos, dies as a consequence of rivalry fights. As campsites have never been found, their archaeological visibility must be very low. In terms of artefact spectra, they were probably not very different from the abundant hunting and butchering sites of which we know so many. Moreover, raw material procurement, artefact classes and transformational processes indicate more circulating than radiating mobility patterns (Chabai, Richter & Uthmeier 2005). Quite possibly, campsites were small and not very distant from the lakes and springs which form the centres of Eemian land-use (fig. 6).

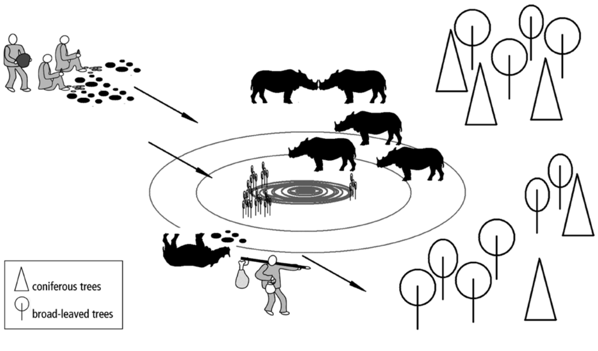

Figure 5. Model for MIS 5e scavenging (or ambush hunting) on megafauna near a small lake. The model illustrates the time window reflected by many MIS 5e archaeological sites.

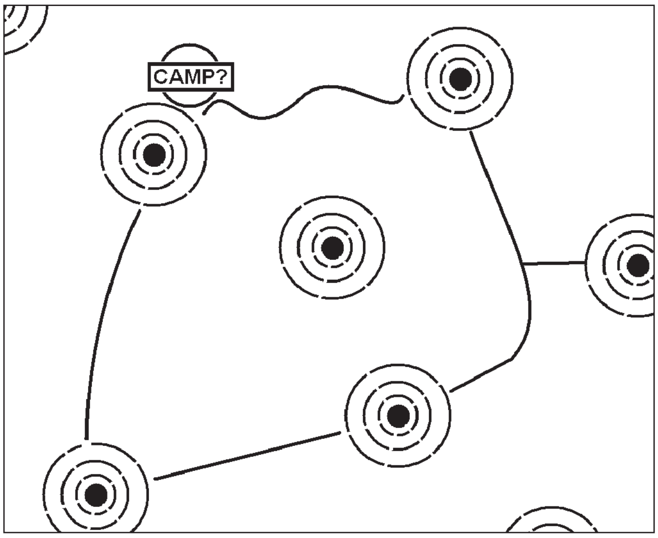

Figure 6. Model of Eemian perception of landscape. Land use was centered around waterplaces (black dots). Pathways served to traverse the space between waterplaces within circulating mobility patterns.

Lakes, springs and pathways between them must have been the constitutional elements of what appeared as the *Erscheinungsbild* of Eemian landscapes to prehistoric humans.

Europe during the Weichselian Interpleniglacial

Case studies of the late Middle Paleolithic cover such different landscapes as central Italy (Kuhn 1995), southern Germany (Uthmeier 2004), the Negev desert (Marks 1976) and the Crimean peninsula (Marks & Chabai 1998) and support models of differential territories, differential land-use, different types of camps, combined multi- and mono-species hunting, and combined universal and differential technological concepts, perhaps due to an increased population size. For Central Europe, the Sesselfelsgrotte Shelter near Kelheim in Bavaria has yielded a number of clues to Neanderthal land-use patterns (Richter 2000).

The Sesselfelsgrotte case

The Paleolithic cave site of Sesselfelsgrotte is situated in the valley of the lower Altmühl river (Bavaria), a tributary to the Danube (fig. 7). Only a few kilometres to the southeast of the site, the narrow Altmühl valley opens to the large valley of the Danube (fig. 8). The site is important because of its unique sequence of 22 Middle Paleolithic occupations and 6 Upper Paleolithic occupations (fig. 9). Field campaigns at the site were carried out from 1964 to 1977, and again in 1981, directed by G. Freund and collaborators (University of Erlangen; Freund 1998).

About 7 m of sedimentary deposit was excavated. The layers consisted mainly of limestone debris from the roof of the shelter and from the slope above the cave. Eight occupation units were uncovered from the lower part of the sequence (Weißmüller 1995). Analysis by W. Weißmüller suggests

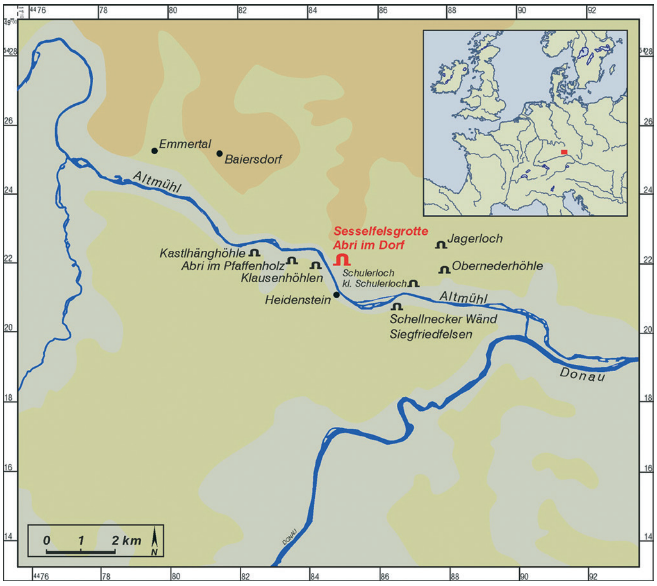

***Figure** 7*. Sesselfelsgrotte and other Palaeolithic and Mesolithic sites in the Altmuehl valley (Bavaria, South Germany). Emmertal and Baiersdorf are important raw material sources.

***Figure** 8*. View of Essing village at the foot of "Sesselfels" rock face. The Gravettian site "Abri im Dorf" is under the large shelter behind the church steeple. The Sesselfelsgrotte is the small shelter (partially hidden by trees) to the left of the large one (from Freeden & Schnurbein 2002:74).

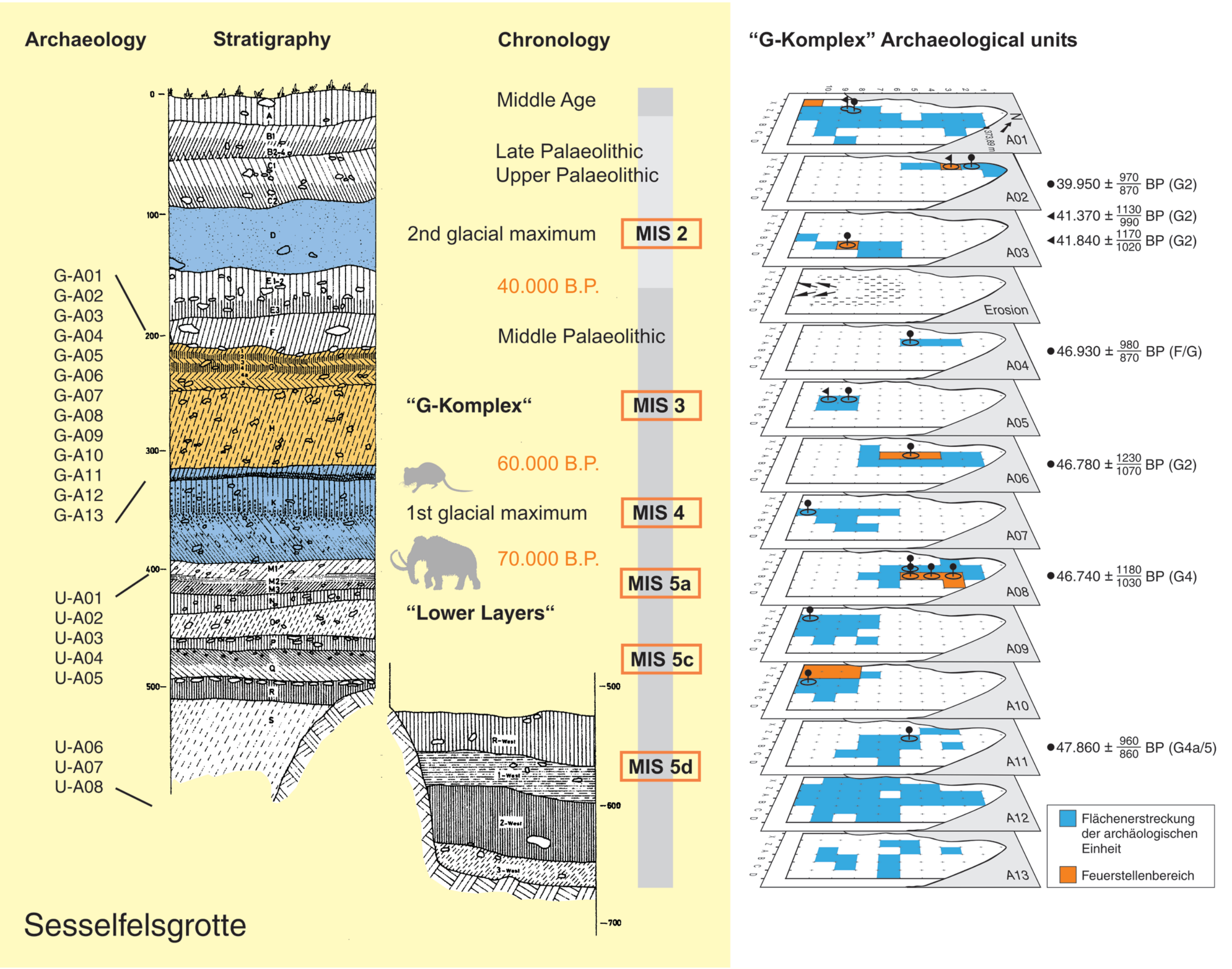

***Figure** 9*. Sesselfelsgrotte yielded 22 Middle Palaeolithic and 6 Upper/Late Palaeolithic occupations from the beginning of the last Glacial to its end. The late Middle Palaeolithic "G-Complex" (Micoquian or "Mousterian with Micoquian Option" M.M.O.) is dated to the first half of MIS 3. The "G-Complex" contains 13 assemblages with oscillating bifacial/non-bifacial tool ratios. Some of these would conventionally be classified as "Central European Micoquian", and some as "Mousterian". All are now interpreted as different parts of one and the same land use system under the "M.M.O." frame.

an early Weichselian date for these assemblages, which are typologically and technologically similar to contemporaneous western European Mousterian industries. These occupations took place under interstadial conditions (MIS 5c and 5a) with forest and open landscape. Hunting of horses was an important subsistence activity. Only in the uppermost part of the lower layers (layers 3-West to M1), and quite close to the interface to the first glacial maximum (oxygen-isotope stade 4) of the Weichselian glaciation, does glacial fauna such as Mammoth occur for the first time.

A series of layers follows upward, containing no archaeological material, but abundant rodent remains (layers L, K, I). They are dated to the first glacial maximum of the Weichselian glaciation (MIS 4). The rodent bones (remnants of owl pellets) suggest several subsequent stages of environmental change from a steppe landscape towards an arctic tundra landscape.

The overlying "G-Komplex" (layers H, G5, G4a, G3, G2, G1) yielded 13 Mousterian and Micoquian assemblages (Richter 1997). Some of them were recovered from virtual living floors (in particular the layers G4 and G2 with several fireplaces). 85.000 stone artefacts from the "G-Komplex" accompany abundant remains of prey, mainly from mammoth, reindeer and horse. Man was living in a steppe landscape with some arctic elements, increasing towards the top of the stratigraphic series. The "G-Komplex" is presumed to be part of an evolved stage within the Oerel-Glinde interstadial complex. Human presence is dated to between 55.000 and 45.000 cal. B.P.

Separated by an archaeological sterile layer (layer F), the "G-Komplex" is overlain by another late Middle Paleolithic horizon (layer E3). On top are loessy deposits of the second glacial maximum of the Weichselian and another two archaeological horizons with several late Upper Paleolithic and Late Paleolithic assemblages.

Differential land use among the "Micoquians"

Surprisingly, the "G-Komplex" assemblages display a particular pattern of raw material procurement that is repeated four times (fig. 10). Raw material procurement was obviously embedded in a differential mobility pattern. At the beginning of each of the four cycles, heterogeneous raw materials from a large number of sources dominate, and towards the end of each cycle, homogenous raw materials from only a few different sources dominate. Thus, initial inventories, within each cycle, reflect higher group mobility than consecutive inventories. Initial inventories indicate short-term occupations, consecutive inventories indicate long-term occupations. Comparison of diversity graph versus denticulate abundance within the "G-Komplex" confirms this hypothesis (fig. 11). N. Rolland argued that denticulates form the integral part of Mousterian inventories. Denticulates were basic tools for regular, daily use (Dibble & Rolland 1992:13). Their absolute number reflects, in a linear mode, increasing occupation time. This is highly probable for the "G-Komplex" inventories as well.

Among the assemblages with Levallois flake production, it turns out that small assemblages with few denticulates tend to have broad-spectrum raw material procurement, and large assemblages with many denticulates tend to have specialized raw material procurement (compare fig. 10 and 11).

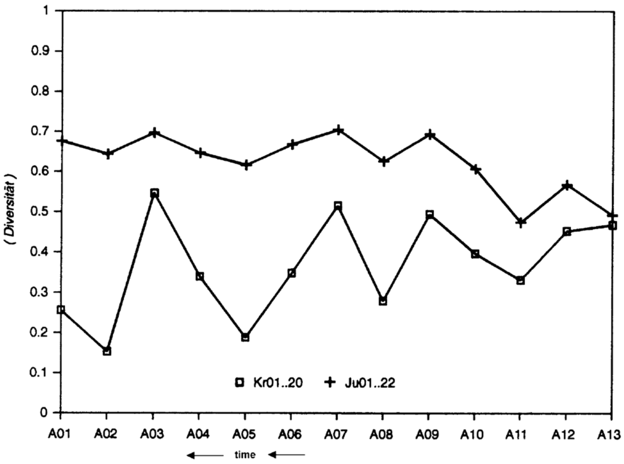

Figure 10. Oscillations in raw material diversity (maximum 1.0, vertical axis) observed among stone artefacts from the Sesselfelsgrotte G-Complex (see fig. 9 for archaeological units as indicated on the horizontal axis). Cretaceous (rectangles) and Jurassic (crosses) cherts display the same cyclic pattern which repeats four times. Raised raw material diversity is interpreted as a summer feature, decreased raw material diversity as an autumn/winter feature (longer stays in base camps and/or logistic expeditions allow for repeated exploitation of a smaller number of raw material sources; from Richter 2000:215).

Thus, initial mobility covered longer distances than consecutive mobility. As this can be observed four times in the "G-Komplex", a regular change of the underlying land use pattern may be concluded. A regular change between circulating land use at the beginning, and radiating land use at the end of an occupation cycle can explain the data. Therefore, the Sesselfelsgrotte data indicates changing land use within the same cultural system (fig. 12).

During the initial stage of land use (spring and summer), humans migrated between ephemeral campsites. At this stage, the Sesselfelsgrotte served as one such ephemeral campsite. Either small task groups collected raw material at a short distance from the ephemeral campsites, or raw material procurement was fully embedded in residential mobility and was conducted on the way between ephemeral camps. The initial stages might represent the summer season when big game like Reindeer and horse where dispersed over the mountainous region around the Altmühl river valley.

During the consecutive stage of land use (autumn), the Sesselfelsgrotte became a principal camp. The humans stayed here for longer periods. Task groups were sent out for hunting, collecting, and raw material procurement. Special task sites where established around the camp. A number of such sites are attested for the region (cf. Weißmüller 1995:54, fig. 15). The consecutive stage of land use occurred probably during autumn when large herds of game gathered to come down from the mountains. They passed the Altmühl river valley on their way to their winter habitat near the Danube River plain.

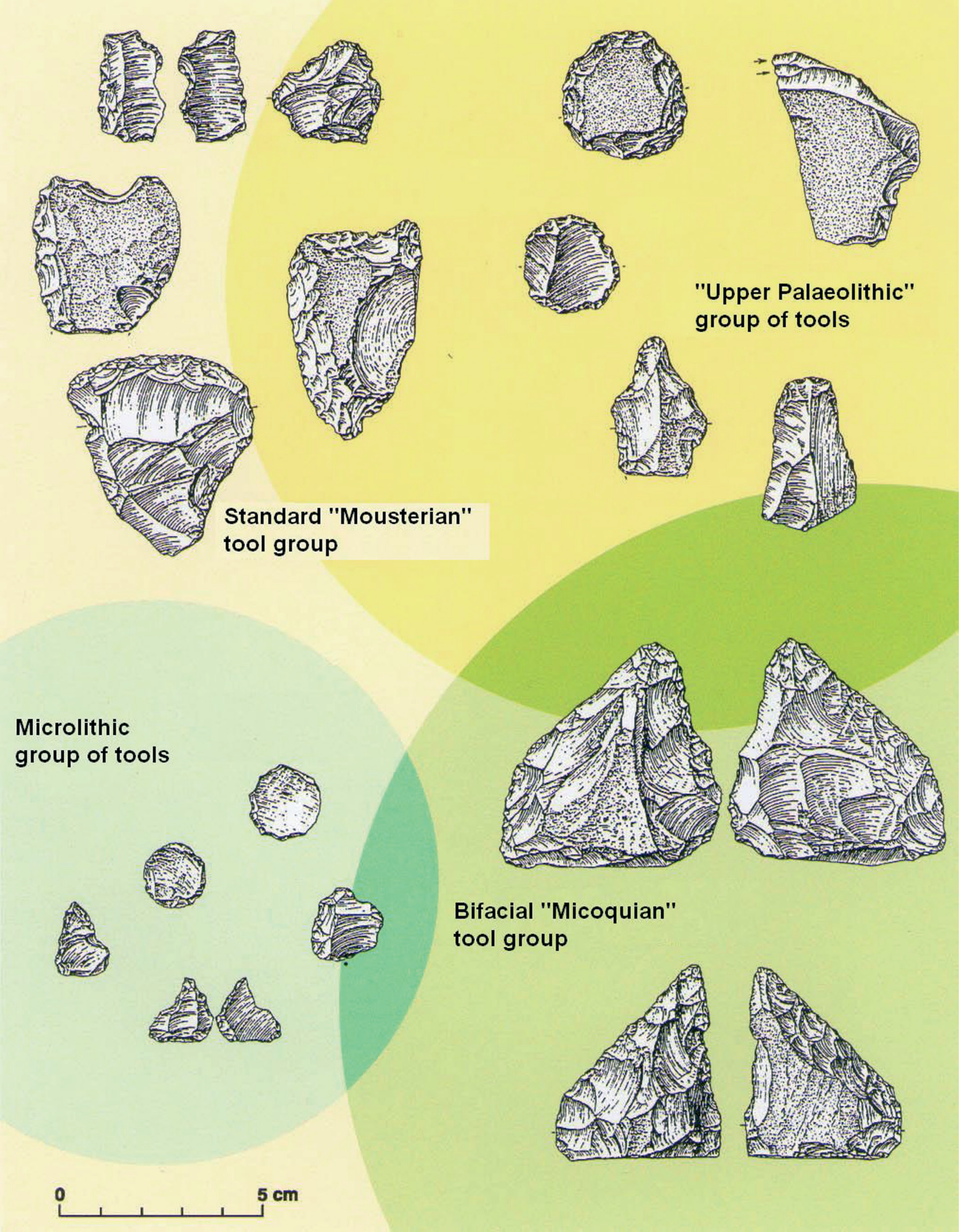

Figure 11. Four tool groups of the Central European Micoquian/M.M.O. The standard Mousterian tool group is a "fond commun" for all assemblages. During summer (residential, circulating mobility - short stays) the "fond commun" dominates small assemblages. During autumn/ winter (logistic, radiating mobility – long and short stays, functional sites) functional demands were more diverse, thus adding more of the other three tool groups to the assemblages. Within the M.M.O. cultural repertoire, summer assemblages look more "Mousterian", and autumn/winter assemblages look more "Micoquian".

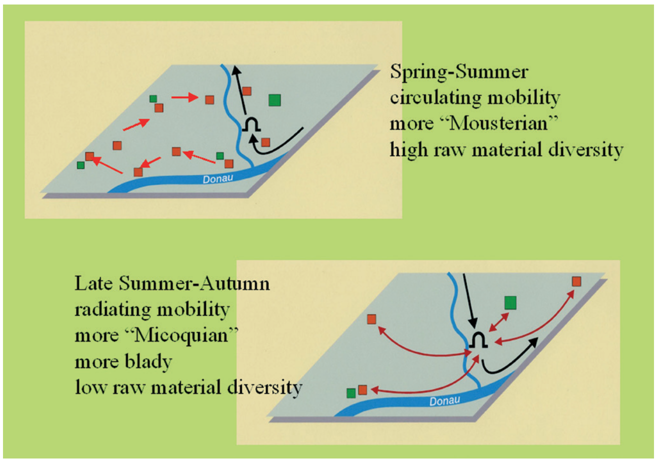

Figure 12. During summer, the Sesselfelsgrotte functioned as one of several short stay camps, while game was widely dispersed over the landscape. In winter, Sesselfelsgrotte functioned as a principal campsite close to migration routes between summer (limestone plateau to the north) and winter habitats (Danube valley to the south) of ungulate herds.

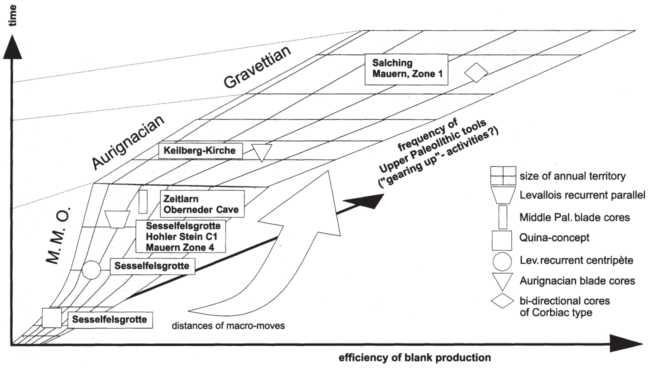

Figure 13. Model for the Middle to Upper Palaeolithic tansition in South Germany. Increasing macro-move distances within larger annual territories were crucial for the development of differential land use patterns, larger group sizes and longer periods of occupation. Technological changes were closely related to growing complexity of land-use systems (from Uthmeier 2000:147).

The differential land use system reconstructed for the "G-Komplex" humans obviously resembles upper Paleolithic land use systems. In his recent thesis, Th. Uthmeier compared Middle and Upper Paleolithic land use systems in Southern Germany (Uthmeier 2004a). He argues for continuous land use strategies between 50 and 30 ka characterised by increasing band territories (fig. 13). With Clive Gambles ideas in mind (Gamble 1993), a continuous process of "exaption" is realized here which began as early as in the time of the "Micoquians", and became fully evolved in the time of the "Gravettians" in Southern Germany.

From the mountains to the plains: Salzgitter-Lebenstedt

Most of the central European Micoquian sites might well be explained by the same seasonal land use patterns, which were found in the Altmühl region. In many cases, the geographical positions of the sites resemble the Sesselfelsgrotte case. As a common phenomenon, the larger Micoquian sites tend to concentrate near the interface between plains and mountains where game passed by during their seasonal migrations.

The Salzgitter-Lebenstedt open-air site is one of the northernmost Micoquian occurrences in Germany (fig. 14). It is situated 81,78 m above sea level at the southern fringe of the Northern European plain. To the south, the Harz mountain massif reaches heights of more than 1000 m a.s.l. To the southwest, there extend the *Mittelgebirge* landscapes of moderate height, less than 600 m a.s.l. The Lebenstedt site was uncovered from fluvial sediments of the lower terrace of the Fuhse River where the narrow river valley opens to a large floodplain. Alfred Tode carried out excavations in 1952, followed by Klaus Grote in 1977. The archaeological layers, only partially found in situ, have been dated to one of the early MIS 3 interstadials (Oerel or Glinde).

The site delivered not only thousands of stone artefacts, but also botanical and faunal remains and Neanderthal bones.

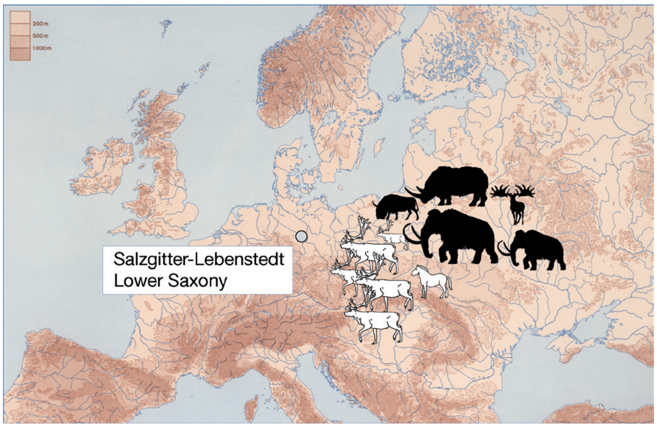

Figure 14. Salzgitter-Lebenstedt (Lower Saxony, Germany), a MIS 3 Micoqiuen/M.M.O. open air site situated a the southern fringe of the north European plain. The escarpment of the mountainous Mittelgebirge area is only few kilometres to the south of the site. The Salzgitter territory combined, like the Sesselfelsgrotte territory, lowlands and mountainous landscapes. At Salzgitter, hunting was specialised on Reindeer, while it is not attested for other large mammals (in black) found at the site.

Hunting was specialized on reindeer. Mammoth, woolly rhino, bison, horse, wolf, fishes, and birds were also present although they were not hunted (fig. 15).

The pollen record represents different vegetation zones such as:

- arctic to subarctic tundra and forest tundra of the surrounding plains, and
- subarctic boreal forest of the mountains to the south or southwest.

Abundant botanical macro-remains indicate tundra vegetation with conifers scattered around the site. The botanical remains compare well to those found in the stomach of the Taymir mammoth (Northern Siberia, early Alleröd; Pfaffenberg

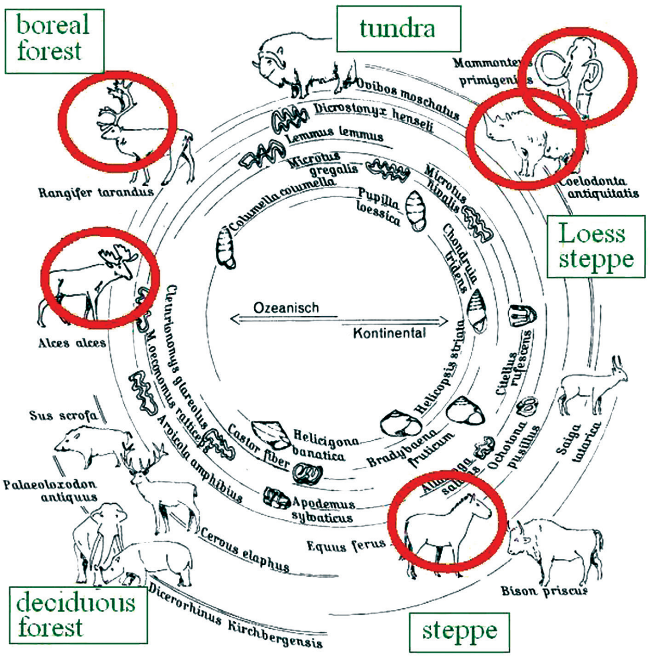

Figure 15. Salzgitter Lebenstedt was situated at the steppe/forest (mountains) and tundra (plain) interface. Mammals found at the site are indicated (red circles) on a scheme of related ecotopes (modified after Thenius 1962).

1991:209), thus underlining the extreme situation of the site at the northern fringes of the inhabited world (fig. 16).

Recent re-analysis of the faunal remains from Lebenstedt (Gaudzinski & Roebroeks 2000) has proved the exploitation of more than 80 reindeer during the autumn season. Most of the animals died during September. Whereas hunting was not selective, sub-adult and juvenile animals were afterwards selected for marrow extraction. Many of the hunted animals were not fully exploited. Exploitation tended to be prime-dominated and compares well to Upper Paleolithic examples such as Stellmoor A (Gaudzinski & Roebroeks 2000:268).

Local raw material occurrences of Baltic flint were also intensively exploited at the site. All stages of "chaines opératoires" of Levallois flake production are present, as well as abundant bifacial production of the Micoquian mode (fig. 17). Imported artefacts could not be identified and it was concluded that most of the lithic inventory was produced on the site (Pastoors 2001:245-247), thus indicating an extended length of occupation.

Salzgitter-Lebenstedt was an autumn hunting camp, which was designed to exploit large herds of reindeer during their seasonal migrations from the boreal forests of the mountainous belt southwest of Lebenstedt to the steppe-tundra of the northern plains. According to the Sesselfelsgrotte model, it can be interpreted as belonging to the consecutive stage of seasonal land-use. This would imply larger groups of humans and an extended length of occupation. Like reindeer, their principal prey, people spent the consecutive stage of land-use in the north European plain. The Micoquian site of Lichtenberg, about 90 km north of Lebenstedt and roughly contemporaneous, might belong to the same territory (Veil *et al*. 1994).

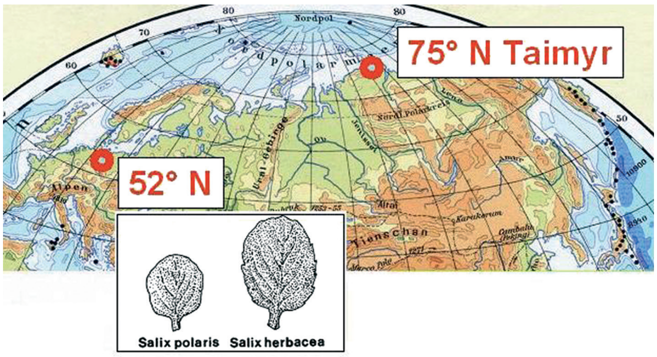

Figure 16. Botanical macro-remains found in the Salzgitter peat compare well to those found in the stomach of the Alleröd Taimyr mammouth. Salzgitter (probably together with the Lichtenberg Micoquian/M.M.O. site) attests to the presence of Neanderthals in extreme arctic environment, comparable to the present 75° north latitude (drawings from Pfaffenberg 1991).

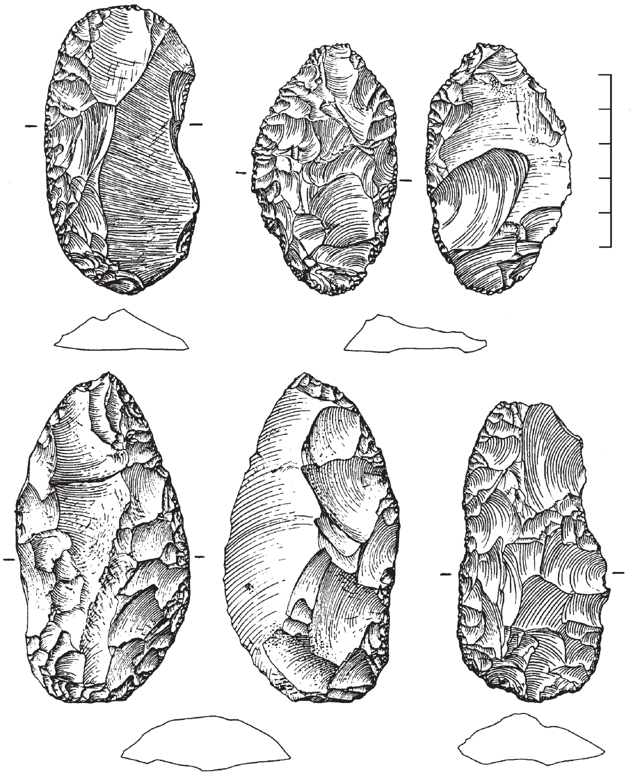

Figure 17. Bifacial scrapers from Salzgitter-Lebenstedt (after Tode 1991).

Corresponding spring and summer camps (initial stage of seasonal land-use) were probably situated in the *Mittelgebirge* Mountains to the southwest of the site. This would imply a north to south extension of the annual territory of 150 km over two essentially different kinds of landscapes.

Close to the sky: Neanderthals in the Alps

It has been known for a long time that Neanderthals visited the Alps. In the Salzofen Cave (Totes Gebirge/Austria), they reached 2005 m a.s.l. (fig. 18). Many middle Paleolithic sites are now known from the high mountain areas of the

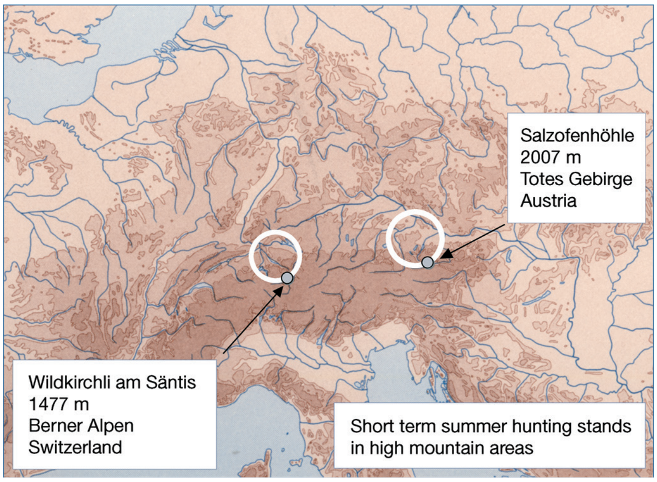

Figure 18. Late Middle Palaeolithic summer huntings stands in the Northern Alps. White circles indicate possible annual territories of 100 km.

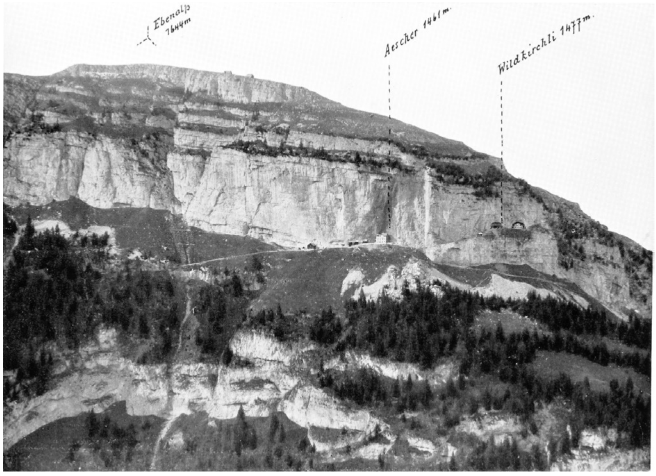

Figure 19. Ebenalp with Wildkirchli (St.Gallen, Switzerland; from Bächler 1940:177).

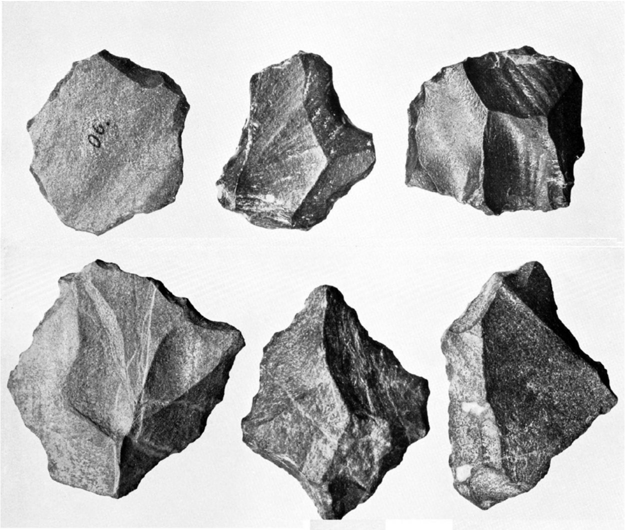

Figure 20. Wildkirchli. Denticulated and notched stone tools made of "Ölquarzit" from the Schwende valley (assembled from Bächler 1940:149).

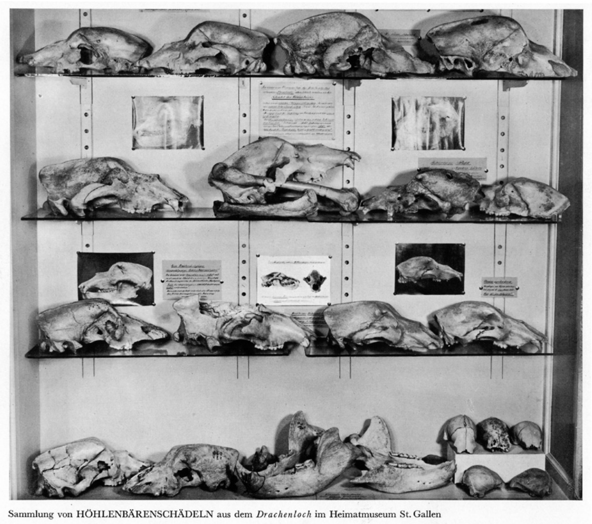

Figure 21. Collection of cave bear remnants from the nearby Drachenloch ("Dragon´s hole") cave site on exhibit at the St. Gallen local museum during the 1930s. Baechler authored the hypothesis of a Middle Palaeolithic "Höhlenbärenkult" (cave bear worship). Abundant cave bear remains from Wildkirchli, Drachenloch and Wildenmannlisloch are nowadays explained as natural, long term accumulations without any anthropogenic traces (from Bächler 1940:124).

Alps (Jequier 1975; Tillet 2001; Le Tensorer 1998), most of them dated to MIS 3. It is clear that these sites can only be interpreted as summer occupations, as access during winter is impossible.

When I recently tried to visit Wildkirchli Cave (Ebenalp, St. Gallen/Switzerland) at 1477 m, under interglacial conditions during May 2005 (fig. 19), access to the cave was impossible due to a snow cover in excess of 1 m. Wildkirchli shelter was excavated by Emil Bächler from 1904 to 1908 and yielded a series of stone artefacts of the middle Paleolithic discoid concept of flake production. The raw material of the artefacts ("Ölquarzit") came from the Schwende river gravel 600 m below the cave. Whereas Bächler was correct in recognizing the stone artefacts as evidence Neanderthal activities (fig. 20), he failed in his interpretation of abundant faunal remains from cave bear as the remnants of their hunting prey or even as artefacts.

Bächler was even convinced that two neighboring caves, Drachenloch (fig. 21) and Wildenmannlisloch, which had delivered abundant cave bear remains, were holy places of the so-called "Höhlenbärenkult" (cave bear worship). For several decades of the last century, the three sites served to define a "Wildkirchlikultur", a "protolithische Knochenkultur" (protolithic bone culture), and a "Höhlenbärenjägerkultur". After a re-analysis by J.-M. Jequier and others it became clear that the cave bears were neither hunted nor worshiped, and that their skeletal remains were naturally altered and not modified by humans. Carnivores played an important role in the transformation processes of the faunal remains. Cave lion, cave panther, alpine wolf (*Cuon alpinus*), and wolf are among the faunal remains from Wildkirchli (Bächler 1940:211).

At Wildkirchli, Ibex, Cervus elaphus and Rupicapra rupicapra, which are all present among the faunal remains, are the most probable candidates for hunting. Wildkirchli was obviously the southernmost place within a large area of Neanderthal land use. Jequier detected imported raw materials from 120 km away (Jequier 1975). The Wildkirchli lithic assemblage contains many scrapers and denticulate pieces which compares well to the summer inventories of the contemporaneous Sesselfelsgrotte land use system.

The *Erscheinungsbild* of Weichselian landscapes among late Neanderthals

MIS 3 Neanderthal land use concepts rely on the dichotomy between mountainous areas (summer) and plains (autumn/winter) as migrating animals were preferably exploited at pass situations (fig. 22). Adaptation to different seasonal habitats caused different mobility patterns, raw material procurement and toolkits for summer and autumn/winter situations (fig. 23) which were previously mistaken as distinct cultural units ("Micoquian" and "Mousterian") by archaeologists. It appears that the Sesselfelsgrotte model of land use can easily integrate and explain MIS 3-Mousterian assemblages such as Wildkirchli, as well as MIS 3-Micoquian assemblages such as Salzgitter-Lebenstedt. The MIS 3 evidence underlines that hunter-gatherer systems of adaptation must be understood in terms of five different scales, expressed as levels A, B, C, D and E (fig. 24).

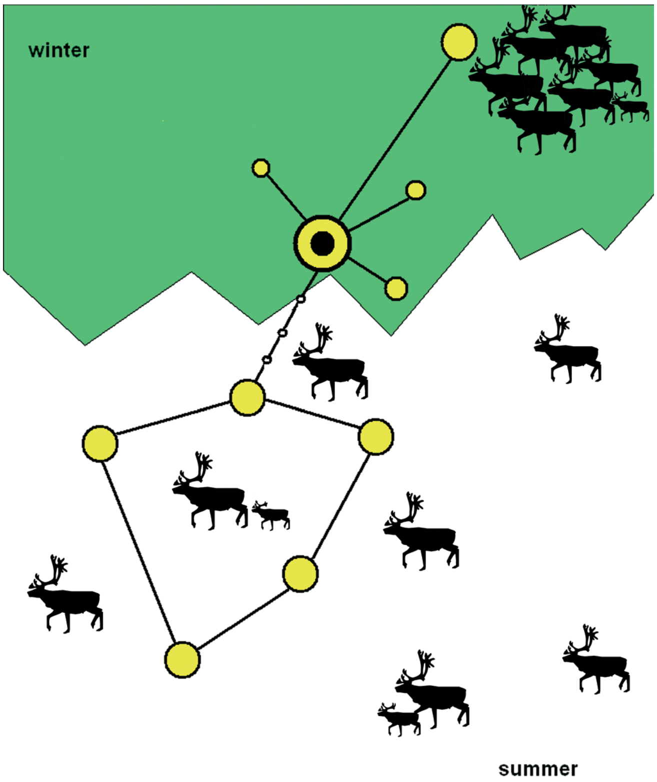

Figure 22. Model of MIS 3 Micoquian (M.M.O.) perception of landscape. Annual territories are situated at interfaces between mountainous summer game areas and autumn/winter lowland areas where migrating animals change between their seasonal habitats.

The hierarchy of levels defines a layout for Neanderthal perception of environment and landscapes. Among hunter-gatherers, consciousness of about Level A, as a whole, has usually been founded on mythology. This must also apply to Neanderthals, though humans must have realized the extreme position of sites like Salgitter at the northern edge of the oikumene. Level B was also experienced rather locally and close to the edges (for example at the regional interface between Micoquian/M.M.O. and MtA) than as a whole (compare fig. 25). Overall recognition of landscape began at Level C, the spatial maximum of annual mobility of one group. Particular land use strategies and mobility patterns

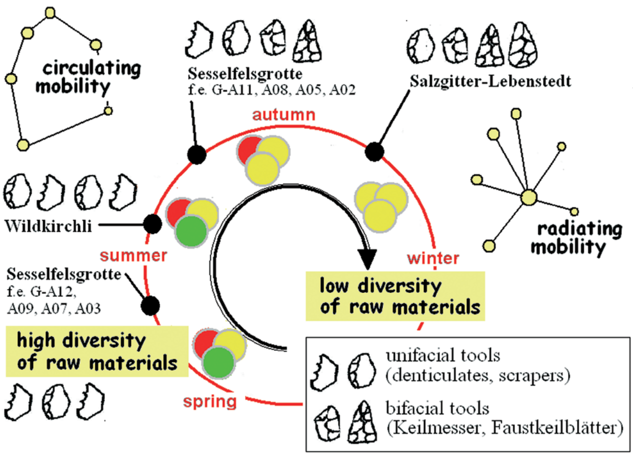

Figure 23. Model of MIS 3 Micoqian (M.M.O.) annual land use cycles. Different assemblage types are explained as functions of different stages within the annual cycles. Circulating (summer) and radiating (autumn/winter) mobility modes are indicated by raw material spectra.

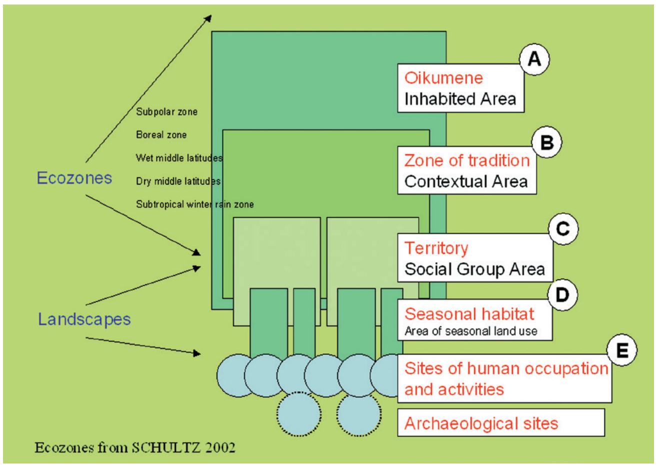

Figure 24. Model of five different scales of hunter-gatherer perception of the earth´s surface. More or less hazardeous segments of level E constitute the principle windows of access for the archaeologist. Archaeologists need level B to evaluate the functional place of a given site within a particular land-use system, and level C to recognize the complete cultural repertoire of a social group (modified after Richter in Zimmermann *et al*. 2005).

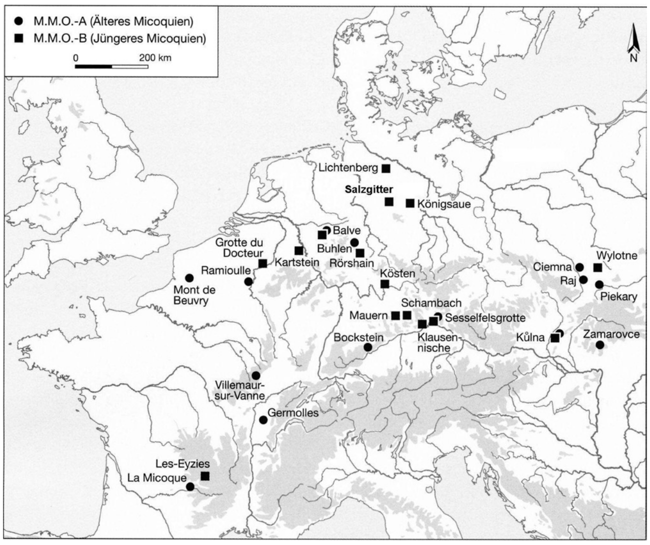

Figure 25. M.M.O. principal sites. Archaeological sites of the Central European Micoquian define a contextual area from southern Poland to Burgundy, with outliers in Southwestern Fance. An earlier stage (M.M.O.-A) combines non-Levallois with plan-covex bifacial technology, and a later stage (M.M.O.-B) Levallois (recurrent) with plan-convex bifacial technology.

Figure 26. Europe between 60.000 and 40.000 B.P. Red circles indicate annual territories (from west to east: Wildkirchli, Salzgitter, Sesselfelsgrotte, Pradnik region and Crimean sites) with diameters from 80 (atlantic climate) to 200 km (continental climate) diameter. Territory diameters are estimated from maximum distances of raw material importation. White outlines display contextual areas as indicated by different technological modes.

apply to level D. Occasionally, if human habitat remained the same all the year, Level C and D were also the same. Functional demands (camping, production and maintenance activities, raw material procurement, hunting, butchering, storage, funeral, worship) evoked topographic selection, spatial organization and equipment of single sites at level E. For archaeological reconstruction of hunter-gatherer cultures, level C delivers the key data sets. The proper knowledge is needed of the whole cultural repertoire dipersed over the surface of an annual mobility cycle in order to evaluate assemblages from single palaeolithic sites.

The size of annual territories can be assumed if maximum distances of raw material importation are compared. For the MtA, a maximum distance of 80 km is repeatedly attested and for the Micoquian/M.M.O. distances between 80 km in the West and 200 km in eastern central Europe have been observed. (Feblot-Augustins 1997; Floss 1994). If these distances are taken as diameters of circles representing the size of an annual territory, we can compare these to the sizes of level B contextual areas (fig. 26). This allows for a rough estimation of some demographic variables (tabl. 1). The estimations depend on the preposition that each contextual area was filled with adjoining circular territories which is certainly highly hypothetical. On one hand, territories might have interlaced, on the other hand, not all-possible territories might have been occupied. Based on site distributions the contextual area of the central European Micoquien/M.M.O. comprised **391.000 km²** (fig. 25) and that of the MtA about **150.000 km²** (see Soressi 2002:7; the minimum area is 84.000 km²: see Mellars 1996:261).

It occurs that territory diameters of 200 km would fail to support a population density required for long-term survival of a population. Consequently, the given distances of importation slightly exaggerate possible territory sizes, and thus should be regarded as over-average rather than as average values. More realistic estimations (tabl. 1, in yellow) derive from diameters between 80-100 km (for both MtA and M.M.O.) and may indicate that Middle Paleolithic contextual areas comprised as few as only 20-80 territories with a total population of less than 2000 persons each. The population density was certainly less than 0,02 persons per km², most probably around 0,005 persons per km².

Consequently, the land surface which was personally known by single humans did not exceed 8000 km². Compared to

Minimum territory diameter (km)	MTA or M.M.O. size of territory (km²)	MTA social groups (bands*) (n)	MTA population (n)	M.M.O. social groups (bands*) (n)	M.M.O. population (n)	MTA or M.M.O. population density (n/km²)
40	1256	119,4	2985,6	311,3	7782,6	0,0199
80	5024	29,8	746,4	77,8	1945,6	0,00498
100	7850	19,1	477,7	49,8	1245,2	0,00318
200	31400	4,7	119,4	12,4	311,3	0,0008

Table 1. Demographic estimations for MIS 3 Nanderthal land use. (*****) 25 persons per band, one band per territory

Eemian perception of landscape which was concentric and centripetal (focused on water-places) but infinite in terms of its monotonous, repeated character of site functions and assemblages, MIS 3 land-use was tied to interfaces between complementary landscapes and restricted by the capacity to maintain knowledge about particular environmental features in order to support a wide spectrum of appropriate adaptation strategies. Neanderthal MIS 3 perception of landscape had the shape of a linear structure bridging dichotomous (seasonal differentiation) parts of annual land-use cycles.

Concluding remarks: Evolution or Continuity?

Several authors have noted that land use patterns essentially differed between earlier and later middle Paleolithic humans, and the question arises weather Neanderthal perceptions of landscape should be better understood in terms of evolution than in terms of continuity (tabl. 2).

For the earlier part of the middle Paleolithic, it was suggested that humans were extremely mobile and land use was rather organized in terms of pathways than in terms of territories (Kolen 1993). In my own opinion, explanation of the mentioned differences may base on two theoretical alternatives: an evolutionary one and a functional one.

Evolutionary explanation

Mental capacity and social behavior were less complex during MIS 10 to 5e than during MIS 5d to 3. Innovations were rare and did not survive due to low population density. During the late middle Paleolithic, the situation changes dramatically. Populations increased, regional traditions (Micoquian, MtA etc.), central places, dwelling structures and burials occurred. The overall increase of complexity indicates evolutionary progress from early to classic Neanderthals (Gamble 1993). Clive Gamble underlined this progress by his ranking of early humans as "Ancients" (*Homo erectus* to early Neanderthal), "Pioneers" (Archaic *Homo sapiens* and late Neanderthals) and "Moderns" (*Homo sapiens sapiens*).

Functional explanation

Eemian land use patterns resemble very much those of the earlier middle Paleolithic connected with early Neanderthals. Anthropologically, Eemian Neanderthals, however, are grouped together with their Weichselian successors and thus are accepted as standard Neanderthals. On the other hand, most of our earlier middle Paleolithic datasets comes from interglacial environments. Biache, Maastricht-Belvedere, and much of the Rheindahlen sequence are connected with open forests and non-migratory game. The differences between early and late Neanderthal behavior might well mirror the different conditions of interglacial versus interstadial landscapes. The large number of moderate phases within a glacial stage is obviously unique to the Wuermian glaciation. The earlier glaciations, MIS 6 and MIS 8 were not interrupted by interstadials, as far as we are presently aware.

Whereas the evolutionary explanation principally identifies behavioral variability on a time scale, the functional explanation would presuppose that such variability can occur as a consequence of differential adaptation systems or even of cultural choice at a given time. For the moment, this perspective seems more promising, as the comparison of the Eemian and Weichselian evidence from Central Europe show:

- Eemian land-use is homogenous, no seasonal differentiation is visible as yet;
- Early and middle Eemian artefact inventories are monotonous;
- Eemian variability increases when open landscapes extend;
- Weichselian (MIS 3) territories included different elevations and landscapes;
- Weichselian seasonal habitats were preferably at geographical interfaces;
- Weichselian land use patterns changed according to seasons;
- Weichselian land use comprised different types of sites, camps and assemblages.

Neanderthal land-use patterns have yielded a principal explanation for the variability of middle Paleolithic artefact inventories, which, as it turns out, were strongly dependent on seasonal and functional parameters.

Early Middle Paleolithic Late Heidelbergensis / Early Neanderthal	Late Midddle Palaeolithic Standard Neanderthal
- small, short-term camps	- different types of camps
- circulating land-use patterns	- differential land-use
- large territories	- differential territories
- multi-species hunting	- multi- and mono-species hunting
- universal technological concepts	- universal and differential concepts
- very low population density	- increased population?

Table 2.

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COMPORTEMENTS DE SUBSISTANCE DES NÉANDERTALIENS D'EUROPE

Marylène PATOU-MATHIS
CNRS, Département Préhistoire du MNHN, USM 103, I.P.H., rue René Panhard 1, F-75013 Paris. patmath@mnhn.fr

Résumé: Dès la phase ancienne du Paléolithique moyen, les Néanderthaliens d'Europe possèdent des techniques d'acquisition de viande diversifiées (chasse et charognage). Ils ont pratiqué différents modes cynégétiques avec cependant une capture préférentielle de deux ou trois espèces (chasse orientée) ou d'une seule (chasse spécialisée). L'abattage des animaux a été souvent sélectif, avec des choix effectués en fonction de l'âge, du sexe, de la taille et de l'éthologie des proies. Les traditions culturelles ont également guidé leur choix. En effet, les espèces rares dans l'environnement ou peu "rentables" ou encore difficiles à capturer ont parfois été préférées. L'animal est considéré par les Néanderthaliens comme un ensemble de ressources alimentaires et non alimentaires. Il est dépouillé, dépecé, désarticulé et décharné selon des chaînes opératoires identiques à celles qui seront élaborées au Paléolithique supérieur. La pratique de chasses saisonnières avec occupations récurrentes de certains sites souligne la grande mobilité des Néanderthaliens au sein d'un vaste territoire de subsistance. Mettre en œuvre des stratégies, planifier et gérer l'alimentation quotidienne, nécessite une pensée complexe, avec des capacités cognitives individuelles, que possédaient les Néanderthaliens, et une organisation sociale qu'ils ont su développer au fil du temps.

La majorité des exemples qui illustrent notre article sont tirés de l'analyse archéozoologique de sites d'Europe occidentale septentrionale, d'Europe centrale et d'Europe orientale, datés de la fin du pléistocène moyen et du début du Pléistocène supérieur (contemporains des stades isotopiques 7 à 3). En introduction, nous replacerons brièvement les différents contextes environnementaux et climatiques.

Les Néanderthaliens ont, au fil du temps, colonisé toutes les régions de l'Europe. À la fin de l'avant-dernière glaciation, il n'était présent qu'en Europe Centrale et surtout Occidentale. Puis, lors du réchauffement climatique du dernier interglaciaire, des groupes vont, en empruntant les vallées, migrer vers l'Est[1] et le Proche-Orient. En effet, globalement, de la phase ancienne à l'Interpléniglaciaire on remarque une augmentation du nombre de gisements. La plupart du temps, les Néanderthaliens ont installé leur campement sur les plateaux et leurs versants. De ces postes d'observation, ils pouvaient aisément voir le déplacement du gibier[2]. Ils ont également occupé les plaines et, beaucoup plus rarement, les hauts-reliefs. Ils ont tout particulièrement fréquenté les régions aux biotopes variés. Lors des phases de fort refroidissement, les Néanderthaliens se sont éloignés du front glaciaire en descendant vers le Sud ou en se réfugiant dans des zones au micro-climat plus favorable[3]. Ils ont déserté les grandes plaines, polonaise ou ukrainienne, préférant s'installer dans les vallées aux bords des grands fleuves[4]. Durant les périodes froides de la dernière glaciation, les Néanderthaliens ont vécu principalement dans des grottes[5] (souvent à l'entrée) ou des abris-sous-roche, mais également, surtout en Europe Centrale et Orientale, en plein air. La nature des sites occupés a varié en fonction du temps. Après le stade 5e, on constate une augmentation des occupations en grotte, il y a par rapport aux périodes précédentes une inversion. Les gisements en abris sont un peu plus nombreux au début Glaciaire et à l'Interpléniglaciaire. Il existe donc, peut-être, à partir du Dernier Glaciaire, une recherche d'habitats abrités, donc un choix du lieu d'implantation en fonction de ce critère. Pour

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[1] Durant le Dernier Interglaciaire (contemporain du stade isotopique 5e), les sites sont plus fréquents en Europe centrale qu'en Europe occidentale septentrionale et Orientale. Cette phase n'est pas connue en Crimée. De même, durant le début glaciaire (période contemporaine des stades isotopique 5d à 5a) les sites d'Europe Orientale demeurent relativement rares. Ce n'est qu'à partir du Premier Pléniglaciaire que cette région devient riche en gisements, on constate alors une inversion de fréquence d'occupation.

[2] Par exemple, en France, comme à Biache-Saint-Vaast (Pas-de-Calais), au Mont-Dol (Ille-et-Vilaine) à Beauvais-La Justice (Oise), à Mutzig et à Acheinheim (Bas-Rhin), dans la région de l'Eiffel en Allemagne, en Pologne, comme à Zwolen, dans les Monts du Bükk en Hongrie, dans les Carpates, sur les Monts de Crimée ou dans le Caucase (Patou-Mathis 2000).

[3] Pour une durée relativement longue, dans vallées de la Meuse, du Rhin et de leurs affluents, de la partie moyenne de la Saale, de l'Elbe en Bohême, de la Svitava en Moravie, de la Vah en Slovaquie, ou plus occasionnellement, comme dans les vallées du Haut Danube en Allemagne et du Danube.

[4] La Vistule en Pologne, le Dniestr, le Prut, le Dniepr, la Desna et le Donetz en Ukraine.

[5] Il est probable que les campements en plein air, plus difficiles à repérer et plus sensibles à la destruction, étaient plus abondants que ce que laissent supposer les découvertes archéologiques.

leur installation, ils choisissaient de préférence les bords de rivières (souvent à proximité d'un gué), les talwegs abrités des vents ou les pieds de falaises en surplomb. Ils ont donc dressé ses campements sur des terrains de natures différentes. Par exemple, durant le dernier Interglaciaire, les Neanderthaliens, en Allemagne, en Tchéquie et en Slovaquie, ont vécu à proximité de sources thermales. À d'autres périodes, dans la moyenne vallée du Rhin, ils s'étaient installés près des volcans de l'Eiffel.

Quelles que soient la période et la région, les Neanderthaliens se sont installés près des ressources indispensables à leur vie quotidienne. La proximité de l'eau et du gibier semble avoir été, à quelques exceptions près, les facteurs déterminants. Selon la disponibilité de ces ressources, ils dressaient des campements de plus ou moins longue durée: des camps de base saisonniers[6], des camps temporaires[7] ou des haltes de chasse[8]. Ils ont également exploité, lors de cours séjours, des gîtes lithiques[9] et des lieux où abondait le gibier, ces gisements sont communément appelés sites d'abattage (ou de "charognage") et de boucherie[10]. Cette diversité de types de campements[11], liée aux différentes activités pratiquées, atteste que les Neanderthaliens avaient une parfaite connaissance des ressources disponibles dans leur environnement et qu'ils savaient les gérer en fonction de leurs besoins, notamment en ayant une grande mobilité. Ils ont, en effet, plus souvent installé des camps saisonniers ou temporaires que des camps de base de longue durée. Grâce à leur grande faculté d'adaptation et à l'augmentation de leurs connaissances, qui leur ont permis d'accroître leurs savoir-faire techniques, les Néanderthaliens ont donc su, au cours du temps, acquérir une plus grande indépendance vis-à-vis de leur environnement[12].

Pour se procurer les ressources nécessaires à leur vie, les Néanderthaliens, comme tous les chasseurs-cueilleurs nomades, se déplaçaient au sein d'un territoire qui leur était propre. Ils y installaient leur habitat principal et/ou leurs campements temporaires. Or, dans les sociétés traditionnelles, ce sont les chasseurs qui délimitent le territoire.

Les comportements de subsistance

Chez les peuples chasseurs-cueilleurs, comme les Néanderthaliens, la recherche de la nourriture était l'activité sociale la plus importante. N'exploitant que des aliments sauvages, ils dépendaient des ressources du milieu; cette contrainte majeure a marqué profondément leurs comportements alimentaires. Cependant, pour un groupe humain, aux facteurs liés à l'environnement physique et biologique, il faut inclure les aspects de la culture qui ont pu influer sur ses choix.

Les Néanderthaliens étaient omnivores. Ce type d'économie dit mixte, c'est-à-dire, basée sur la consommation de produits d'origine à la fois végétale et animale, élargit le champ des ressources (entraînant ainsi une plus grande sécurité alimentaire) et diminue le temps consacré à la recherche de nourriture, laissant de ce fait du temps pour d'autres activités. Les Néanderthaliens ont pratiqué la cueillette, la collecte (y compris le "charognage"), la pêche et la chasse[13]. Comme tous les primates supérieurs, ils ont élaboré des "cartes mentales" de leur environnement et su ainsi localiser leur nourriture potentielle, végétale et animale.

Parmi les ressources disponibles, les poissons fournissent de la viande. Cependant, d'après les données archéologiques, contrairement à la chasse, la pratique de la pêche par les Néanderthaliens apparaît relativement occasionnelle[14]. Ils étaient surtout de gros mangeur de viande de mammifères. C'est ce que prouvent les résultats des analyses biochimiques de ses ossements, notamment celles fondées sur l'étude du marquage isotopique naturel (13C/12C et 15N/14N) du collagène osseux et dentaire de l'individu, qui reflète celui du composant protéique de sa nourriture. Ces études biogéochimiques ont mis en évidence qu'il avait, durant les périodes froides mais aussi tempérées[15], un régime alimentaire plus carnivore qu'omnivore (proche de celui du loup)[16].

Ses modalités d'acquisition de produits carnés ont varié en fonction de facteurs environnementaux (topographie, climat, biotope) et culturels (traditions et structure sociale du groupe). Pour se procurer de la viande, les Néanderthaliens

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[6] Comme à Biache-Saint-Vaast, à Mesvin en Belgique, à Salzgitter-Lebenstedt et Ehringsdorf en Allemagne, à Cracovie-Zwierzyniec et Dziezyslaw en Pologne, à Kulna, Beçov, et Sipka en République Tchèque, à Subalyuk en Hongrie, à Betalov Spodmol en Slovénie, à Ripiceni-Izvor en Roumanie, à Molodova, Ketrosy et Kiik Koba en Ukraine (Patou-Mathis 2000).

[7] Comme à Mutzig, à Ariendorf, Wannen, Schweinskopf et Tönchesberg en Allemagne, à Ciemna en Pologne et à Tata en Hongrie (Patou-Mathis 2000).

[8] Comme à Beauvais-La Justice, à Baume des Peyrards (Vaucluse), à Sclayn en Belgique, à Plaidter Hummerich et Wallertheim en Allemagne et dans les sites caucasiens à culture dite de Koudaro (Patou-Mathis 2000).

[9] Comme à Hermies en France, à Königsaue et Rheindahlen en Allemagne, à Boritov en Tchéquie, dans les sites à industries bohunicienne et szélétienne de Moravie et à Kichlianski Yar en Ukraine (Patou-Mathis 2000).

[10] Comme en France à Arques, où dans le niveau supérieur, associé à d'autres restes fauniques, un squelette complet de mammouth a été découvert, et au Mont-Dol, en Pologne à Zwolen et à Skaratki, en Allemagne à Lehringen et à Gröbern et en Crimée à Kabazi II (Patou-Mathis 2000).

[11] Pour certains sites préhistoriques, notamment en grotte, il existe une difficulté majeure pour caractériser un campement, c'est la présence de palimpsestes (superposition de sols d'occupations indifférenciables). Il alors difficile de savoir si les occupations ont été uniques ou non, récurrentes ou non, de courte ou longue durée.

[12] L'abondance, dans toute l'Europe, du nombre de sites datés du premier grand refroidissement de la dernière glaciation en témoigne.

[13] Comme la plupart des peuples chasseurs-cueilleurs, pour compléter son menu, Neanderthal a probablement mangé des insectes. Parfois, lorsque l'occasion se présentait, il a peut-être ramassé des produits, riches en protéines ou autres nutriments vitaux, comme les œufs ou les coquillages marins accessibles à marée basse.

[14] Il y a 45.000 ans, à Banyoles, en Espagne, Neanderthal a consommé des poissons séchés avec la peau, durant une grande partie de sa vie qu'il a passée au bord d'un lac. Les micro-usures dentaires sont indentiques à celles qui ont été observées sur le fossile du lac Mungo en Australie (*Homo sapiens* daté de 30.000 ans) et sur celle des indiens sub-actuels de la côte pacifique au Nord-Ouest des USA, qui sont des pêcheurs de saumons (Puech 1993).

[15] Durant les phases froides, le couvert végétal se raréfiant, la prédation avait alors un caractère impératif, ce qui n'était pas le cas durant les phases tempérées.

[16] Par exemple, l'enfant de Gibraltar avait une alimentation fortement carnée, comme les adultes de Marillac en Charente (40.000 ans, stade glaciaire), de Sclayn en Belgique (120.000, stade interglaciaire) et de Saint-Césaire en Charente-Maritime (Bocherens 1997).

ont tantôt été chasseurs, tantôt charognards[17]. Ce double mode de subsistance était présent chez plusieurs peuples chasseurs-cueilleurs sub-actuels[18]. On constate que les Néanderthaliens, grâce à leurs outils, ont dépecé des carcasses de gros animaux (éléphants ou mammouths, rhinocéros) morts naturellement ou tués par un autre prédateur[19] et, beaucoup plus rarement, de petites espèces. Ils ont pratiqué cette activité surtout durant des périodes où la végétation ou le gibier étaient plus rares; les saisons froides et sèches sont propices au "charognage", car beaucoup d'animaux meurent durant ces périodes. C'est une pratique ancienne qui a traversé toutes les époques et persiste encore aujourd'hui dans certaines régions. En outre, c'est une activité plus difficile que l'on ne le pense. Pour consommer la viande, les Néanderthaliens devait intervenir le plus tôt possible sur la carcasse. Ils devaient également savoir détecter les divers indices de la présence d'une charogne ou d'un animal en train d'être tué. Le "charognage" nécessite donc la mise en œuvre de stratégies tout aussi élaborées que celles de la chasse. Cette pratique n'est donc ni archaïque, ni la preuve d'une culture peu évoluée communément appelée primitive !

La chasse

Les armes néanderthaliennes contraignaient à l'approche du gibier. Par exemple, pour toucher un animal avec sa lance, le chasseur devait être au plus à 15 mètres et ce malgré une anatomie qui leur permettait de lancer plus loin et plus fort, donc de se tenir à plus grande distance de sa proie. En effet, l'anatomie des Néanderthaliens révèle ses grandes aptitudes pour la chasse. Les régions du cerveau concernées par les opérations mentales impliquées dans la réalisation des gestes successifs pour viser et toucher une proie, étaient chez eux très développées[20]. D'autre part, ils devaient lancer très régulièrement des armes de jet avec puissance et précision (Hambucken 1993; Voisin 2004). En outre, l'amplitude de ce mouvement était grande et ce dans toutes les directions; certains muscles du bras faisaient ainsi office de levier (Trinkaus 1977, 1983, 1992; Trinkaus & Churchill 1988). Cependant, s'ils voulaient avoir une chance d'atteindre leur proie, les chasseurs devaient quant même se trouver à moins de 20 mètres[21].

Comme chez les chasseurs-cueilleurs sub-actuels, les choix culturels stratégiques des Néanderthaliens résultaient de l'adéquation entre la proie convoitée et l'ensemble technique méthodes-armes. Ce dernier a donc varié en fonction du gibier choisi; les Néanderthaliens ont adapté leurs stratégies cynégétiques au gibier qu'ils convoitaient[22]. Il est probable que l'abondance dans l'environnement proche, la productivité et la facilité de capture de certaines proies ont influé sur ses choix. Cependant, ses goûts et surtout ses traditions, reposant, entre autres, sur ses savoir-faire et ses aptitudes, ont sans doute joué un rôle. Les Néanderthaliens connaissaient non seulement les mœurs des animaux qu'ils chassaient, mais également leur anatomie. En effet, pour plus de succès, il faut viser juste un organe vital ou occasionner une forte hémorragie, la poursuite d'une bête blessée entraînant une dépense énergétique supplémentaire. Quelles que soient la région et la période, les Néanderthaliens ont préféré les herbivores aux carnivores. Cependant, certaines espèces, notamment les loups, les renards ou les ours bruns (comme à Biache-Saint-Vaast et à Taubach en Allemagne), ont parfois été tués pour leur chair et surtout leur fourrure. Les Néanderthaliens ont exploité tous les biotopes, mais, ils ont surtout chassé les animaux qui vivaient dans les milieux ouverts, comme la steppe ou la prairie (chevaux, bisons et rennes). Cependant, durant les phases tempérées où les forêts prirent une plus grande extension, ils ont également chassé des espèces forestières (notamment le cerf) et, dans les régions à reliefs, des espèces rupicoles (chamois et surtout bouquetins). D'autres animaux, plus difficiles à tuer, ont été plus rarement choisis. C'est le cas des ovibos, des aurochs (à Biache-Saint-Vaast et à Livernon dans le Lot). et des sangliers. D'autres enfin, n'étant présents qu'à certaines périodes climatiques ou dans certaines régions, ont globalement été peu chassés par les Neanderthaliens, c'est le cas du mégacéros (à Kiik-Koba en Crimée), de l'élan, du chevreuil, du daim, de l'antilope saïga et d'*Equus hydruntinus.* Si les Néanderthaliens ont souvent consommé la viande de gros mammifères, rhinocéros et éléphants ou mammouths, ils ne les ont par contre qu'occasionnellement chassés. Cependant, il y a 125.000 ans, à Lehringen en Basse-Saxe (Allemagne), ils ont profité d'un environnement marécageux, le bord d'un lac, pour achever un éléphant antique, probablement enlisé, à l'aide d'un épieu en bois de 2,4 m de long. Puis, ils l'ont dépecé sur place avant de repartir vers leur campement en emportant de gros morceaux de carcasse[23]. D'après les témoins archéologiques, les Néanderthaliens ont donc occasionnellement chassé des mammouths et notamment, probablement par piégeage, des jeunes. Pour l'abattage des adultes, l'hypothèse la plus

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[17] Comme le montre les études réalisées sur les faunes de nombreux sites comme la Cotte-Sainte-Brelade (Jersey), à Gröbern et à Lehringen en Allemagne, à Chokurcha en Crimée, à Skaratki et Krakow-Nowa Huta en Pologne (Patou-Mathis 2000).

[18] Chez les Hadza, chasseurs-cueilleurs du Nord de la Tanzanie, les animaux "charognés" représentent 20 % de la totalité des espèces consommées (Zèbre, Girafe, Phacochère, Impala...). Seul l'éléphant n'apparaît que dans la catégorie des animaux "charognés" (O'Connell *et al*. 1988).

[19] Les rhinocéros (à Beauvais dans l'Oise, à Scladina, Spy et Mesvin IV en Belgique, à Salzgitter-Lebenstedt, Ariendorf, Schweinskopf, Lehringen en Allemagne, Zwolen en Pologne, Kulna en République tchèque, Tata en Hongrie, Krapina en Croatie) et les mammouths (à Beauvais, Scladina, Spy, Mesvin IV, Salzgitter-Lebenstedt, Ariendorf, Schweinskopf, Zwolen, Kulna) (Patou-Mathis 2000).

[20] Ces opérations sont conçues, comme d'ailleurs le langage, dans la région pariétale du cerveau gauche. Les zones d'association et de coordination, situées au carrefour des aires auditives (hémisphère droit, vers l'arrière), du toucher (hémisphère droit) et de la vue (occipital), étaient également bien développées.

[21] Ce n'est qu'au Paléolithique supérieur que, grâce au propulseur, un chasseur peut lancer sa sagaie à 30 mètres.

[22] Les caractères inhérents au gibier sont d'ordre biologique, éthologique et écologique. Les analyses quantitatives et qualitatives des ossements complétées par des données éco-éthologiques sur le gibier et sur l'environnement d'alors, ont fourni les principales informations qui ont permis de formuler des hypothèses comportementales.

[23] Dans le niveau V fut exhumé le squelette d'un éléphant antique avec, fiché entre ses côtes, les fragments d'un épieu en bois. Autour de la carcasse de cet éléphant ont été trouvés 27 éclats qui portent des micro-traces d'utilisation correspondant à des marques de dépeçage (Thieme & Veil 1985; Wenzel 1996).

probable est la pratique de chasses collectives dans des endroits propices comme les marécages ou les fondrières, durant la période estivale. Le petit gibier était également présent au menu. Les Néanderthaliens ont tué de nombreux lapins et lièvres, pour leur viande, mais aussi pour leur peau. Ils ont parfois capturé des oiseaux, mais, ils ne semblent pas avoir chassé les mammifères marins.

En fonction de leurs besoins, les Néanderthaliens ont pratiqué des chasses sélectives en fonction de l'âge et du sexe des animaux. En outre, préférant les animaux à viande grasse, ils ont évité de tuer des bêtes trop vieilles ou amaigries, comme le sont les mâles après le rut ou les femelles après la mise bas. Pour les grosses espèces, comme les rhinocéros et les mammouths, ce sont surtout des très jeunes ou des vieux individus, plus faciles à capturer, qu'ils ont abattus. Ils n'ont pas hésité à tuer des femelles gravides, probablement lorsque le gibier se faisait rare (comme à Biache-Saint-Vaast, Auguste 1995 ou à Mutzig, Patou-Mathis 1999b). Mais, le plus souvent, contrairement aux autres prédateurs, ils ont chassé des individus dans la pleine force de l'âge, même d'espèce de grande taille, ce qui témoigne d'un savoir-faire cynégétique. Les Néanderthaliens, connaissant les mœurs de leur gibier, se sont surtout attaqués aux grands troupeaux d'herbivores pâturant dans les vastes espaces découverts, sans doute parce que ces animaux grégaires sont faciles à tuer. Ce qui ne l'a pas empêché parfois de s'orienter vers des espèces au comportement plus solitaire (comme le rhinocéros de Merck et l'ours brun à Biache-Saint-Vaast et à Taubach ou le Mégacéros à Kiik-Koba). Les Néanderthaliens savaient donc parfaitement surmonter les difficultés liées à la rareté de certaines proies en appliquant des stratégies *ad ho*c. De même, ils ont souvent préféré les espèces migratrices (Renne, Cheval, Bison, *Equus hydruntinus*, Antilope saïga) aux espèces sédentaires. Dans certains cas, ils ont installé leur campement sur les voies de migration de certains animaux, notamment de celles des rennes à la fin du printemps ou en automne (comme à "La Justice" à Beauvais dans l'Oise, Locht & Patou-Mathis 1998). À côté de ces espèces migratrices, des proies au comportement plus sédentaire (Cerf, Aurochs, Rhinocéros, Bouquetin, Chamois) ont été également abattues. On les retrouve quelquefois associées dans un même site[24], ce qui indique que parfois, les Néanderthaliens tuaient, selon les saisons, les animaux disponibles dans son environnement proche. Par exemple, à Kiik-Koba, le Mégacéros, espèce sédentaire, et le Cheval et l'Antilope saïga, espèces migratrices, ont été chassés. Sur leur territoire, les Néanderthaliens ont choisi une espèce plutôt qu'une autre, probablement en fonction de leur savoir-faire cynégétique, mais peut-être aussi d'exigences culturelles (voire cultuelles) qui nous échappent.

D'après les données archéozoologiques[25], les Néanderthaliens ont pratiqué simultanément différents modes de chasse: diversifiée (ou opportuniste), orientée vers quelques espèces, spécialisée sur une ou deux espèces et hyper-spécialisée (sur une seule espèce). Ils chassaient de grands animaux, la pratique exclusive d'une chasse au petit gibier n'a pas été mise en évidence. La chasse diversifiée, ou opportuniste, apparaît relativement rare. La chasse orientée vers deux ou trois espèces était fréquente[26], notamment durant les phases froides. Quant à la chasse spécialisée sur une ou deux espèces, elle était apparemment plus habituelle lors des phases tempérées (elle semble décroître de la fin de l'Eémien au début de l'Interpléniglaciaire) peut-être parce qu'alors, le gibier étant plus abondant et les troupeaux plus conséquents en nombre de têtes, le choix était plus grand. Elle a été observée principalement dans des sites, en grottes ou en abris, correspondant souvent à des haltes de chasse. Par contre, les Néanderthaliens ont rarement pratiqué une chasse hyper-spécialisée, sur une seule espèce. Cependant, en Crimée par exemple (à Chokurcha, Buran Kaya, Starocelié et Kabazi II), c'étaient essentiellement des chasseurs d'antilopes saïga ou d'un petit équidé, *l'Equus hydruntinus*. Ils ont souvent utilisé les pièges naturels (marécages, avens, vallons en cul-de-sac, précipices) présents dans leur environnement. En bordure de marécages, des rhinocéros (à Biache-Saint-Vaast, Taubach et Krapina) ou des mammouths (comme à Mutzig I) ont été abattus. À Starocelié en Crimée, des Néanderthaliens ont chassé des *Equus hydruntinus* en les forçant à entrer dans l'étroite gorge de Kanly-Dere qui se termine en cul-de-sac.

Quel que soit son mode de chasse, les Neanderthaliens ont le plus souvent pratiqué des chasses saisonnières. Ils ont donc installé: des campements temporaires de plus ou moins longue durée (comme à Biache-Saint-Vaast, Taubach, Zwolen en Pologne, Erd en Hongrie, Kabazi II), des camps saisonniers (à Wallertheim en Allemagne, Kulna en République tchèque ou Ripiceni-Izvor en Roumanie) ou des haltes de chasse (à Mutzig I, "La Justice" à Beauvais, Sclayn, Spy et Couvin en Belgique, Tönchesberg 1B et Plaidter Hummerich en Allemagne, Tata en Hongrie, Krapina en Croatie, Cioarei et Ripiceni-Izvor niveau II en Roumanie et Koudaro I et III en Géorgie). On remarque parfois, dans un même niveau, deux saisons différentes d'abattage, soit pour une même espèce (le Cheval à Tönchesberg, site 1, couche B et le Renne à Kulna), soit pour des espèces différentes (l'Aurochs, le Rhinocéros de prairie et l'Ours brun à Biache-Saint-Vaast, le Cerf et le Cheval à Tönchesberg, site 1, couche A). Deux hypothèses peuvent être proposées. Soit, les Hommes ont occupé le site toute l'année, en pratiquant des chasses sélectives en fonction de la saison; soit, ils sont venus à deux saisons différentes, les périodes d'occupations n'ont pu être mises en évidence lors

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[24] Comme les rhinocéros, l'aurochs (les deux espèces ont été tuées à la fin de l'hiver) et l'ours brun (en automne) à Biache-Saint-Vaast (Auguste 1995), le chamois à Sclayn (tués à la fin de l'hiver, Patou-Mathis 1998), le cerf au Lazaret, dans les Alpes-Maritimes (Patou 1984), et aux Canalettes dans l'Aveyron (Patou-Mathis 1993b). À Tönchesberg (Allemagne), site 1 couche A, les cerfs sont morts durant la période hivernale et les chevaux au printemps (Conard 1992).

[25] Les analyses quantitatives et qualitatives des ossements complétées par des données éco-éthologiques sur le gibier et sur l'environnement d'alors, fournissent les principales informations qui permettent la formulation d'hypothèses (Patou 1984, 1989; Patou-Mathis 1993a et b, 1997a et b, 1998a).

[26] La présence, dans de nombreux gisements, de palimpsestes et non de sols bien individualisés dans le temps, rend parfois difficile la mise en évidence d'un mode de chasse. En effet, les espèces déterminées ont pu être chassé à des périodes différentes; ce qui conduit alors à l'hypothèse, non pas d'une chasse orientée par exemple vers trois ou quatre espèces, mais à celle d'une chasse spécialisée, sur une seule de ces espèces, pratiquée à des périodes espacées dans le temps.

des fouilles (problème de palimpsestes). Les chasses ont eu lieu à toutes les saisons, cependant, le renne semble avoir été chassé de préférence au printemps et en automne (périodes de leur migration) et les espèces sédentaires plutôt durant la période hivernale. En outre, les Neanderthaliens revenaient s'installer souvent aux mêmes endroits (sites à occupations récurrentes), ce qui atteste de leurs déplacements fréquents au sein d'un même territoire. Il ne semble pas y avoir de corrélation entre la culture matérielle associée et le mode de chasse pratiqué.

Une fois tué, l'animal était, le plus souvent, ramener au campement[27]. Lors d'une chasse, il y a un équilibre à réaliser: l'énergie fournie par la proie[28] doit être nettement supérieure à celle dépensée pour la tuer et la transporter[29]. Le transport entraîne donc une dépense énergétique qui va dépendre du poids de l'animal, de la distance entre le lieu d'abattage et le campement, de l'altitude à laquelle ce trouve ce dernier, du moyen de transport et du nombre de porteurs. Le facteur de portabilité joue donc en défaveur des grosses et grandes espèces, les Néanderthaliens ont malgré cela chassé et consommé de lourdes espèces. Ils ont alors partiellement traité les bêtes abattues sur le lieu de chasse. En effet, pour les éléphants, les mammouths et les rhinocéros, seules certaines parties, voire uniquement la viande, ont été récupérées par les Néanderthaliens. De même, à la différence des animaux de taille moyenne et petite transportés entiers, il a quasi systématiquement dépecé les grandes espèces, comme les chevaux et les bisons, sur le lieu de leur abattage et n'en a rapporté à son campement que des quartiers. L'équilibre entre énergie récupérée et énergie dépensée était ainsi réalisé.

Les Néanderthaliens ont donc pratiqué simultanément différents comportements cynégétiques qui montrent une parfaite adaptation à l'environnement, même défavorable. En outre, ils ont su planifier et gérer leur alimentation carnée en en contrôlant notamment le transport. Ils ont chassé de grands mammifères, ce qui atteste de leurs nombreuses aptitudes inhérentes à cet acte: habileté physique, sens de l'observation et de l'organisation (planification, gestion), connaissances du terrain et du gibier et la maîtrise des techniques. L'acquisition de ces connaissances et savoir-faire nécessite un apprentissage et de nombreuses capacités cognitives, dont le langage (Edelman & Tononi 2000:234-235), que possédaient donc les Néanderthaliens.

De plus, la chasse, qui met en jeu des comportements très complexes, forge des traditions et crée des souvenirs individuels et collectifs (Patou-Mathis 1996). Elle a une fonction sociale autant qu'économique. Elle est structurante car elle augmente la cohésion du groupe notamment par la coopération, diversement réglée en fonction du mode de chasse pratiqué; plus la stratégie est sophistiquée, plus elle exige de collaboration. De ce fait, la coopération peut être élargie à plusieurs groupes, par exemple lors de grandes chasses, ces alliances temporaires scellent un *nexus* inter-groupe. Une chasse collective est plus fructueuse, mais elle sous-entend la nécessité de la capture d'une proie plus importante en taille ou de l'abattage de plusieurs bêtes et surtout une bonne coordination entre les chasseurs (avec communication orale ou gestuelle) et une organisation sans faille. Par exemple, les chasses aux mammouths, collectives et exceptionnelles, devaient donner lieu, comme hier chez les chasseurs d'éléphants, à des préparatifs et à des réjouissances. Elles favorisaient également les échanges entre groupes, de savoirs et de biens, créant ainsi un réseau où hommes et femmes pouvaient trouver un partenaire. Mais, c'est, peut-être, le partage qui est le facteur social le plus important. Chez les populations de chasseurs-cueilleurs, le partage du produit de la chasse est équitable; cette pratique égalitaire assure la cohérence du groupe et renforce les interrelations. Souvent celles-ci dépassent le cadre du groupe; un morceau de gibier peut devenir au sein du réseau tissé entre différentes communautés un objet d'échange ou un présent. Les conséquences de cet acte sont essentielles, les vieillards, les malades et les jeunes enfants restés au camp reçoivent leur part, ce qui est une forme de socialisation évoluée. Il nous apparaît plus que probable que les Neanderthaliens partageaient au sein de leur groupe le produit de leurs chasses. La chasse est donc un phénomène social, mais c'est aussi un révélateur social. C'est la valeur accordée à la viande qui lui confère son rôle primordial. La viande rouge sauvage donne de la force puisque force, il faut avoir eu pour l'obtenir. Dans les sociétés traditionnelles, un bon chasseur acquiert virilité et statut social; il est un partenaire privilégié pour la femme et un allié recherché pour le groupe, donc l'idéal convoité. En outre, la consommation de la viande, du fait de son statut, obéit à des impératifs de dons ainsi qu'à des interdits alimentaires. Les animaux, fournisseurs de ce bien être qu'est la viande, sont dans de nombreuses civilisations objets de culte. On ne peut exclure qu'il n'en fut pas de même chez les Néanderthaliens, puisque comme l'a écrit C. Fischler (1993) "*L'Homme biologique et l'Homme social, la physiologie et l'imaginaire sont étroitement, mystérieusement mêlés dans l'acte alimentaire*".

Le traitement des proies

L'animal est riche en ressources variées, alimentaires ou non. L'étude détaillée des marques de boucherie[30] permet de retrouver les principales étapes techniques du traitement du gibier. Les activités de boucherie sont à différencier des altérations qui peuvent affecter les ossements (des bactéries aux primates). En outre, la plupart du temps, dans des contextes

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[27] Plusieurs critères d'analyses du matériel osseux permettent la mise en évidence de l'apport ou non d'animaux entiers au campement, notamment les indices de conservation des différents ossements. Par exemple, si la plupart des éléments du squelette sont présents dans le site, c'est que l'animal y a été ramené entier.

[28] L'apport calorique, nutritif, est fonction de la taille de la proie. Dans cette équation rentre également en ligne de compte le nombre de bouches à nourrir.

[29] À cette adéquation, il faut ajouter la possibilité d'un stockage de viande, l'apport calorique doit donc être plus important, ce qui nécessite, soit une proie plus grosse, soit l'abattage de plusieurs animaux et donc sous-tend un choix de stratégies adaptées (par exemple un animal particulièrement "gras").

[30] Leur répétition, orientation et localisation sur l'os, la longueur, largeur et profondeur des stries, la morphologie et la morphométrie des impacts de percussion.

de boucherie, l'organisation spatiale des ossements n'est pas contingente et permet de la rattacher à certaines techniques. Lors de l'étude d'un matériel, on peut séparer les espèces ou des groupes d'espèces, par exemple en fonction de leur taille (poids ou masse). La mise en évidence des techniques de traitement des proies est très importante pour la compréhension globale des modes de subsistance; c'est un indice culturel fort. Dès le stade 7, les Hommes du Paléolithique moyen ont récupéré, de façon quasi-systématique de la viande, de la graisse et de la moelle des os longs. Le traitement des proies met en évidence une chaîne opératoire où les différentes étapes s'enchaînent logiquement en fonction de l'anatomie de l'animal et de la période (d'abondance ou de pénurie). Il ne semble pas y avoir de corrélation entre la culture matérielle associée et le mode opératoire de traitement du gibier. En outre, les Néanderthaliens ont su gérer, les périodes de pénuries (surtout au Pléniglaciaire), en adaptant leurs stratégies d'acquisition et de traitement du gibier, notamment en installant leur campement à des endroits propices, en sélectionnant leurs proies, en les exploitant au maximum (jusqu'à la confection de "bouillons gras") et probablement en pratiquant un "stockage" limité dans le temps (réserves saisonnières). Par contre, si l'on peut supposer que la cuisson de certains morceaux de carcasses a été pratiquée par les Néanderthaliens, les preuves directes demeurent rares. Seules des preuves indirectes attesteraient de l'utilisation du feu pour cuire la viande, voire la fumer comme à "La Justice", Beauvais.

Dès le stade 7, les Néanderthaliens ont non seulement abattu des animaux pour leur viande et leur graisse, mais également pour leur peau. Les ligaments et les tendons ont également été prélevés, au moins à partir de l'Eémien. La fourrure de certains carnivores (Ours brun, Loup, Renard) a peut-être été la motivation principale de leur chasse (comme à Mutzig I). Les ossements ont également été utilisés, comme combustible, outil, récipient, support de travail ("planche" à découper, comme l'os coxal d'un jeune rhinocéros de Merck découvert à Krapina), armature d'habitations notamment de plein air (Molodova, Ukraine)[31] et peut-être d'art mobilier (la scapula gravée et peinte de Mammouth exhumée de la couche 2 de Molodova I par exemple). Au Pléniglaciaire et à l'Interpléniglaciaire, les Néanderthaliens ont utilisé l'os comme combustible, à Beauvais, au Trou du Diable et à Engihoul (Belgique). Ils ont effectué des choix au sein du matériel osseux à leur disposition, préférant les éléments les plus adaptés.

L'industrie sur os ou sur bois de Cervidés est très peu présente au Paléolithique moyen, ce n'est qu'au Paléolithique supérieur qu'elle se développera véritablement. Cependant quelques exemples attestent de la fabrication d'objet en os, des racloirs, des pointes et des esquilles retouchées ont été découverts en Allemagne, en Belgique, en Hongrie, en Tchéquie, en Roumanie, en Ukraine et en Géorgie. On note également la présence d'accumulations de bois de Cerf sans marques apparentes d'utilisation, à Tönchesberg 2B en Allemagne. Cependant, les "outils" en os de cette période sont principalement des retouchoirs. L'ablation de l'ilion, de l'ischium et du pelvis de coxaux de grands ongulés, pour ne conserver que la cavité cotyloïde qui pouvait servir alors de "godet", a été pratiquée (notamment à la Quina en Charente et en Belgique).

Vastes territoires et grande mobilité

La superficie du territoire de subsistance dépend du comportement de subsistance du groupe humain (stratégies mises en œuvre, temps d'occupation), mais également de la diversité et de l'abondance des matières premières utilisables. Les Neanderthaliens étant essentiellement des mangeurs de viande, ils avaient donc besoin d'un vaste territoire. En outre, les territoires de subsistance varient en fonction des contraintes écologiques liées notamment au climat qui les conditionne. Lors des phases froides, le climat se "continentalisant", les variations annuelles deviennent plus grandes, entraînant un déplacement du gibier sur de plus longues distances, donc une augmentation de la superficie des territoires de chasse (Keeley 1988).

Les Neanderthaliens ont vécu durant une longue période et dans des contextes topographiques, climatiques et environnementaux différents. Il est donc plus que probable que leurs modes d'occupation territoriale ont varié selon ces facteurs et que, peut-être, ils ont pratiqué différents types de nomadisme. Chez les peuples chasseurs-cueilleurs, deux grands types de stratégie d'exploitation d'un territoire ont été constatés. Ceux qui vivent en milieux non contrastés, ce qui était le cas d'une grande partie de l'Europe durant les phases climatiques tempérées[32], exploitent les ressources locales disponibles jusqu'à leur épuisement, puis le groupe dans son entier se déplace vers un autre territoire (*Foraging strategy*, Binford 1980). Les activités de subsistance sont alors spécialisées, à l'échelle d'une journée, mais intégrées à l'échelle du déplacement entre deux campements (incluant la collecte d'autres ressources comme les roches). Ce type de mobilité (qui correspond à un degré de mobilité élevé), lié à une prédation opportuniste au jour le jour, implique l'existence d'un camp de base (ou résidence), correspondant à l'habitat, d'où les hommes rayonnent, sur de courtes distances[33]. En revanche, en milieux contrastés, ce qui était le cas d'une partie de l'Europe durant les périodes glaciaires, les chasseurs-cueilleurs exploitent un troupeau ou une harde lors de ses migrations. Cette stratégie implique des déplacements de type saisonnier au sein d'un même territoire qui est plus vaste que dans le cas précédent (comme chez les Inuits, *logistically organized collectors*, Binford 1980). Les activités de subsistance sont spécialisées, chasse ou collecte

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[31] L'utilisation par les Néanderthaliens de grands os, notamment de Mammouth, pour servir d'armature d'habitations de plein air semble probable. Celles-ci se rencontrent dans des régions où les abris sont rares (grandes plaines) et ce très tôt (dès le stade 6), notamment lorsque les conditions climatiques étaient rigoureuses. Par contre, l'hypothèse selon laquelle ces pachydermes auraient été chassés nous apparaît peu fondée. Il s'agit, plus vraisemblablement, de récupérations d'ossements sur des carcasses d'animaux déjà morts et en état de décomposition avancé, voire d'os déjà fossilisés.

[32] Existence de biotopes diversifiés répartis sur une faible superficie.

[33] Dans ce type de mobilité, appelé résidentiel, les déplacements sont multidirectionnels, en étoile ou rayonnant.

de roches, mais ne concernent qu'une partie du groupe. Les déplacements unidirectionnels (linéaires), de ce type de mobilité[34], entraînent l'existence d'un camp de base de plus longue durée, mais également de camps spécialisés ou camps de transit à caractère saisonnier (Jarman *et al*. 1982)[35]. Cette stratégie d'exploitation d'un territoire nécessite l'anticipation et la planification des trajets à moyen ou long terme.

Au Paléolithique moyen, notamment durant les périodes de refroidissement, il existait deux grandes saisons, une estivale et une hivernale, de plus longue durée lors des phases froides et en milieu continental. Pour subvenir à leurs besoins vitaux, les Néanderthaliens, dépendant des variations saisonnières des ressources, devait donc se déplacer périodiquement, soit au sein de leur territoire, soit en changeant de territoire. L'étendue des territoires néanderthaliens nous est connue grâce aux animaux qu'ils ont chassés, mais également par l'analyse des roches qu'ils ont utilisées pour tailler ses outils. Les Néanderthaliens se déplaçaient beaucoup plus fréquemment et sur de plus grandes distances que ses prédécesseurs (Féblot-Augustins 1997:100). Cependant, ils s'approvisionnaient le plus souvent dans des gîtes situés à moins de 20 km de son campement (à 5 Km en moyenne). Les distances parcourues par les Néanderthaliens au sein de leurs territoires varient en fonction des régions. En Europe occidentale, quelle que soit la période, ils ne se déplaçaient pas au-delà de 100 à 120 Km (Féblot-Augustins 1999:229) et fréquentaient peu les gîtes éloignés de plus de 20 Km de son campement[36]. En outre, pour les atteindre, ils ne franchissaient pas d'obstacles majeurs, comme les montagnes[37]. Ses déplacements sont proches du type conjoncturel, liés à une subsistance plutôt opportuniste (Féblot-Augustins 1999:244). Ce qui pourrait correspondre au type de stratégie d'exploitation d'un territoire dans les milieux non contrastés[38]. Un peu plus à l'Est, en Rhénanie, les Néanderthaliens pour se procurer des roches, parcouraient plus fréquemment des distances supérieures à 20 km[39]. De plus, ils effectuaient couramment des trajets de 80 et de 100 Km, suivant un axe Nord-Ouest/Sud-Est (des basses plaines septentrionales aux plateaux rhénans, Féblot-Augustins 1999:232). À l'Est de l'Europe centrale, lors du dernier glaciaire[40], les Néanderthaliens se sont déplacés jusqu'à 200, voire 300 Km, parfois en franchissant des barrières géographiques naturelles (Féblot-Augustins 1999:229). La longueur de ses déplacements était souvent supérieure à 20 kilomètres[41]. En outre, ils s'approvisionnaient périodiquement à des gîtes lithiques situés à 50 et à 100 km de leur campement (Féblot-Augustins 1999:229). En Rhénanie et dans l'Est de l'Europe Centrale, les Néanderthaliens effectuaient donc des déplacements anticipés à long ou moyen terme, entre vallées et collines ou plateaux de moyenne altitude, dans le cadre d'une exploitation saisonnière d'animaux migrateurs de milieux ouverts, comme le renne ou le bison (Féblot-Augustins 1999:244). Cette stratégie correspond à celle de l'exploitation d'un territoire dans les milieux contrastés[42]. La continentalité, plus que la latitude, a donc joué un rôle sur l'organisation socio-économique et la mobilité des Néanderthaliens. La nature plus ou moins contraignante du milieu expliquerait donc, en partie, la variabilité comportementale des divers groupes régionaux. Le climat plus continental à l'Est de l'Europe, notamment durant les phases glaciaires, a entraîné plus de fluctuations saisonnières dans la disponibilité des ressources ce qui a contraint les Néanderthaliens à agrandir son territoire de subsistance[43] et à planifier des déplacements saisonniers de 50, voir 100 km. D'après les données faunistiques, ils ont pratiqué deux types de stratégies. Parfois, ils ont suivi le gibier en déplacement saisonnier, mais plus fréquemment, comme à Beauvais dans l'Oise, ils se sont installés au carrefour de leurs routes migratoires. L'augmentation des distances parcourues, donc de l'étendue du territoire, atteste d'une structuralisation territoriale. Celle-ci nécessite l'existence d'une bonne entente entre les différents groupes de Néanderthaliens présents dans une même région. Pour survivre, ils ont dû tisser des réseaux relationnels, sans doute géographiquement étendus notamment à l'Est de l'Europe, qui leur ont permis d'entretenir des rapports étroits, sur le plan génétique (liens de parenté) et culturel, avec des membres d'autres petits groupes relativement dispersés[44]. Ces réseaux sont en effet particulièrement vastes dans les milieux où les ressources sont rares ou sujettes à des fluctuations importantes, comme les ressources animales en milieu continental froid. L'existence de réseaux semble attestée à Kulna en République tchèque (Valoch 1995). Des groupes de Néanderthaliens, dont les campements étaient distants de 100, 200, voir 300 km les uns des autres, auraient entretenu des relations et pratiqué des échanges, probablement de proche en proche[45]. Grâce aux territoires de chasse, les divers groupes néanderthaliens ont pu se côtoyer pendant plusieurs millénaires. Les échanges ont été certainement plus nombreux et diversifiés que ne le laissent percevoir les indices archéologiques. Par exemple, les affinités régionales constatées entre certaines industries lithiques témoignent de l'existence d'échanges de savoir-faire techniques et donc, probablement, de traditions sociales et culturelles. Échanges cependant insuffisants pour considérer la civilisation néanderthalienne comme unique et homogène.

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[34] La mobilité est alors de type logistique, seule une partie du groupe se déplace, soit pendant un jour, soit plus longtemps.

[35] Ce type de mobilité a été attesté en Transdanubie (Féblot-Augustins 1997).

[36] Seulement 31,3 % des roches proviennent de gîtes situés à plus de 20 Km (Féblot-Augustins 1997).

[37] Ses trajets s'inscrivaient dans une unité géographique au sens large et souvent, comme dans le Sud-Ouest de la France, il se déplaçait au sein de zones écologiques identiques (Féblot-Augustins 1999:229).

[38] *Foraging strategy* avec une mobilité de type résidentiel correspondant à des déplacements multidirectionnels à partir d'un camp de base.

[39] 44% des roches sont exogènes et la distance maximale est de110 Km au maximum (Féblot-Augustins 1997).

[40] C'est n'est qu'à partir du dernier interglaciaire et surtout du début de la dernière glaciation que le peuplement de cette région de l'Europe semble avoir eu lieu.

[41] 53% de roches sont exogènes; par exemple, à Zwolen en Pologne, plus de 70 % des outils sont sur des roches provenant d'un gîte situé à 40 Km (Féblot-Augustins 1997).

[42] L*ogistically organized collectors*, avec une mobilité de type logistique correspondant à des déplacements linéaires sur un territoire de subsistance occasionnellement plus vaste.

[43] Moins de biomasse animale avec une disponibilité plus fluctuante nécessite un territoire d'approvisionnement plus vaste.

[44] L.R. Binford (1982) définit deux zones territoriales qui peuvent correspondre à l'étendue du réseau relationnel: une zone connue mais non exploitée (*extended range*) et une aire de visite (*visiting zone*).

[45] Chez les peuples traditionnels, l'échange de proche en proche est attesté pour des groupes spatialement distants (Renfrew 1984).

Les Néanderthaliens possédaient donc de vastes territoires de subsistance. Dès la phase ancienne du Paléolithique moyen s'esquisse une occupation différentielle de l'Europe, qui s'accentue durant la phase récente où l'on assiste à une véritable structuration territoriale et à une planification des déplacements. Face aux contraintes environnementales et à la nécessité de se reproduire, les Néanderthaliens ont donc opté pour une grande flexibilité territoriale.

Mettre en œuvre des stratégies, planifier et gérer l'alimentation quotidienne, nécessite une pensée complexe, avec des capacités cognitives individuelles, et une organisation sociale, que les Néanderthaliens ont su acquérir et développer. Ces hypothèses comportementales, reposant sur l'analyse archéozoologique, doivent, bien entendu, être confrontées à celles qui sont émises par d'autres disciplines. Notre objectif était, par cette synthèse originale résultant de l'analyse de données issues de nombreux sites dispersés sur une vaste aire géographique, de contribuer à une meilleure connaissance des comportements de subsistance des Néanderthaliens européens. Dans leurs comportements de subsistance, les Néanderthaliens montrent plus de similitudes avec ceux des premiers modernes européens que de différences.

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LES NÉANDERTALIENS EN EUROPE CENTRALE

Janusz K. KOZŁOWSKI
Instytut Archeologii, Golebia 11, 310007 Krakow, Pologne. KOZLOWSK@argo.hist.uj.edu.pl

Introduction

À partir du stade isotopique 7 (environ 250.000 ans), l'Europe centrale était devenu le domaine des Néandertaliens, ayant remplacé les formes précédentes pré-néandertaliennes attribuées, soit à *Homo erectus,* soit à *Homo heidelbergensis.* Le peuplement européen pendant le stade isotopique 8 (250.000-300.000 ans), durant lequel commence le Paléolithique moyen, est encore peu connu mais il est probable que les formes pré-néandertaliennes, bien connues dès le stade isotopique 9, ont été responsables de premières manifestations culturelles du Paléolithique moyen. En Europe centrale, les restes fossiles humains du stade isotopique 9 (antérieurs à 300.000 ans) sont connus à Bilzingsleben, mais leur position taxonomique est toujours discutée (Vlcek 1999). Par contre, pendant le stade 7 (242.000-186.000 ans), la présence des Néandertaliens est confirmée par les restes de 8 individus dans les travertins d'Ehringsdorf près de Weimar; malheureusement, les restes les plus complets (Ehringsdorf H et F) ont fait l'objet de découvertes fortuites en 1914 et 1925 (Vlcek 1983). Au stade 7, nous pouvons éventuellement attribuer le crâne de Steinheim, trouvé en 1933 dans les couches à Éléphant *antiquus*, dont la position systématique, jadis attribuée au passage de l'*Homo erectus* à l'*Homo sapiens*, est rattachée aujourd'hui aux Néandertaliens archaïques (Stringer 1985). À partir du stade 5e jusqu'au stade 3 (130.000 à 40.000 ans), les Néandertaliens ont été les seuls habitants de l'Europe, puis dans certaines régions (Balkans, bassin du moyen Danube) ils ont co-existé, entre 40.000 (?) et 28.000 avec les premiers Hommes anatomiquement modernes (fig. 1).

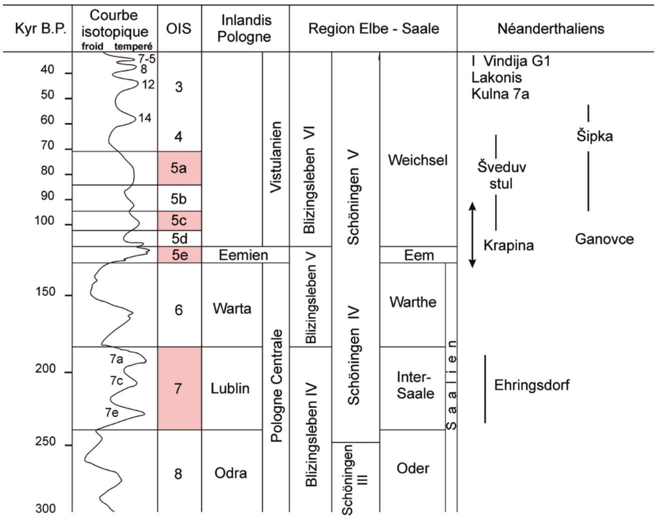

Figure 1. Cadre chronologique et paléoclimatique du Paléolithique moyen et la position des trouvailles des restes neanderthaliens en Europe Centrale.

Le but de cette contribution est de présenter l'évolution culturelle des Néandertaliens en Europe centrale. Ce sujet a été l'objet de deux synthèses importantes de G. Bosinski: la première publiée en 1967 (Bosinski 1967) et la deuxième en 2001 (Bosinski 2000-2001). Dans ces synthèses (surtout celle de 2001), l'évolution culturelle du Paléolithique moyen était surtout fondée sur les découvertes de la partie occidentale de l'Europe centrale; notre contribution sera d'abord fondée, par contre, sur les évidences provenant de la partie orientale de l'Europe centrale, y compris la Plaine de Volhynie-Podolie et le bassin du Dniestr supérieur.

Dans ce travail, nous allons suivre l'évolution paléo-environnementale exprimée par les stades isotopiques corrélés avec les transgressions et régressions de l'inlandsis. Dans le domaine culturel, les étapes successives seront marquées par les innovations technologiques, présentées sur le fond de la différentiation culturelle. Cette dernière pose la question de la signification anthropologique (ethnographique) des entités taxonomiques distinguées sur la base des caractères techno-morphologiques des outillages lithiques.

Stade isotopique 8 (300 000-250/240 000 ans) (fig. 2)

C'est la période de grande transgression de l'inlandsis du stade de l'Oder (Drenthe), du Saalien ou de la glaciation de Pologne centrale. Le front de l'inlandsis a fait une profonde intrusion dans le bassin de l'Oder, presque jusqu'à l'embouchure nord des "Portes de la Moravie". Les voies de communication entre les bassins de l'Elbe et de la Saale, et l'est de l'Europe ont été

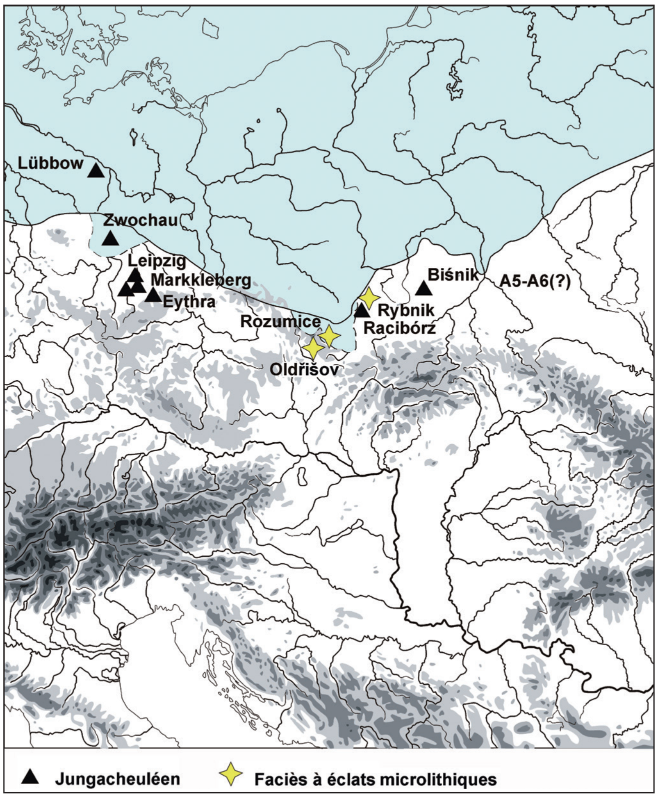

Figure 2. Carte des gisements datés du stade isotopique 8.

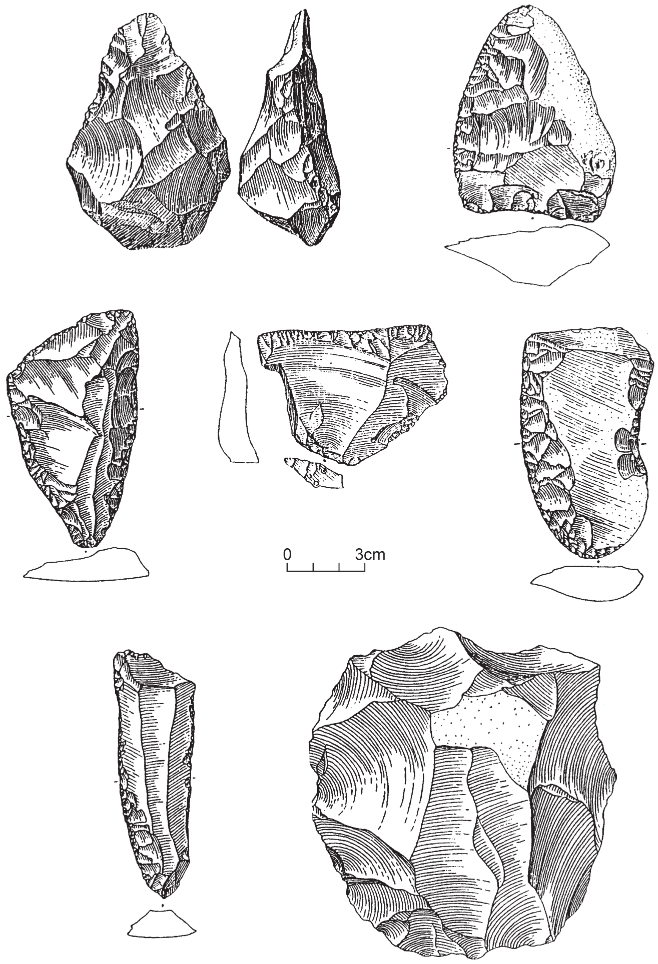

Figure 3. Markkleeberg près de Leipzig (Allemagne). Outillage lithique de Jungacheuleen: biface, racloirs et nucleus Levallois (d'après D. Mania).

coupées et la communication entre la Moravie et le bassin de la Vistule – par les "Portes de Moravie" – était devenue difficile.

Néanmoins, plusieurs sites de cette période sont connus dans les bassins de l'Elbe et de la Saale, découverts dans les nappes alluvionnaires sous-jacentes à la moraine de la glaciation de la Saale. Parmi ces sites, notons surtout ceux de la région de Leipzig, y compris d'énormes ateliers de transformation de silex à Markkleeberg, dont la surface dépassait probablement les 450.000 m², d'après D. Mania; ils ont livré plus que 100.000 silex taillés au-dessus de 2 cm (Grahmann 1955; Baumann & Mania 1983). Les sites antérieurs à la moraine du stade de l'Oder apparaissent également plus au nord, dans la vallée de l'Elbe, dont certains ont occupé une position très avancée vers le nord (par exemple, Lubbow; Stugeweit 1998). Du point de vue taxonomique, ces outillages lithiques montrent la présence de la technique levalloisienne bien classique et de rares outils bifaciaux, ou bien d'éclats provenant de la taille bifaciale (fig. 3). Cette entité a été appelée par G.Bosinski "Jungacheuleen" (Bosinski 1967). Les restes fauniques associés à ces sites indiquent des milieux de steppe périglaciaire qui pourraient évoquer la "steppe à mammouths" du Pléniglaciaire supérieur.

La deuxième région avec plusieurs sites du stade 8 est le bassin supérieur de l'Oder. Contrairement aux sites du bassin de l'Elbe – antérieurs à la transgression maximale de l'inlandsis –, les sites du bassin superieur de l'Oder datent de la phase de la récession de l'inlandsis. Il est intéressant de noter que certains sites de cette période reposent directement dans les dépôts glacio-lacustres ou fluvio-glaciaires de la phase de récession de l'inlandsis du stade de l'Oder. Le plus important parmi ces sites est Rozumice 3, en Haute Silésie, site avec 10 niveaux archéologiques dont certains bien préservés *in situ,* avec des structures telles que des foyers alimentés par des ossements (niveau VII – fig. 4), les traces d'une hutte circulaire dont la structure était formée par des branches fixées à l'aide des blocs erratiques (niveau V) et d'un abri dont la fondation reposait sur un demi-cercle de pierres (niveau IV – fig. 5). Les niveaux archéologiques en question ont été datés par OSL SAR entre 279.000±17.000 et 253.000±17.000 ans (Foltyn *et al*. 2004). Du point de vue taxonomique, la séquence de Rozumice pourrait être attribuée aux industries à éclats microlithiques du type bien connu encore au Paléolithique inférieur (fréquemment sous la dénomination de Bilzingsleben-Vertesszöllös (Burdukiewicz & Ronen [éd.] 2003, Burdukiewicz 2003). Ces industries sont caractérisées par la production de petits éclats à partir de nucléus à un plan de frappe, avec orientation changée, plus rarement à partir de nucléus discoïdes; ces éclats ont été transformés par retouches, fréquemment denticulées, en racloirs, grattoirs, perçoirs, etc. (fig. 6). Un foyer avec petite concentration d'artefacts a été fouillé à Gardawice, en Haute Silésie, dans les dépôts fluvio-glaciaires du stade de l'Oder. Plusieurs autres sites, dont le matériel a été remanié

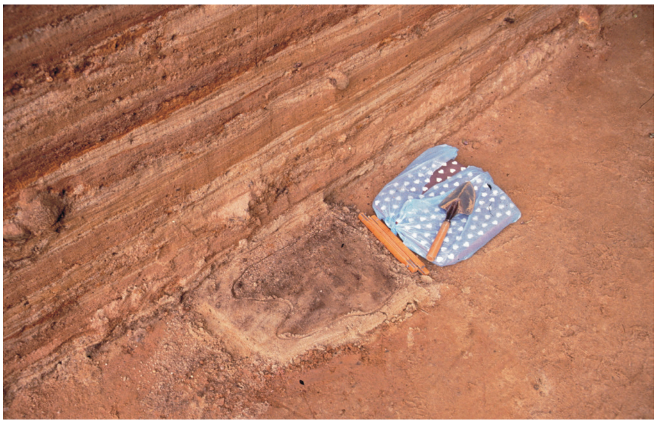

Figure 4. Rozumice 3 (Haute Silésie, Pologne). Foyer du niveau archéologique VII.

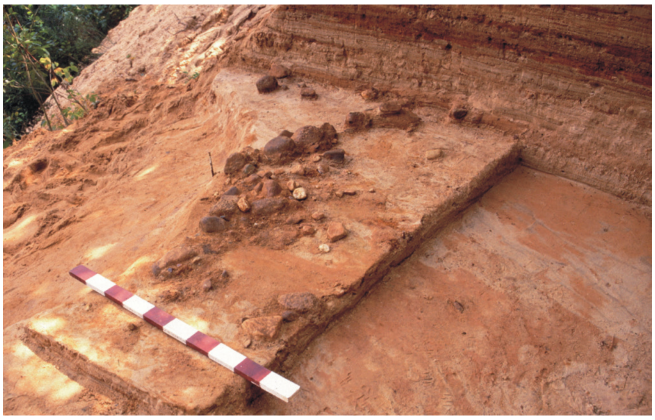

Figure 5. Rozumice 3 (Haute Silésie, Pologne). Fondation en pierre d'un abri semi-circulaire du niveau archéologique IV.

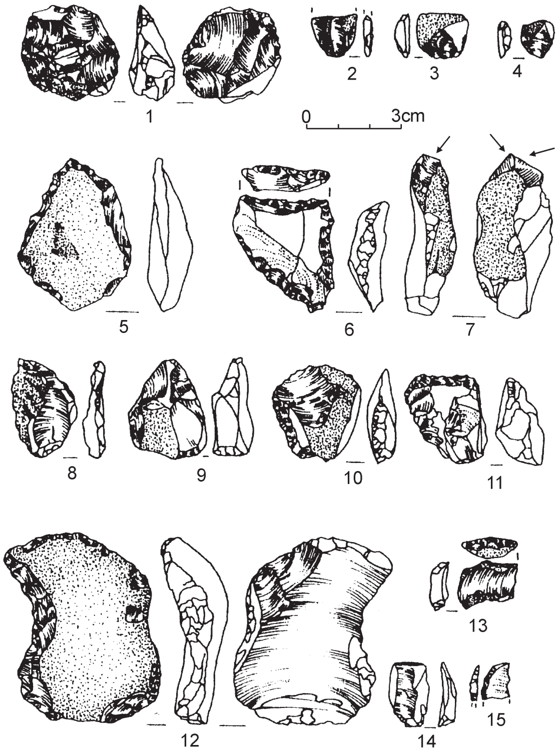

Figure 6. Rozumice 3 (Haute Silésie, Pologne). Industrie sur microéclats: nucleus discoïde (1), éclats retouches (5, 6, 8-11, 13-15), burin (?–7) et pièce a encoche (12).

(également dans les dépôts de la phase de récession du stade de l'Oder), appartiennent au complexe à éclats microlithiques (Rybnik-Kamien, Bienkowice, Zory-Rowien en Haute Silésie [Pologne] – Foltyn *et al*. sous presse – et à Oldrisov en Silésie d'Opava [République Tchèque] – Kerekes 1994).

En même temps, les sédiments de la récession du stade de l'Oder ont fourni quelques traces d'outillages différents, où la technique levalloisienne est représentée et où quelques déchets de taille d'outils bifaciaux apparaissent également, comme dans le "Jungacheuleen" du bassin de l'Elbe. Il s'agit, par exemple, du site de Raciborz-Studzienna en Haute Silésie, où les artefacts lithiques peu nombreux apparaissent associés aux traces d'un foyer alimenté par du bois de pin (Kozłowski 1964). Dans ce site, le niveau archéologique appartient à une nappe alluvionnaire correspondant à la terrasse de l'Oder au moment où les eaux de cette rivière ont pu être drainées vers le nord-ouest par une grande vallée marginale formée pendant la récession du front glaciaire (Foltyn *et al*. sous presse).

Il n'est pas impossible que les niveaux les plus anciens de la grotte de Bisnik (couches 16,17; assemblages A5, A6 – Cyrek [éd.] 2002), dans la partie nord du Plateau jurassique de Cracovie-Czestochowa, fournissent un mélange d'artefacts de ces deux entités, évoquées ici comme typiques du stade isotopique 8, notamment à éclats microlithiques et à technique levalloisienne caractéristique du "Jungacheuleen" de G. Bosinski. En tout cas, les datations U/Th des couches 16 et 17 sont antérieures à 200.000 ans, mais malheureusement peu consistantes (Hercman & Gorka 2002). La faune indique des conditions de steppe-toundra, avec le lemming dominant parmi les rongeurs.

L'analyse des sites qui apparaissent dans les sédiments glacio-lacustres et fluvio-glaciaires du bassin supérieur de l'Oder indiquent que les Néandertaliens ont pénétré, probablement pendant l'été, la zone proche du front glacier en cherchant les voies de passage entre la Moravie et le bassin de la Vistule. Cette pénétration est confirmée, non seulement par la présence de campements dans les dépôts glacio-lacustres ou fluvio-glaciaires, mais également par les importations dans ces sites de matières premières provenant aussi bien de Moravie (radiolarites, chailles) que du bassin supérieur de la Vistule (silex). Il est intéressant de noter que les Néandertaliens occupant la zone extra-glaciaire de la glaciation de la Saale ont pu mieux s'adapter aux conditions de cette zone que les hommes du Paléolithique supérieur, qui ont presque totalement abandonné la zone extra-glaciaire du dernier Pléniglaciaire (environ 20.000 ans BP); ou alors les conditions écologiques pendant le Pléniglaciaire saalien étaient différentes de celles du dernier Pléniglaciaire würmien.

Les caractères techno-morhologiques de ces ensembles lithiques indiquent la continuation des traditions du Paléolithique inférieur, confirmant dans le cas du complexe à éclats microlithiques, un développement local des populations néandertaliennes à partir de *Homo heidelbergensis*. Les assemblages du type "Jungacheuleen" n'ont pas d'antécédents locaux en Europe centrale, car l'Acheuléen *sensu stricto* n'est pas connu en Europe à l'est du Rhin. Il doit s'agir, dans ce cas d'une vague de population venant de l'Occident, bien adaptée aux conditions de la steppe périglaciaire ou de la steppe-toundra, mais les mécanismes de formation de cette entité ne sont pas encore claires.

Stade isotopique 7 (fig. 7)

Le stade isotopique 7 correspond à l'interstade entre les deux transgressions du Saalien. Les sites de cette période sont connus dans différents types de sédiments, notamment des travertins (Thuringe, Slovaquie), des nappes alluvionnaires (bassin de l'Elbe), des paléosols inter-lœssiques (Ukraine trans-carpatique), des sédiments lacustres (vallée de Geisel, Allemagne orientale) et des remplissages de grottes (bassin de la Vistule). Aussi, les activités représentées dans les sites sont-elles plus différenciées (camps de base, lieux d'abattage d'animaux, camps éphémères).

Les outillages de cette période sont aussi plus différenciés et représentent non seulement le complexe à éclats microlithiques et le "Jungacheuleen", mais aussi le Moustérien ancien, le Micoquien et le Levalloisien à pointes foliacées.

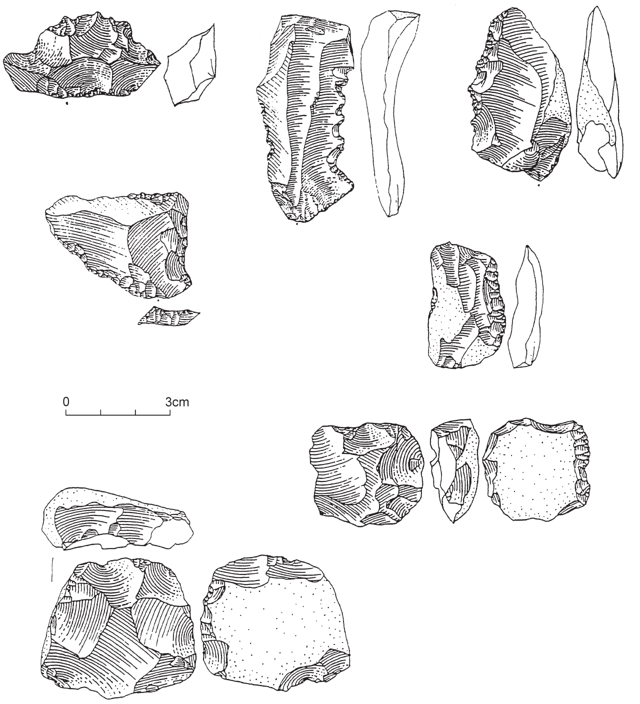

Figure 8. Neumark-Nord (Allemagne). Outillage lithique de killing-site: éclats denticules, racloirs, nucleus (d'après D. Mania).

Le complexe à éclats microlithiques est connu dans cette période probablement par un seul site – Neumark Nord dans la vallée de Geisel –, dont l'attribution est assez incertaine puisqu'il s'agit d'un lieu spécialisé dans l'abattage des animaux au bord d'un lac interstadiaire et qui n'a fourni qu'un choix limité d'outils et de restes de débitage (fig. 8). Le choix fonctionnel pourrait contribuer à une plus forte fréquence des éclats retouchés, des denticulés et des encoches, néanmoins obtenus à partir de nucléus discoïdaux, en présence de quelques éclats Levallois (généralement absents dans les ensembles microlithiques). La faune chassée à Neumark Nord comprend, en dehors de l'Éléphant antique et du Rhinocéros *kirchbergensis*, les restes de *Bos primigenius*. La datation TL d'environ 204.000 ans pour des dépôts lacustres correspond à cet interstade (Mania 1992, 2000).

Le "Jungacheuleen" correspondant à cette période est connu à Hundisburg, en Allemagne orientale, qui a fourni aussi bien des éléments de technique levalloisienne que de rares traces de taille bifaciale (Toepfer 1981).

Les témoignages du progrès technologique caractéristique de la formation du Paléolithique moyen relèvent des outillages appartenant aux nouveaux complexes apparaissant pendant le stade isotopique 7. Il s'agit d'abord du Moustérien ancien d'Ehringsdorf, qui apparaît dans le travertin inférieur daté par U/Th entre 245.000 et 190.000 ans, formé sous des conditions assez tempérées, sub-continentales, parfois même avec certaines influences de végétation méditerranéenne. Ce Moustérien ne diffère guère du Moustérien classique de la phase récente (post-eemienne) du Paléolithique moyen (fig. 9). La technique des nucléus discoïdaux domine; les supports assez épais ont été transformés en racloirs, pointes ou limaces par des retouches aussi bien abruptes ou scalariformes qu'envahissantes (Behm-Blancke 1960). Les groupes moustériens dans cette période ont chassé autant des éléphants antiques que des rhinocéros, mais également des chevaux et des castors (Soergel 1922).

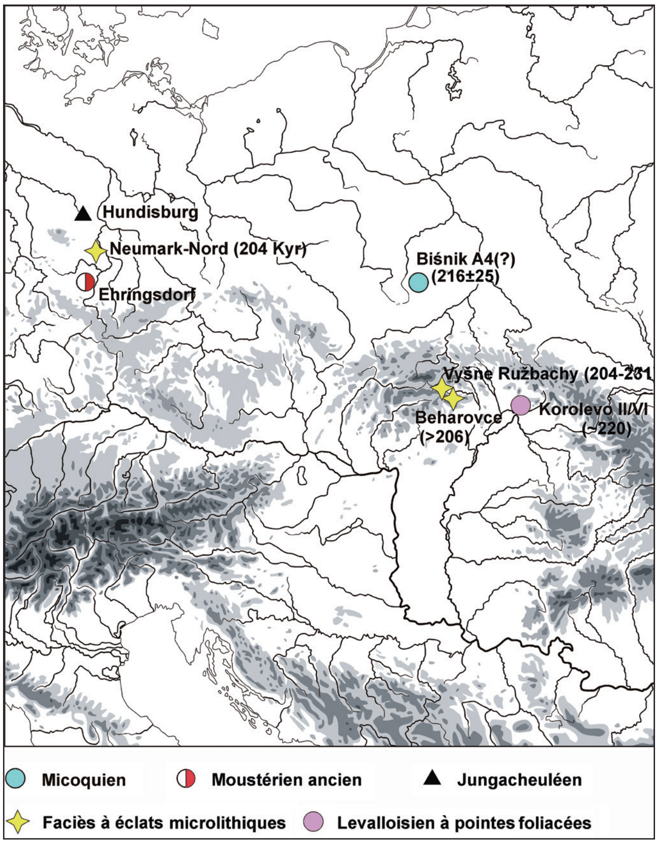

Figure 7. Carte des gisements datés de stade isotopique 7.

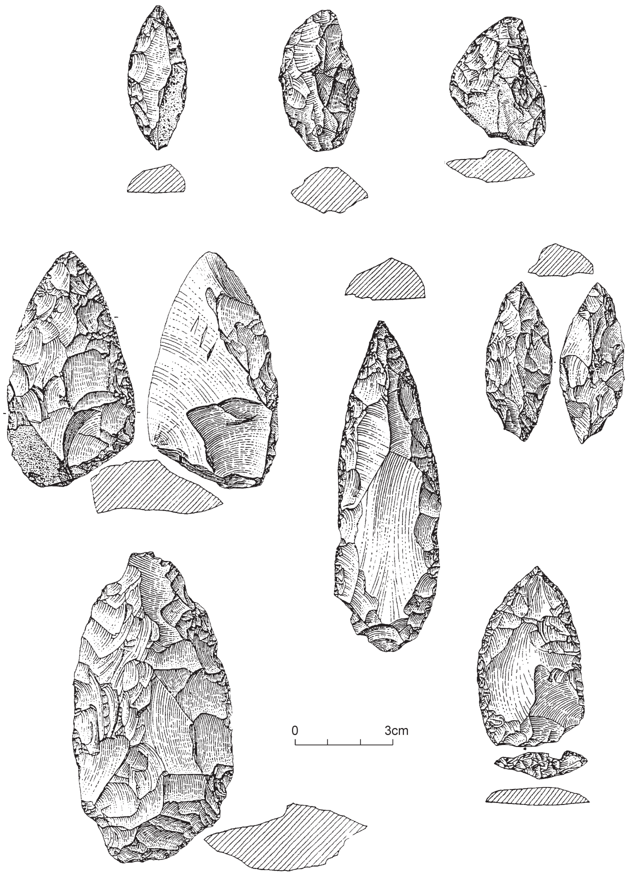

Figure 9. Ehringsdorf près de Weimar (Allemagne). Outillage lithique du Moustérien ancien: racloirs et pointes bifaciaux (d'après D. Mania).

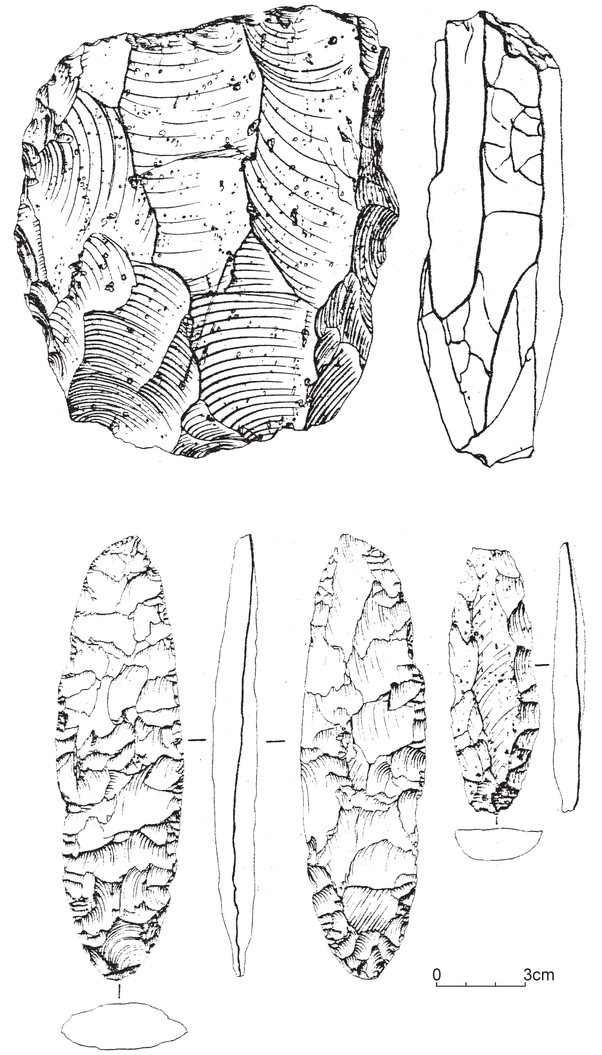

Figure 10. Korolevo II niveaux Vb, Va. Nucleus levalloisien et pointes foliacées (d'après V. Gladiline et V. Sitlivy).

Un autre aspect de progrès technologique dans le stade 7 correspond à l'association de la technique levalloisienne avec les pointes foliacées, connue dans le paléosol inter-lœssique qui contient le niveau Vb dans la séquence de Korolevo, en Ukraine trans-carpatique (fig. 10). Le paléosol en question était daté par TL d'environ 220.000 ans. La même association de belles pointes foliacées avec la technique levalloisienne continue dans l'horizon Va du même site (Gladilin & Sitlivy 1990).

Le progrès technologique que nous observons dans ces deux dernières entités correspond surtout à l'introduction d'armes de chasses nouvelles, notamment des javelots munis de pointes en silex (pointes foliacées, limaces, pointes moustériennes) qui ont partiellement remplacés lances entièrement en bois végétal, telles que nous les avons connues autour de 400.000 ans à Schöningen (Thieme 2002). Les nouveaux projectiles ont été des armes de chasse beaucoup plus efficaces pour le grand gibier et ont contribué au développement de nouvelles techniques de chasse.

Nous pouvons seulement supposer que dans cette période apparaissent aussi les premiers témoignages d'un nouveau techno-complexe qui jouera un grand rôle, surtout dans la phase récente du Paléolithique moyen, notamment du Micoquien (ou des industries à "Keilmesser" de G. Bosinski). La présence de couteaux-racloirs asymétriques (fig. 11) dans l'ensemble A4 (couche 15) de la grotte Bisnik en Pologne pourrait éventuellement témoigner en faveur de cette hypothèse, surtout si nous tenons compte de la datation radiométrique (U/Th) de cette couche: 216.000±25.000 ans (Cyrek [éd.] 2002). Dans ce cas, les éléments micoquiens pourraient apparaître aussi tôt en Europe centrale qu'en Europe occidentale (Gouedo 1999, Kozłowski 2001), ce qui pourrait remettre en question la filiation directe entre l'Acheuléen cromérien et le Micoquien du Saalien dans le Nord-Ouest de l'Europe (Gouedo 2001).

Stade isotopique 6 (fig. 12)

La deuxième transgression du Saalien, connue comme le stade de Warthe, était plus limitée que la première transgression de l'Oder, surtout en Pologne, où il n'y a pas eu d'extension de l'inlandsis vers le bassin supérieur de l'Oder. C'était la période de sédimentation du lœss ancien supérieur dans lequel apparaissent plusieurs sites archéologiques de cette période. Nous connaissons donc trois agglomérations de sites pour le stade isotopique 6: dans le bassin du Rhin (Bosinski 2000-2001, Conard & Fischer 2000), en Haute Silésie (Fajer *et al*. 2001) et

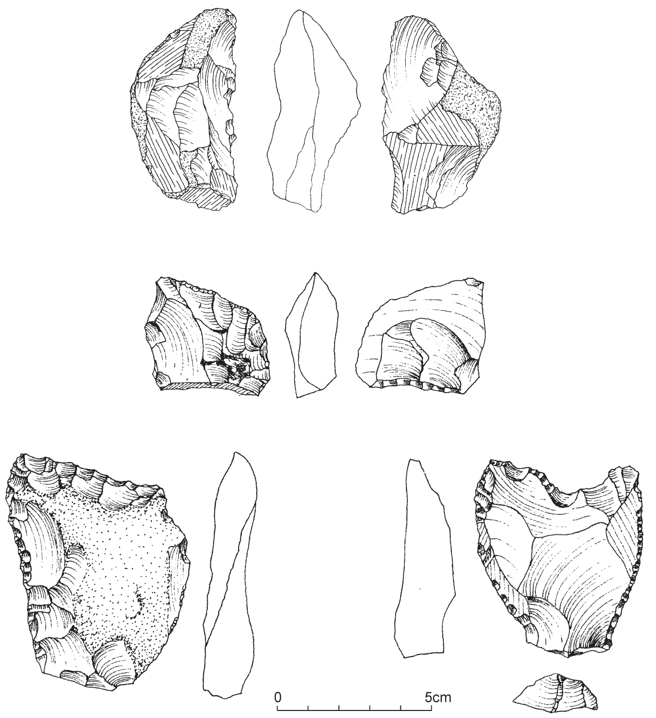

Figure 11. Grotte de Bisnik près de Strzegowa (Pologne). Assemblage A4: couteau racloir asymétrique bifacial micoquien, racloir a base amincie, racloir déjeté et éclat retouche (d'après K. Cyrek).

dans le bassin supérieur du Dniestr (Sitnik 2000). Seuls deux sites de cette période sont connus dans le Bassin carpatique.

Du point de vue taxonomique, deux entités, qui sont déjà apparues dans la période précédente, ont joué le rôle le plus important, notamment le Micoquien et le Levalloisien à pointes foliacées. Le Micoquien est connu dans le lœss ancien supérieur à Dzierzyslaw I en Haute Silésie, daté par TL de 180.000±35.000 ans, mais représenté seulement par deux pièces asymétriques bifaciales et un éclat provenant d'un nucléus discoïde (Foltyn *et al*. 2000). Un site beaucoup plus important – Pietraszyn 49, également en Haute Silésie – a fourni un ensemble de pièces diagnostiques micoquiennes beaucoup plus nombreux, y compris des couteaux-racloirs asymétriques bifaciaux, des bifaces micoquiens, des pointes foliacées et des racloirs bifaciaux (fig. 13). Les éclats accompagnant ces outils proviennent presque exclusivement de la taille bifaciale. Cet ensemble évoque le Micoquien le plus classique de la période récente du Paléolithique moyen, bien que les dépôts alluvionnaires qui ont fourni cette industrie aient été datés par TL et OSL entre 193.000±17.000 et 130.000±10.000 ans.

Un ensemble micoquien avec plusieurs formes diagnostiques (biface sub-triangulaire, couteaux-racloirs asymétriques bifaciaux; fig. 14) apparaît dans la séquence de la grotte Bisnik en Pologne, dans la couche 14 datée par U/Th de 126.000±30.000 ans, donc avec un large sigma, mais cette couche est sous-jacente aux couches 12 et 13 contenant des éléments fauniques eemiens (assemblage A3; Cyrek [éd.] 2002). La faune de la couche 14 a fourni par contre des éléments de steppe-toundra, ce qui pourrait confirmer la datation au stade de Warthe.

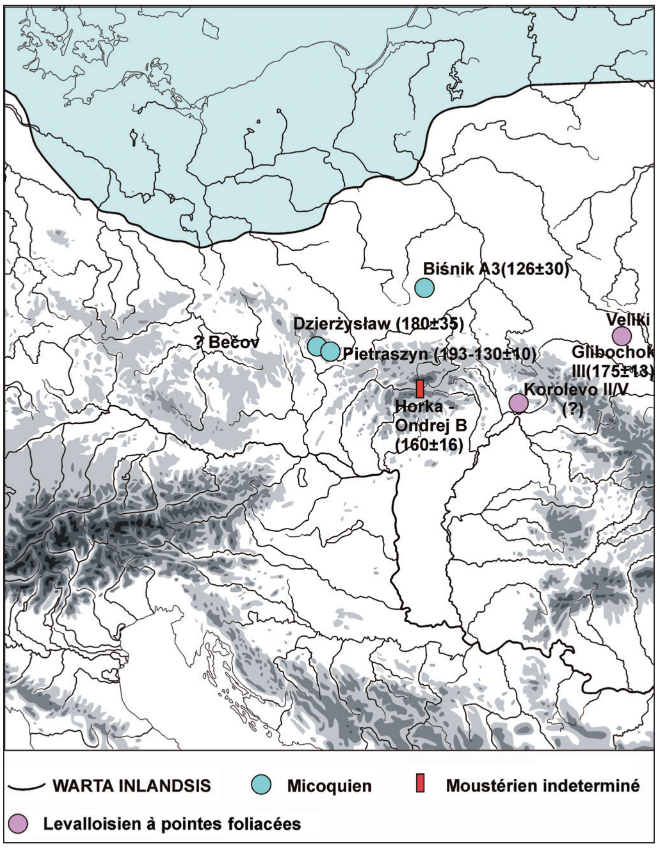

Figure 12. Carte des gisements datés de stade isotopique 6.

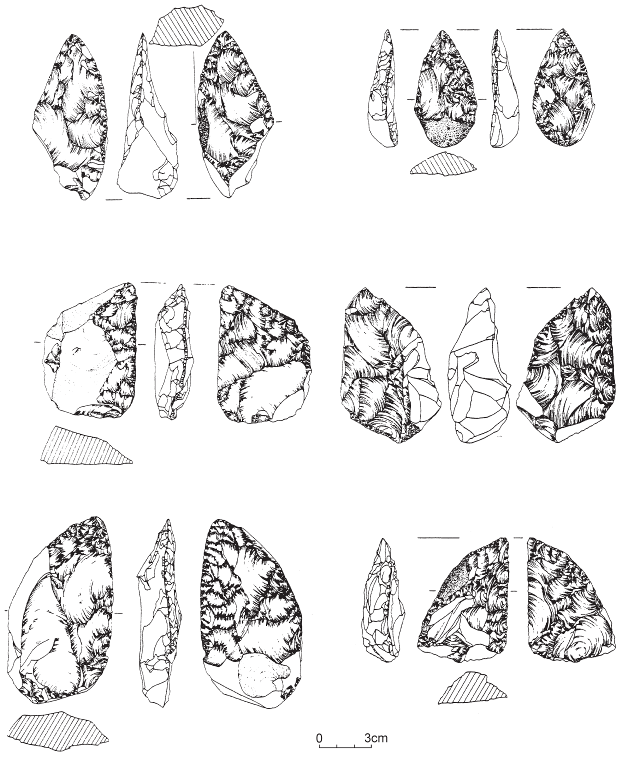

Figure 13. Pietraszyn 49 (Haute Silésie, Pologne). Outils micoquiens: bifaces et couteaux-racloirs (Keilmesser).

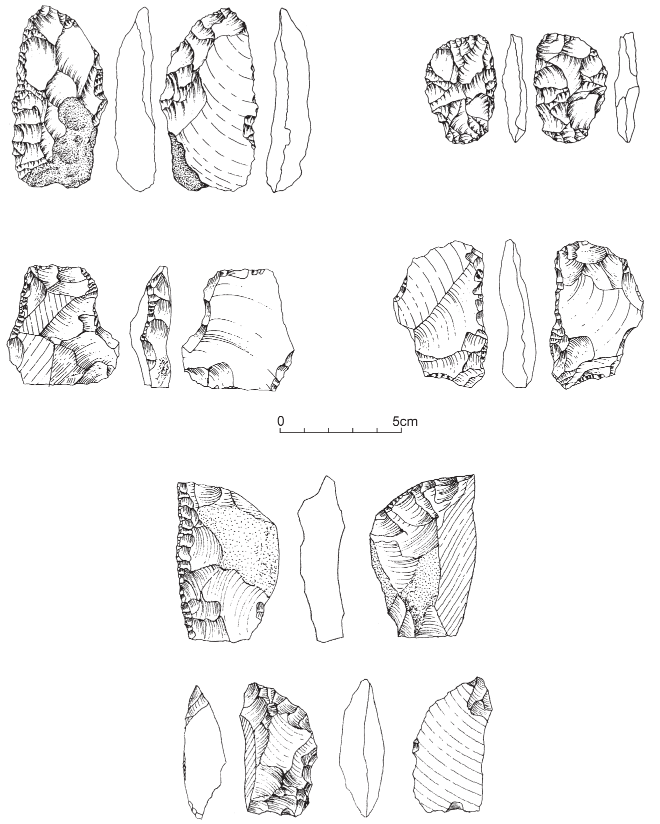

Figure 14. Grotte Bisnik près de Strzegowa (Pologne). Assemblage A3. Outils micoquiens: couteaux-racloirs asymétriques (d'après K. Cyrek).

La présence de sites micoquiens dans le sud de la Pologne pendant le stade isotopique 6 confirme une continuité de cette tradition culturelle en Europe centrale avant le dernier interglaciaire.

Une deuxième entité – le Levalloisien à pointes foliacées – est connue aussi bien dans le Bassin carpatique, dans le niveau V de la séquence lœssique déjà évoquée de Korolevo en Ukraine trans-carpatique (Gladilin & Sitlivy 1990), que dans le bassin du Dniestr supérieur à Veliki Glibochok, niveau III, près de Ternopil en Ukraine occidentale. Le lœss dans lequel le niveau III apparaît a été date par TL de 175.000±13.000 ans (Sitnik 2000). Ces deux ensembles ont fourni des produits de la technique Levallois (avec nucléus préférentiels) et des pointes foliacées très bien taillées, associées à des racloirs et des pointes moustériennes sur éclats ou pointes levalloisiennes (fig. 15).

Ajoutons que dans le bassin du Rhin apparaissent pendant cette période les industries du type de Rheindalen B3, généralement comparées au Moustérien occidental du type La Ferrassie (Bosinski 2000-2001). Les nombreux sites spécialisés dans les volcans de la Rhénanie (Schweinkopf, Wannen) appartiennent également à cette période.

Stade isotopique 5e (dernier Interglaciaire, Eemien) (fig.16)

Le denier Interglaciaire est caractérisé en Europe centrale par des conditions particulièrement favorables, documentées non seulement par l'extension des forêts, en particulier de la chênaie mixte, mais aussi par la présence d'essences méditerranéennes comme par exemple *Buxus* sp. Dans la faune, les éléphants, comme *Palaeoloxodon antiquus*, et les rhinocéros, comme *Stephanorhinus kirchbergensis*, occupent une place importante.

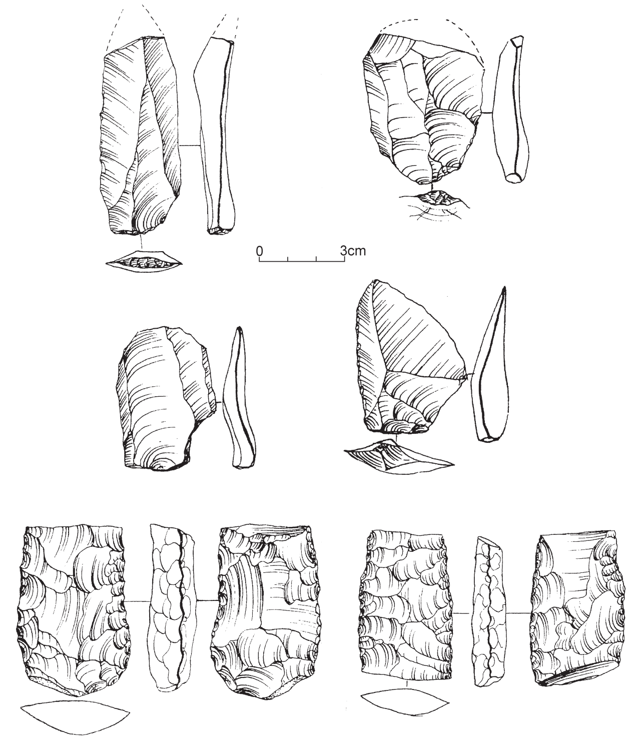

Figure 15. Veliki Glubochok (Ukraine occidentale). Outils du Levalloisien a pointes foliacées: pointes et éclats Levallois et pointes foliacées (d'après O. Sitnik).

L'Europe centrale – du point de vue taxonomique – est subdivisée dans cette période en deux parties: la partie occidentale, jusqu'au Bassin carpatique, est occupée par le Taubachien; par contre, la partie orientale, surtout à l'est de l'arc des Carpates, est occupée par les industries moustéro-levalloisiennes.

Le Taubachien (Valoch 2003) est caractérisé par la prolifération des instruments sur petits éclats, y compris les denticulés, les encoches, des racloirs de différents types, mais aussi des grattoirs et même des burins. Les pointes existent également, unifaciales (du type de Tayac), rarement bifaciales. La technologie est fondée sur des nucléus unipolaires et multi-directionels (Moncel & Neruda 2000), plus rarement sur des nucléus discoïdes, exceptionnellement sur des nucléus Levallois. Ces caractères sont proches de ceux qui sont diagnostiques pour les industries à éclats microlithiques du Paléolithique inférieur et moyen ancien (fig. 17). Cela a conduit K. Valoch à souligner une filiation techno-morphologique entre les industries du type Vertesszöllös-Bilzingsleben et le Taubachien. Cette hypothèse nous paraît beaucoup plus plausible que l'hypothèse qui explique l'origine indépendante des différentes industries microlithiques à éclats par l'adaptation aux milieux interglaciaires et surtout aux

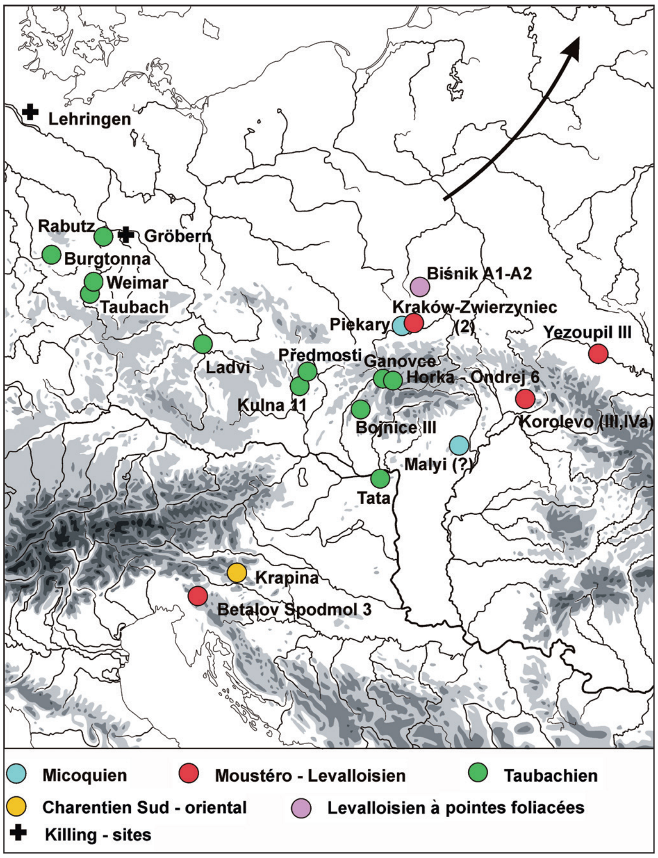

Figure 16. Carte des gisements datés du stade isotopique 5e.

environnements des sources thermales. Bien que la plupart des sites à industries microlithiques à éclats apparaissent dans les travertins qui se sont formés auprès de sources thermales, nous connaissons aussi ces industries dans des sites de plein air ou dans des grottes, non seulement dans des périodes interglaciaires, mais aussi pendant les Pléniglaciaires (par exemple, pendant le stade 8).

Le Moustéro-Levalloisien qui est caractéristique pendant le stade 5e surtout pour la partie orientale de l'Europe Centrale, semble dériver des industries levalloisiennes à pointes foliacées (fig. 18). La disparition des pointes foliacées pourrait s'expliquer par le retour aux techniques de chasse typiques de milieux forestiers, où le chasseur pouvait s'approcher du gibier, en utilisant de nouveau des lances légères uniquement en bois. Les industries moustéro-levalloisiennes dans cette période sont probablement connues aussi dans les Balkans, mais à l'exception des séquences de Betalov spodmol dans le Karst slovène (Brodar & Osole 1979), nous n'avons pas de preuve radiométrique de leur âge eemien.

Les Balkans ont sans doute été l'aire d'une nouvelle entité moustérienne apparaissant pendant l'Interglaciaire, le Charentien sud-oriental. C'est à ce faciès culturel que nous pouvons rapporter les Néandertaliens classiques de Krapina, mais il est également connu dans la couche interglaciaire XXIV de Crvena stijena, au Montenegro (Basler 1975). Ce faciès est caractérisé par l'utilisation simultanée de la technique discoïde et de celle en "quartier d'orange", et par la transformation des éclats par retouches scalariformes, surtout en racloirs épais du type Quina. Est-ce que ce faciès serait l'effet de la réutilisation et de la transformation des racloirs connus dans le "Moustérien typique" (comme dans le Charentien classique occidental), il est difficile d'en juger, puisque nous ne connaissons pas dans les Balkans de Moustérien typique datant de cette période; par contre, une différence technologique profonde existe entre le Moustéro-Levalloisien balkanique et le Charentien sud-oriental.

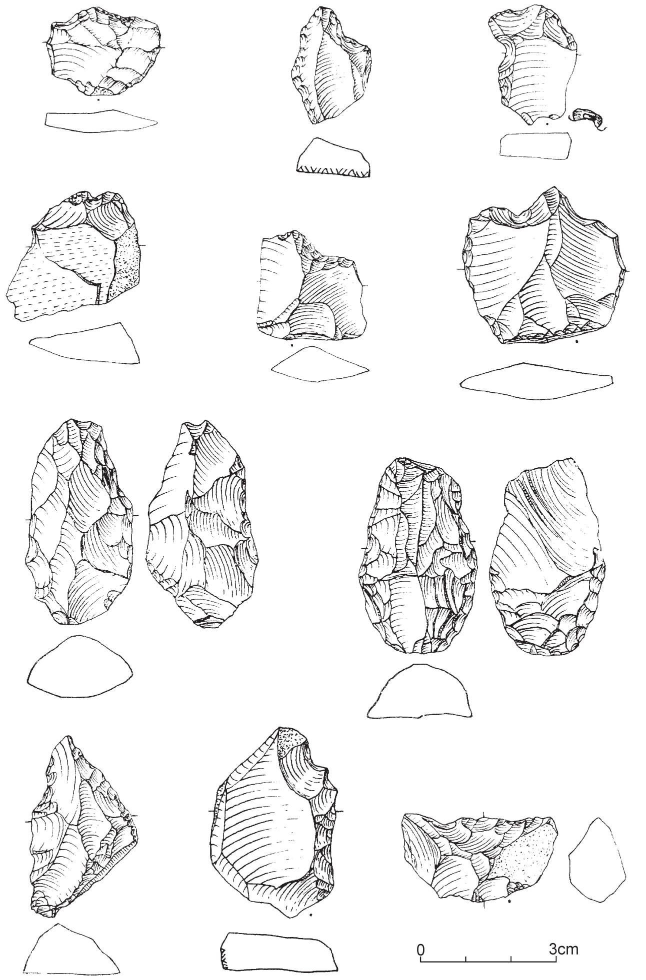

Figure 17. Kulna, couche 11. Outils du Taubachien: éclats à encoches, racloirs bifaciaux et outils denticules (d'après K. Valoch).

Le Micoquien interglaciaire est peu connu. Les seuls cas de présence du Micoquien eemien se trouvent éventuellement dans les sables remaniés probablement pendant cette période à Piekary IIa en Pologne (couche 7c2), dans les argiles d'altération de Piekary III et dans le paléosol de Malyin près de Miskolc en Hongrie.

Tous les faciès centre-européens datant du dernier Interglaciaire nous paraissent être le résultat d'une filiation à partir des périodes antérieures, plutôt qu'une adaptation aux conditions écologiques interglaciaires. Néanmoins, certaines traditions ont été mieux adaptées aux conditions écologiques spécifiques, comme par exemple le Taubachien (aux environnements des sources thermales) et le Moustero-Levalloisien (aux forêts développées sur les plateaux au nord et à l'est des Carpates).

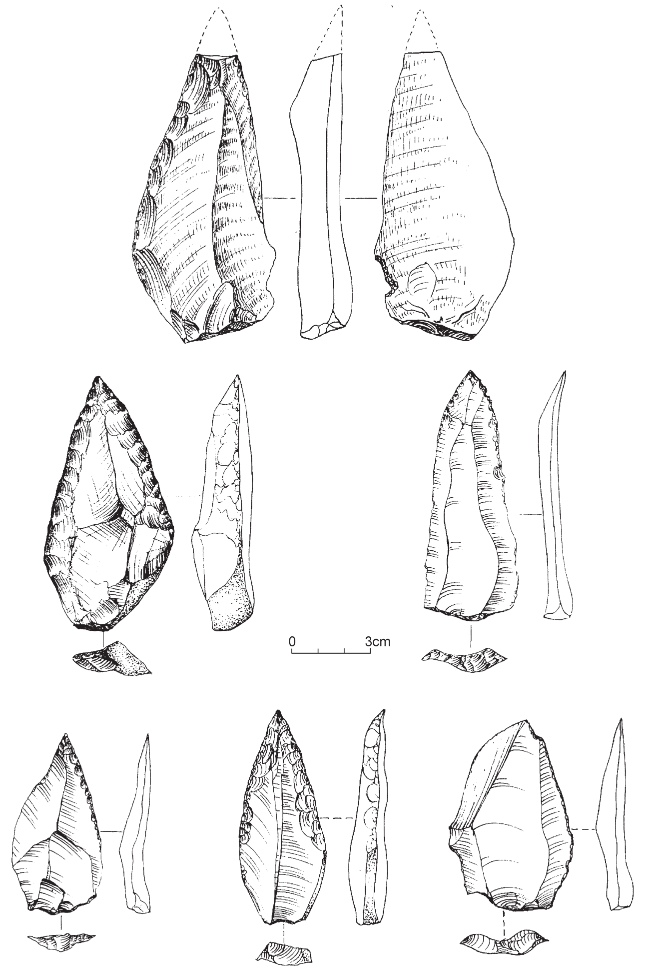

Figure 18. Yazoupil près de Galych (Ukraine). Outils moustéro-levalloisiens du niveau inférieur: pointes levalloisiennes (d'après O. Sitnik).

Le dernier Interglaciaire favorisait sans doute un progrès de l'habitat vers le nord, malheureusement les sites de cette période sur la Grande Plaine de l'Europe du Nord sont profondément ensevelis sous les nappes de dépôts du dernier Pléniglaciaire. Une découverte exceptionnelle, qui confirme la présence de l'habitat au nord de l'Europe pendant l'Eemien, a été récemment faite en Finlande.

Du point de vue technologique, le dernier Interglaciaire n'a pas introduit de progrès considérable. Nous observons même une certaine "décadence" dans la maîtrise de la taille lithique dans le Taubachien, qui est peut-être le résultat de l'accessibilité plus difficile aux matières premières à cause de la couverture forestière. Notons aussi que dans le Moustéro-Levalloisien, nous n'observons pas la présence des grands ateliers de transformation de silex, comme dans la phase ancienne du Paléolithique moyen.

Le progrès technologique pourrait, par contre, se manifester dans l'émergence des outils en bois de cervidé et en os. Les outils de ce type apparaissent aussi bien dans le Taubachien (par exemple, à Taubach où plusieurs pics en bois de cerf ont été signalés; Behm-Blancke 1960) que dans le Levalloisien interglaciaire de la grotte de Bisnik (assemblage A1; Cyrek [éd.] 2002).

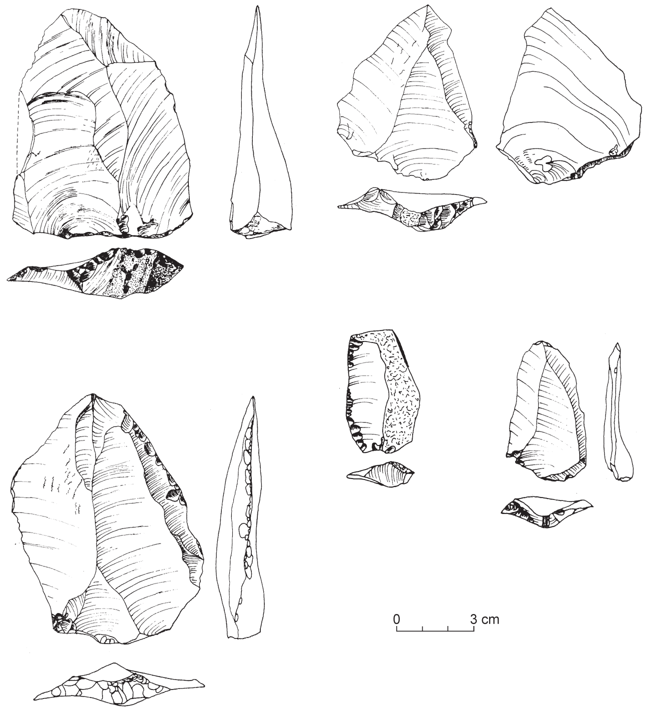

Figure 19. Krakow-Zwierzyniec (Pologne).Outils moustéro-levalloisiens de couches 5/6: éclats et pointes Levallois, racloir (d'après W. Chmielewski).

Notons aussi les manifestations symboliques enregistrées dans les sites interglaciaires. Il s'agit surtout de la fameuse plaquette de Tata, en Hongrie, façonnée en ivoire et couverte d'ocre (Marshack 1990) et de la collecte de fossiles (à Tata – Vertes 1965 – et à Stuttgart-Unterturkheim – Bosinski 2000-2001). Les ossements néandertaliens de Krapina présentent, en dehors des traces supposées de cannibalisme, les évidences des pratiques *post mortem,* qui entrent sans doute dans le répertoire de premiers comportements symboliques.

La période du Vistulanien ancien (OIS 5d-5a et 4) (fig. 20)

Le début du Vistulanien – entre 115.000 et 70.000 ans – était une période d'instabilité climatique; les périodes froides, peut-être même marquées par des transgressions de l'inlandsis autour de 100.000 ans BP (hypothétique stade de Torun dans la basse vallée de la Vistule), alternent avec des épisodes tempérés (interstades d'Amersfoort et de Brørup/Odderade). Les datations des sites de cette période sont particulièrement imprécises en raison de la faible fiabilité des méthodes radiométriques. Dans ces conditions, notre image de l'habitat du Paléolithique moyen récent est peu précise, aussi bien dans son cadre environnemental que quant aux synchronismes entre les sites.

La carte de cette période montre, en général, une subdivision entre les plateaux et la plaine au nord des massifs montagneux de l'Europe moyenne – dominés par le Micoquien (industries à "Keilmesser") – et le bassin danubien (y compris le nord des Balkans) où apparaît le Charentien sud-oriental et le Moustérien de faciès levalloisien à pointes foliacées (connu également

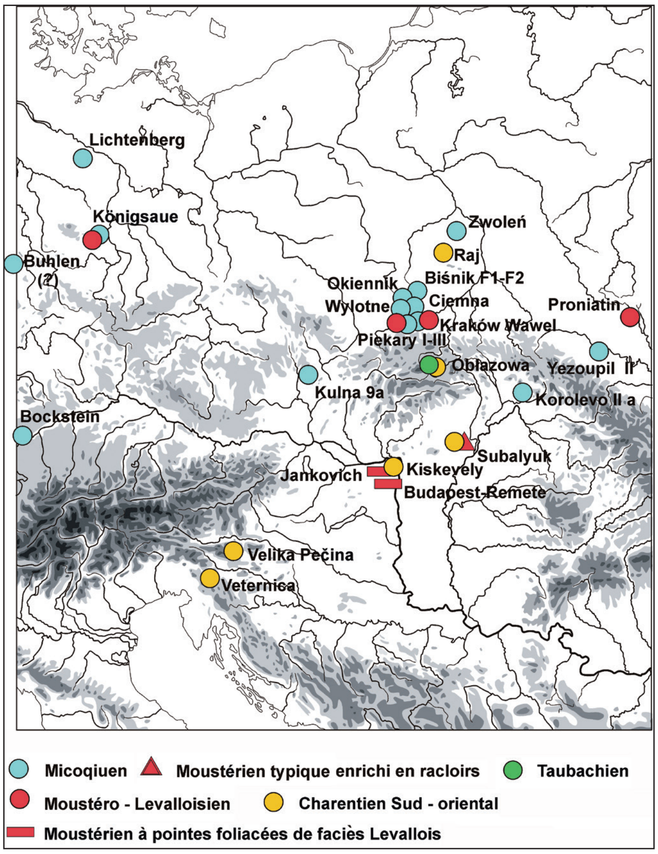

Figure 20. Carte des gisements datés des stades isotopiques 5d-5a et 4.

comme "Jankovichien"). Le Moustéro-Levalloisien apparaît dans toute l'Europe moyenne, généralement dans les mêmes séquences que le Micoquien, ces deux types d'ensembles étant fréquemment inter-stratifiés. Ce phénomène a conduit certains auteurs comme J. Richter (1997) et T. Utheimer (1998) à considérer ces deux entités comme les manifestations de mêmes groupes néandertaliens, mais dans des conditions différentes. Les restes de campements peu spécialisés avec des activités peu diversifiées correspondent au Moustérien; par contre, les campements de base occupés pendant des périodes plus longues correspondent au Micoquien. Cette hypothèse rappelle les explications des faciès moustériens occidentaux par l'intensité de la réduction (réutilisation) des pointes et des racloirs en fonction de la durée d'occupation (Dibble 1987). Néanmoins, ces deux cas ne sont pas comparables, puisque les principes techniques de façonnage des outils micoquiens bifaciaux (ou trifaciaux) diffèrent de ceux de la fabrication des racloirs uni- ou même bifaciaux dans le Moustérien. La plupart des bifaces ou couteaux-racloirs micoquiens sont façonnés sur des blocs de silex et non sur des supports tels que des éclats.

Les études dynamiques sur le façonnage des bifaces et des couteaux-racloirs micoquiens ont prouvé que ces outils correspondent à des modèles prédéterminés, et même la réduction (sous l'effet de la réutilisation multiple) n'a pas conduit à la transformation de ce modèle (Urbanowski 2004).

Il n'existe, comme l'a bien souligné G. Bosinski (2000-2001), aucune transition entre les formes moustériennes et micoquiennes. En particulier, les cas de séquences avec inter-stratification de ces deux types d'industries, comme à Piekary III (et peut être I; Kozłowski & Sachse-Kozlowska, sous presse) et à Konigsaue (Micoquien dans les couches A et C, Moustérien dans la couche B, les trois niveaux se trouvant dans l'unité stratigraphique lb; Mania & Toepfer 1973), ne relèvent aucun caractère transitoire entre ces assemblages.

Pendant les épisodes tempérés du Würmien (Vistulanien) ancien, le Micoquien est représenté non seulement dans les grottes des plateaux jurassiques, mais aussi à la frange méridionale de la Grande Plaine (voir les sites comme Lichtenberg, Konigsaue dans le bassin de l'Elbe, et Zwolen près de Radom en Pologne; Schild *et al*. 2000). G. Bosinski (2000-2001) a même essayé de justifier une distinction taxonomique entre ces deux complexes à "Keilmesser": celui des Plateaux et celui de la Plaine. Le cas de Zwolen montre qu'il s'agit de sites spécialisés dans la chasse, surtout aux chevaux, et la boucherie, datant des phases tempérées comme OIS 5a (80.000-75.000 ans) et même le léger réchauffement d'Ognon, juste au début de l'OIS 4 (environ 70.000 ans).

Une des différences entre le complexe Micoquien et le Moustérien en Europe centrale est le système d'approvisionnement en matières premières. Si dans le Micoquien les matières premières ont été distribuées surtout par les voies latitudinales (par exemple, on rencontre dans le site de Cracovie–rue Kopernika un couteau bifacial asymétrique micoquien en silex crétacé de Volhynie, donc provenant d'une zone située à 400 km vers l'est, ce qui témoigne des mouvements à grande distance entre l'est et l'ouest), dans les complexes moustériens et charentiens par contre, ces voies sont plutôt longitudinales (par exemple, la présence de silex de Swieciechow de la vallée moyenne de la Vistule dans les sites du nord-est de la Hongrie).

Dans cette période, le Bassin carpatique était occupé par les industries du Charentien sud-oriental, connu aussi bien en Croatie qu'en Hongrie. La séquence de la grotte Subalyuk dans les Montagnes de Bükk montre une succession de Moustérien de technique Levallois (enrichi en racloirs; Mester 1990), suivi de Charentien sud-oriental. Une autre séquence dans le cadre du début du Würmien est connue à la grotte Oblazowa, dans les Carpates occidentales près de la frontière entre la Slovaquie et la Pologne, où le Charentien a suivi le Taubachien (rare dans cette période en dehors des montagnes; Valde-Nowak *et al*. [éd.] 2003). La présence du Charentien dans les Carpates pourrait indiquer la voie d'une intrusion éventuelle de ces groupes vers le centre de la Pologne (grotte Raj près de Kielce; Kozłowski [éd.] 1972).

Le refroidissement de l'OIS 4 entre 70.000 et 60.000/55.000 ans a conduit sans doute à des mouvements des populations néandertaliennes en Europe centrale vers le Sud, et à l'abandon des plateaux lœssiques. L'absence de traces d'habitat dans le lœss du Pléniglaciaire inférieur dans toute la zone située au nord des massifs montagneux de l'Europe moyenne, indique que les conditions climatiques n'ont pas été favorables dans cette partie de l'Europe. Le manque de datations radiométriques correspondant à cette période, dans le Bassin carpatique et dans les Balkans, ne facilite pas l'identification des refuges d'occupation contemporains du maximum du Pléniglaciaire inférieur.

Quelques sites existent dans la partie septentrionale de l'Europe centrale, datant de la limite entre les stades isotopiques 3 et 4. Ce sont seulement des sites d'abattage ou de boucherie, éventuellement des bivouacs, confirmant des intrusions saisonnières de chasseurs néandertaliens de mammouths ou de chevaux dans le paysage de steppe-toundra de cette période. Il s'agit des sites localisés dans les milieux alluviaux, comme Wroclaw-Oporow (sites A1, niveau inférieur, et A2; Wiszniewski 2003), dans le bassin moyen de l'Oder, et éventuellement des rares restes lithiques dans le sommet du lœss du Pléniglaciaire inférieur (par exemple, à Raciborz-Ocice dans le bassin supérieur de l'Oder; Kozłowski 1964).

Parmi les innovations technologiques datant de la période du Würmien (Vistulanien) ancien, notons surtout l'apparition de l'exploitation des gisements des matières premières par fosses creusées, non seulement dans les dépôts meubles, généralement secondaires, mais aussi dans les calcaires, comme le montre le cas des mines ouvertes de limnoquartzites d'Avas-Tuzkoves (près de Miskolc, en Hongrie). Ces mines ont été exploitées par les porteurs du Moustérien à technique Levallois (Ringer 2003). L'exploitation des matières colorantes est également possible, mais compte tenu des controverses autour des mines de Balaton-Lovas en Hongrie, toujours incertaine (Dobosi 2000, Patou-Mathis 2002). Néanmoins, plusieurs meules à hématite de la grotte de Raj montrent l'intensification du traitement des matières colorantes (Kozłowski 1992).

Les Néandertaliens pendant l'Interpléniglaciaire (stade isotopique 3) (fig. 21)

La première partie de l'Interpléniglaciaire était caractérisée par la persistance du Micoquien dans le bassin supérieur et moyen du Danube. Les datations de 13 niveaux micoquiens dans l'unité G de Sesselfelsgrotte (vallée d'Altmühl, en Allemagne du Sud; Richter 2002) par C14 se situent entre 48.000 et 39.000 ans (sans tenir compte des datations plus récentes, probablement contaminées), mais les dates TL pour cette unité sont plus anciennes, notamment entre 61.900±10.900 et 51.100±10.200. Un cadre similaire de datations existe pour le niveau 7a, avec le Micoquien le plus classique, dans la grotte Kůlna en Moravie: les datations C14 se situent entre 38.600 +950/-850 et 45.660 +2.850/-2.200 ans; les datations TL entre 53.000-50.000 +5.000/-6.000 ans; Rink *et al*. 1996). Également, l'outillage micoquien de l'abri de Schulerloch en Allemagne a été daté par TL de 51.400±4.500 ans (Richter *et al*. 2000).

Toutes ces datations montrent que le Micoquien dans sa forme classique persistait au début de l'Interpléniglaciaire, mais seulement dans le bassin danubien; par contre, sur les plateaux de la Pologne du sud, jusqu'a présent, nous n'avons pas d'évidence de ce Micoquien tardif. Il est possible qu'entre 45.000 et 40.000 ans BP, le Micoquien dans le bassin du moyen Danube se transforme en Szélétien, une entité "de transition" vers le Paléolithique supérieur. Les datations récentes de la base de la séquence de la grotte Szeleta couvrent la période entre 43.000±1100 et >41.700 ans BP (Ringer 2002).

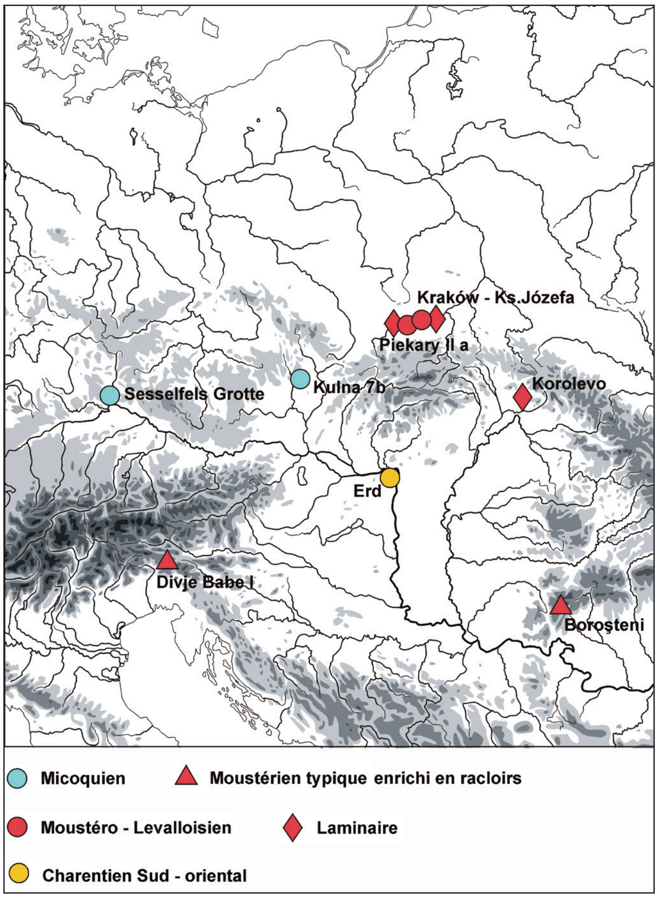

Figure 21. Carte des gisements datés du stade isotopique 3.

L'autre entité qui persiste jusqu'à l'Inter-pléniglaciaire est le Moustéro-Levalloisien, connu surtout dans le bassin supérieur de la Vistule et dans les Carpates. Il s'agit de deux types d'industries:

- à Korolevo, niveau II, les caractères technologiques levalloisiens sont plus faibles, mais la technique discoïdale plus abondante, associés à de nombreux racloirs moustériens (Koulakovska 1989);
- dans le cas de Piekary IIa (couches 7a-7c) et de Cracovie-rue Prince Joseph (surtout, niveaux supérieur et moyen), les outillages sont caractérisés aussi bien par la technique levalloisienne linéale et récurrente que par la technique laminaire volumétrique (fig. 22-23). Ces outillages sont datés par TL à Piekary II entre >60.000 et 35.600 ans (Valladas *et al*. 2003) et par C14 à Cracovie-rue Prince Joseph autour de 42.000 ans BP (Escutenaire *et al*. 2002).

Dans le cas de cette dernière entité, la technique laminaire était probablement le résultat d'une découverte indépendante et locale, sans lien, ni avec les industries laminaires qui se sont développées pendant les stades isotopiques 5c-5a en Rhénanie (Conard & Fisher 2000), ni avec les industries laminaires balkano-danubiennes "de transition", comme le Bohunicien (Kozłowski 2001a).

Notons enfin que dans le bassin du moyen Danube et au nord des Balkans, les industries du type Charentien sud-

Figure 22. Krakow-rue Prince Joseph (Pologne). Remontages des nuclei laminaires provenant du niveau moyen (phot. V. Sitlivy).

oriental et le Moustérien typique enrichi en racloirs ont continué à exister. Le site d'Erd près de Budapest, en Hongrie, atteste l'existence du Charentien dans une période entre 44.300/>50.000 (niveau inférieur) et 38.100 (niveau supérieur) (Gabori-Csank 1968). Néanmoins la présence d'*Equus hydruntinus* dans la faune pourrait suggérer des dates plus anciennes sur les bases paléontologiques (Dobosi 2000). Ce site repose également l'ancienne question de savoir si certains groupes de Néandertaliens ont été spécialisés dans la chasse à l'ours des cavernes, puisque ce site de plein air a exceptionnellement fourni 90% de restes de cet animal (sur 15.000 ossements déterminables).

Le Moustérien typique riche en racloirs du type balkanique est également bien connu dans la période entre 50.000 et 40.000 ans, mais les dates radiométriques précises sont rares. Une intéressante séquence de cette entité est connue à la grotte Divje Babe, dans les Alpes de Slovénie, où les couches 2 à 8 ont fourni des haltes de chasse moustériennes avec outillages pauvres, mais typiques. Les couches 6 à 8 ont été datées entre 43.400 +1.000/-1.400 et 49.200 +2.300/-3.200 ans BP (Turk [éd.] 1997). La partie supérieure de la couche 8 (datée d'environ 45.000 ans BP) a fourni l'os d'ours avec perforations, interprété comme flûte néandertalienne. Cette interprétation est l'objet de nombreuses controverses.

La grotte Cioarei-Borosteni dans les Carpates méridionales a fourni 9 niveaux du Moustérien datées par C14 entre 52.000 +5.300/-3.200 et 47.200 +2.900/-2.600 ans BP, ainsi que des outillages assez pauvres, indiquant l'utilisation de la grotte comme abri de chasse (Cârciumaru *et al*. 2000), ce qui n'empêche pas la présence dans la couche E de fragments de stalagmites qui ont servi de "godets" et portent des traces d'ocre rouge.

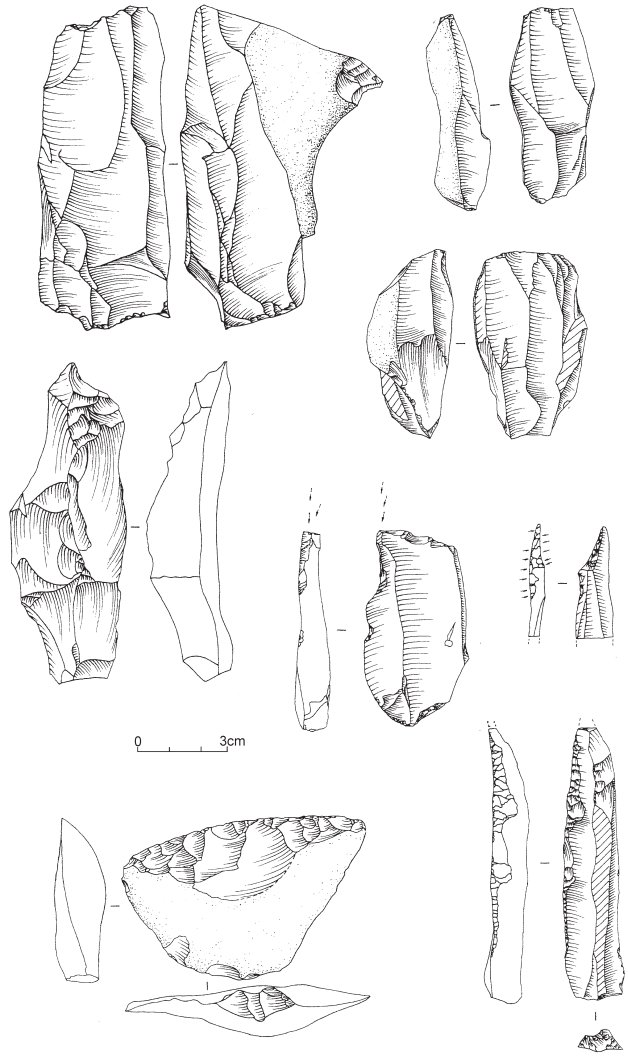

Figure 23. Piekary IIa près de Krakow (Pologne). Outillage laminaire de la couche 7c: nucleus bipolaires volumétriques à lames, lame à crête, burin sur troncature retouchée, racloir, troncature à retouche bipolaire, lame à dos.

Les industries moustériennes tardives, en particulier dans les Balkans et dans le Bassin carpatique, montrent une certaine "détérioration" technologique qui se manifeste non seulement dans l'abandon successif de la technique levalloisienne, mais aussi dans l'utilisation de matières premières plus différenciées, parfois difficiles à tailler (comme le quartz), généralement locales, montrant une faible exigence de tailleur.

Tous ces industries – aussi bien charentiennes que moustériennes – n'ont pas évolué vers la transition au Paléolithique supérieur. Il est difficile d'indiquer quel était le contexte culturel des derniers Néandertaliens en Europe centrale à cause des problèmes que pose la couche G1 de la grotte de Vindija en Croatie. Il est probable que la plus récente date en Europe centrale pour les vestiges néandertaliens de cette couche (29.080±400 et 28.020±360 ans BP; Smith *et al*.

1999) corresponde plutôt aux objets moustériens tels que les racloirs, éclats Levallois et pointe foliacée, qu'aux sagaies et grattoirs aurignaciens découverts dans la même couche G1 (Karavanic *et al*. 1998).

Conclusion

Cette longue histoire des Néandertaliens, vue de la perspective de l'Europe centre-orientale, montre que certaines entités distinguées sur la base des caractères techno-morphologiques se sont développées pendant des périodes assez longues, occupant parfois des territoires distincts, parfois inter-stratifiées entre eux dans les mêmes régions géographiques. Pour le premier types d'entités, nous sommes presque certain qu'elles correspondent aux groupes appartenant aux mêmes traditions culturelles; pour le deuxième, nous n'avons pas cette certitude et nous envisageons aussi la possibilité de différences fonctionnelles.

Chaque période de l'évolution culturelle des Néandertaliens, correspondant aux cycles climatiques majeurs, a introduit des innovations technologiques, de nouveaux modes d'occupation et d'exploitation du territoire et de nouveaux éléments de culture symbolique. Ces innovations sont partiellement l'effet des adaptations aux conditions environnementales, partiellement indépendantes des changements du milieu naturel.

Les différentes entités culturelles étant l'œuvre des Néandertaliens ont persisté jusqu'à la deuxième moitié de l'Inter-pléniglaciaire, étant contemporaines des "cultures de transition" vers le Paléolithique supérieur et partiellement aussi à l'Aurignacien. Néanmoins, en Europe centrale, seul le Szélétien pourrait dériver du fond local micoquien; par contre, les autres "cultures de transition" n'ont pas, pour le moment, de racines locales dans cette partie de l'Europe centrale.

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STAGE 3 CLIMATE AND THE UPPER PALAEOLITHIC REVOLUTION IN EUROPE: EVOLUTIONARY ERSPECTIVES[1]

Paul MELLARS
Department of archaeology, Cambridge University, Downing Street, CB2 3DZ Cambridge, U.K.

The nature and causes of the extraordinary "revolution" in human behavioural patterns which marked the transition from the Middle to the Upper Palaeolithic periods in Europe have generated a large and spirited literature over the past 20 years. Innovations that are customarily linked with this transition are reflected in almost all aspects of the archaeological record: major changes in the form and underlying technology of both stone and, above all, bone, antler and ivory artefacts; the emergence of more extensive distribution and exchange networks for raw materials; the earliest fully ceremonial burial practices; more highly structured living sites; and an effective "explosion" in various forms of explicitly symbolic expression, ranging from a sudden proliferation of laboriously shaped beads and other forms of personal ornaments, through symbolic notation systems, to remarkably varied and sophisticated forms of naturalistic art. There are also a number of more inferential but apparently closely related shifts in the demographic, social and subsistence patterns of the human groups (Bar-Yosef 1998, 2002; Gibson 1996; Sherratt 1997; Gamble 1999; Klein 2000; Kuhn & Stiner 2001; White 1993, 1997; Marshack 1991; Mellars 1973, 1989a & b; 1996a & b, 2001, 2004).

If the basic features of these changes in the archaeological record are now widely agreed, the precise causes and mechanisms of the changes remain much more controversial. Inevitably, current discussions of these issues are closely intertwined with debates over the nature and timing of the replacement of archaic (i.e. Neanderthal) by anatomically modern human populations (e.g. Stringer & McKie 1996; Stringer 2002; Clark & Willermet 1997; Lahr & Foley 1998; Zilhão & d'Errico 1999; Richards & Macaulay 2000; Krings *et al.* 2000; Hublin 2000; Eswaran 2002). Equally controversial is the extent of any changes in the cognition - or indeed innate cognitive *capacities* - of the populations involved (e.g. Donald 1991; Mithen 1996; Noble & Davidson 1996; Mellars & Gibson 1996; Deacon 1997; Mellars 1991, 1998, 2003; Lewis-Williams 2002). It is in this area that Colin Renfrew himself has made major contributions to the modern human origins debate (1996, 2001, 2002).

To attempt even a cursory review of all these issues in a single paper would be at best optimistic. Here I want to focus on just one specific aspect of the current debates, namely, the impact of the rapid changes in climatic and related environmental conditions which are now known to have occurred over the period of the Middle to Upper Palaeolithic transition in Europe, and the ways in which the human populations may have reacted to these changes. The critical question in the present context is how far - if at all - these adaptations may help to explain the patterns we see in the archaeological records of the conventional Middle-Upper Palaeolithic transition in Europe. As discussed further below, the main aim is to view these changes within an essentially Darwinian, evolutionary framework - that is, in terms of the effects of specific behavioural innovations or adaptations on the overall survival and reproductive capacities of the human populations involved (see Shennan 2002, with associated references). Some of the potential problems with this approach are discussed in the final section.

Environmental oscillations

The transition from the Middle to the Upper Palaeolithic falls around the middle of the last glaciation in Europe, during the period now generally referred to as Oxygen-isotope Stage 3 (OIS-3) as defined in the oxygen-isotope records from deep-sea cores, and extending from *c.* 60,000 to 25,000 BP in radiocarbon terms[2] (van Andel 1998, 2002; van Andel

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[2] All radiocarbon dates used here are quoted in 'uncalibrated' terms. For the period of OIS-3, this is likely to underestimate the true (calendrical) age of the samples by between 2000 and 3000 years (Voelker *et al.* 1998).

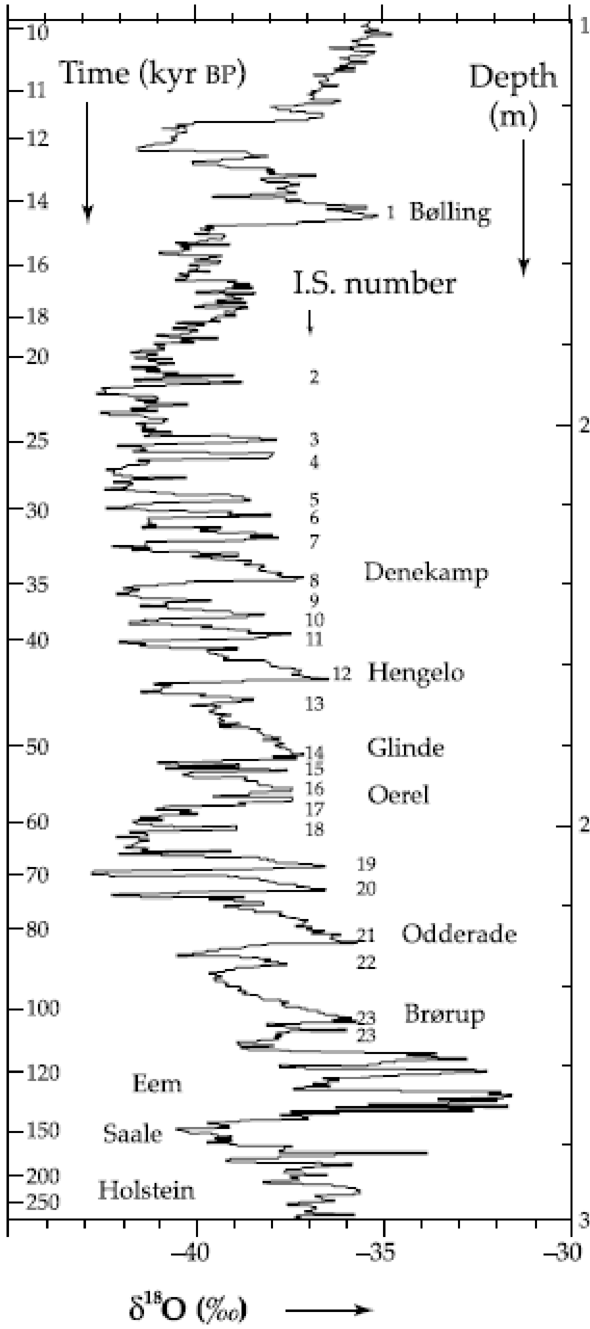

Figure 1. Climatic fluctuations during the last glaciation, as reflected in variations in oxygen-isotope ratios in the "Grip Summit" ice core from Greenland (after Dansgaard *et al*. 1993). Note that the timescale is in uncalibrated radiocarbon years, which are approximately 2000-3000 years older than uncalibrated dates for the later part of OIS-3.

& Tzedakis 1996; Shackleton *et al*. 2000). Stated briefly, this period is characterized by a rapid series of oscillations between periods of cold, essentially full-glacial climate, and much warmer interstadial episodes - the so-called "Dansgaard-Oeschger" events (fig. 1). These oscillations are best reflected at present in the fine-grained and relatively well-dated climatic sequences recorded in the Greenland ice cores (Dansgaard *et al*. 1993). There are also a number of long pollen sequences from sites such as La Grande Pile in France and Monticchio in Italy, and newly emerging sequences of combined pollen and oxygen-isotope records from cores off the Iberian coast (Woillard & Mook 1982; Huntley *et al*. 1999; Shackleton *et al*. 2000; Sanchez Goñi *et al*. 2002). Largely through the efforts of Tjeerd van Andel and his collaborators in the mutidisciplinary "Stage 3" project, we now have an increasingly clear picture of climatic and related environmental events throughout this period in Europe, although specific details of these oscillations and their reflection in different aspects of the related palaeoenvironmental records (pollen, faunal assemblages, etc.) remain problematic (van Andel & Davies 2003).

Even allowing for these uncertainties, however, we can now see that shifts from major cold peaks in the OIS-3 sequence to the intervening warm peaks are likely to have involved temperature changes of at least 5-7°C, with even greater contrasts between seasonal extremes of temperature and associated degrees of rainfall and snow cover. Vegetation records from several parts of Europe reflect changes from essentially open tundra or steppe-like vegetation in the colder periods to at least partial forest cover in the intervening warm phases, the precise patterns of vegetation varying along both north-south and east-west transects across Europe (Huntley *et al*. 1999). Overall, the boundaries between major vegetational zones (as for example between open and more wooded landscapes) could have shifted by several hundred kilometres between adjacent stadial and interstadial episodes (van Andel & Tzedakis 1996).

Similar shifts in the composition of the associated faunal communities would have been equally significant. In southwestern France, for example, we now see that faunal communities at different points during OIS-3 shifted from those heavily dominated reindeer (sometimes comprising over 90 per cent of the total faunal assemblages from contemporaneous archaeological levels) in the colder periods to those dominated by large bovids (*Bos* or *Bison*), horse, or even red deer during the major interstadial phases (Delpech 1983; Boyle 1990; Mellars 1996a:37-48).

The main point to stress here, however, is not simply the scale but the *rapidity* of many of these climatic and ecological oscillations. The earlier part of OIS-3, from *c*. 60,000 to 40,000 BP, was dominated by three major interstadials (Oerel, Glinde and Hengelo), each around 3000-5000 years in length, with shorter intervening cold peaks of around 1000-2000 years duration (fig. 1). In the later part of the period there was a complex succession of much shorter warm/cold oscillations (interstadials 5-11 of the Greenland ice-core sequence) in some cases at intervals of only 1000-2000 years. Some of the transitions from the cold stadial episodes to the following warm phases occurred within a space of only a few decades (Dansgaard *et al*. 1993; Shackleton *et al*. 2000; van Andel 2002).

Clearly, this highly abbreviated account of the complex pattern of ecological oscillations which characterized OIS-3 hardly does justice to the complexities of the relevant palaeoenvironmental records. One major question, for example, is exactly how rapidly the vegetational and faunal communities in the different areas of Europe were able to respond to the rapid changes in climate: to what extent these communities were fully in equilibrium with the associated climatic conditions (Huntley *et al*. 1999). We should also keep in mind the difficulty of dating accurately many of the changes in the environmental and archaeological records, given the current limitations of radiocarbon and other methods in this time-range. Above all, there is the problem of radiocarbon calibration and the complex fluctuations in the atmospheric radiocarbon content over the period in question (Voelker *et al*. 1998; Beck *et al*. 2001; Pettitt & Pike 2001). Nevertheless, the basic message of these recent studies of OIS-3 is clear: that the human communities throughout this period would have been forced to cope with a closely-spaced succession of climatic and related environmental changes which may have impacted, repeatedly and substantially, on many different aspects of their demographic and behavioural adaptations. What follows is an attempt to explore some of the ramifications of this conclusion for specific aspects of the archaeological records from Europe (see also Hopkinson 2004).

Demographic adjustments

Given the nature and scale of these climatic and environmental changes, certain basic demographic adjustments by the human populations could be seen as largely predictable, if not inevitable, in ecological and demographic terms. Briefly, these can be summarized as follows:
1. Arguably the most direct and predictable response would be shifts in the total geographical ranges exploited by specific local and regional populations, in response to displacements in regional ecological or vegetation zones. These would no doubt be most directly predictable at the geographical limits of human occupation - especially at the northern limits of the human ranges, but also perhaps in the exploitation of more marginal ranges at the interface between lowlands and uplands. During warmer phases, populations could be expected to have expanded their ranges towards the north, in much the same way as reflected in the late glacial and early postglacial colonization of Northern Europe (Housley *et al*. 1997). They may also have extended at least seasonally into higher altitudes (Roebroeks & Gamble 1999). In colder phases some corresponding contraction of ranges towards the south, or to lower elevations, might be anticipated.

But if we assume a fairly close correlation between the geographical ranges occupied by specific populations and the nature of local ecological or environmental conditions (and their associated resources) then one could also reasonably predict shifts in the ecological ranges exploited by particular groups in more southerly areas (Binford 2001; Kelly 1995). In other words, in most areas of Europe we might expect significant shifts in these population ranges at frequent and, in some cases, closely-spaced intervals throughout the time range of OIS-3.

2. Significant changes in local and regional population densities would seem equally predictable in ecological terms. As studies by Birdsell (1968), Binford (2001) and others have documented, hunter-gatherer population densities in general seem to be highly dependent on either the primary productivity of the ecosystem as a whole or on the frequency of some specific resources in these ecosystems that were critical to group survival. The nature of these population/ resource relationships can be visualized in different ways:
- in terms of the availability of specific food resources during annual, seasonal or longerterm episodes of resource scarcity (according to the demographic "law of the minimum");
- in terms of the effects of these resource fluctuations on the overall mobility, stress and work-load of the human groups, and especially the effects on mobility and birth-spacing in women (e.g. Lee 1979; Pennington 2001);
- or indeed the similar impact of ecologicallybased social disruptions on human productivity and mating systems in general (Read & LeBlanc 2003; Shennan 2002; Mellars 1996a:345-348).

However the relationships are visualized - whether in crude Malthusian or more complex social terms - some significant shifts in human population numbers and local population densities would again seem largely inevitable and predictable in response to the major ecological oscillations of OIS-3.

3. Similar factors could no doubt have led in certain contexts to episodes of local population extinction. Evidently, such population extinctions would have related closely to the absolute sizes of the local mating networks (and hence their vulnerability to short-term fluctuations in total population numbers) as well as to their dependence on certain specific resources which were critical to group survival, and the scale of the fluctuations in these resources during periods of climatic change (Wobst 1974; Zubrow 1989; Gamble 1999; Binford 2001). Smaller, relatively isolated populations would inevitably have been more vulnerable to ecological oscillations than larger populations with more extended mating networks. Similarly, groups dependent on highly specialized economic resources would in general have been more vulnerable to fluctuations in resource abundance than groups with a more diverse and generalized subsistence base. But overall, episodes of local population extinction would again seem largely predictable if not inevitable at particular times and locations during OIS-3 (cf. Read & LeBlanc 2003). One important corollary of this, of course, is that any such local population extinctions would have provided a further opportunity for the range-expansion of other, adjacent populations to colonize the newlyvacated ecological space.

4. Finally, one potentially critical consequence of the various demographic processes outlined above would have been repeated episodes of increased interaction, and varying degrees of social and demographic competition between the local population units, in response to any climatically induced demographic changes. As local population densities increased or decreased, or the geographical ranges exploited by particular groups shifted in response to changes in the distribution of specific resources or ecological zones, then both the pressures and the opportunities for local groups to expand into, or impinge upon, the territories and territorial resources of their neighbours would inevitably have increased (Read & LeBlanc 2003). It is this direct and recurrent demographic competition between adjacent groups which, combined with

the other adaptive and evolutionary pressures discussed below, could have imposed especially strong selective pressures on the behavioural patterns of the human groups.

Behavioural adaptations

The point of the preceding discussion is to underscore the fact that the human populations occupying the different areas of Europe during the period of OIS-3 would have had to cope with a succession of climatic and associated environmental changes which were not only substantial in scale (whether in terms of temperature, rainfall, snow-cover, vegetation and animal populations) but were above all in some cases extremely rapid and closely-spaced in time. The individual cycles from major cold peaks to intervening warm peaks were frequently spaced at intervals of only one or two millennia. In other words, the human populations had to cope with landscapes which were in an almost continuous process of change, with periods of relative climatic (if not necessarily ecological) stability lasting at most only *c*. 1000 to 3000-4000 years.

To some extent, as discussed above, the impact of these environmental changes could have been mitigated by corresponding demographic adjustments: shifts in the spatial ranges occupied by individual groups, increases or decreases in local population densities, or changes in the annual or seasonal mobility patterns of the human groups. But presumably there would have been equal pressures to change not only the demographic organization of the populations but many other features of their economic, technological and social behaviour. As noted earlier, I am assuming here that the most appropriate way to view these adaptive changes is from an explicitly Darwinian, evolutionary perspective, which places the primary emphasis on the capacity of any economic, technological or social adjustments to increase the long-term reproductive viability of the individuals or societies in question, and thereby to ensure their long-term continuity in the evolutionary record (see Shennan 2002 for an excellent recent review of these issues). The assumption, in short, is that however these behavioural adjustments or innovations originated - whether by "pure" innovation (analogous to a genetic mutation) or by increasing application of elements already present in the existing behavioural systems - the strong selective pressures imposed by the major climatic oscillations of OIS-3 would lead to an increased frequency in these patterns of behaviour in competition with less appropriate (i.e. less selectively advantageous) forms of behaviour.

Viewed in these terms it would be reasonable to anticipate significant changes in at least four separate behavioural dimensions throughout OIS-3:

Subsistence changes

Changes in subsistence strategies are perhaps the most direct and obvious behavioural response to the ecological oscillations of OIS-3. Here one might anticipate changes not only in the total range and relative importance of the different food resources exploited (largely in response to shifts in the frequencies of the resources in the local environment) but also changes in the strategies of exploitation of these resources: in specific hunting strategies, hunting technologies, food-processing or storage techniques, or in the spatial and logistical movements of the human groups to cope with variations in the annual or seasonal distribution of different resources (Binford 2001; Torrence 2001; Kelly 1995). However these changes are envisaged, shifts in the overall structure and organization of subsistence strategies are likely to have been under especially strong selective pressures throughout the rapid environmental oscillations of OIS-3.

Technological changes

Changes in the range and organization of different forms of material technology are likely to have been under similar selective pressures. Some of these would no doubt have derived from changes in subsistence patterns discussed above, such as in the form, construction or complexity of hunting missiles or plant-food processing equipment; technology related to the butchery and transportation of animal carcasses, and the subsequent processing of the carcasses and bone residues; or techniques employed in the freezing, drying or long-term storage of food supplies (Torrence 2001).

Other technological changes could have derived more directly from the nature of the climatic fluctuations themselves - and especially from the impact of extreme winter conditions. Possible adaptations here would have included changes in the design and preparation of skin clothing; similar changes in the construction of living shelters; or changes in travel or transportation technology arising, for example, from the depth and duration of snow cover, or the impact of frozen rivers on winter travel. Any major changes in the availability of different raw materials (such as the effects of heavy vegetation or prolonged snow cover in obscuring flint supplies, or changes in the availability of antler, ivory or particular plant materials) could no doubt have had a similar impact on at least some aspects of technology. Other selective pressures on the precise forms of material technology could no doubt have derived from more social and demographic factors, as discussed further below.

Social changes

The most significant social changes during the period of OIS-3 are likely to have been related to the various demographic adjustments discussed in the preceding section. Two factors may have been especially significant in this context. First, it could be argued that any major increase in local or regional population densities would almost inevitably have created an increased level of competition between adjacent groups for the use of both space and resources (Read & LeBlanc 2003). In certain contexts this might have led to an increased emphasis on group territoriality and the clearer definition of territorial boundaries - and, perhaps, corresponding pressures towards an increased emphasis on social identities and associated "ethnicity" between adjacent territorial groups (Dyson-Hudson & Smith 1978; Price & Brown 1985; Keeley 1988, 1996; Mellars 1996b:190-191; Rowley-Conwy 2001; Binford 2001).

Secondly, it can be argued that any sharp increase in local population densities would at least *facilitate* the formation of larger and perhaps longerterm residential groupings, and perhaps have encouraged the formation of such groups as a direct adaptive response to greater efficiency and group security in the use of the available resources - especially the use of large game resources (Binford 2001; Price & Brown 1985; Mellars 1996b:186-188). As many ethnographic studies have shown, formation of these larger social aggregates can also be heavily dependent on localized concentrations of food resources at particular times and places in the environment (Kelly 1995; Rowley-Conwy 2001; papers in Lee & Devore 1968). It could be argued in turn that the formation of larger or more sedentary residential units would certainly have provided the essential *pre-conditions* for any increased separation of distinct social, economic or personal roles within the groups in question, and might well have exerted significant selective pressures towards social separation and role definition, in terms of the increased efficiency or increased social integration and cohesion of the local groups (Price & Brown 1985; Keeley 1988; Mellars 1996b:188-190; Rowley-Conwy 2001). Whether or not similar factors could have favoured other kinds of role separation and identification, such as those based on age, gender or kinship relationships, is no doubt more debatable. Lastly, as Gamble (1999) and others have emphasized, certain patterns in the spatial and chronological distribution of economic resources (notably the emergence of more localized, patchy or unpredictable distributions of the resources) could well have favoured a significant increase in the spatial scale of social contact between widely-dispersed human groups, in order to provide greater longterm security against the effects of short-term and unpredictable fluctuations in local food supplies. As Féblot-Augustins (1993, 1999) has argued, similar social factors could no doubt have operated at the level of lithic and other raw material supplies - though of course these (at least in the case of lithic resources) would have been less directly under the influence of climatic change.

Symbolic changes

The ways in which the demographic and social patterns discussed above could have impinged on various forms of "symbolic" expression and interactions between local groups, or individuals within these groups, have been discussed at length in the earlier literature (Wobst 1977; Wiessner 1983, 1984; Price & Brown 1985; Keeley 1988; White 1993, 1997; Mellars 1985, 1996b; Knight *et al*. 1995; Gamble 1999; Kuhn *et al*. 2001). The usual line of argument is that the emergence of a clear symbolic component in material culture could be selectively favoured by at least two social situations:

- first, by the emergence of increased densities of local populations leading (as discussed above) to increased territoriality between adjacent groups, and arguably an increased need for certain forms of material symbolism to reflect and reinforce these emerging territorial, social and ethnic divisions (Wiessner 1983; Gamble 1999; Mellars 1996b:190-191; Read & LeBlanc 2003);
- second, by any substantial increase in the total size, permanence or sedentism of local residential groups, which would arguably favour the emergence of separate social, economic or personal roles within these larger residential units generating the associated "need" for symbolic artefacts, body ornamentation, or whatever, to clearly identify and to communicate these social identities to other members of the group (Wiessner 1984; Price & Brown 1985; Mellars 1996b:188-190; White 1993, 1997; Kuhn *et al*. 2001).

Arguably both forms of symbolism - whether at the level of group ethnicity or of individual social or personal identity - could also be reflected in other dimensions of material culture. One such may have been the degree of "stylistic" (as opposed to "functional") investment in the precise forms of stone or bone/antler tools, leading, as discussed further below, to an increased element of consciously imposed form or visual symbolism in the detailed shapes and visual appearance of the tools (Mellars 1989b, 1991). Any increase in group ceremonial or ritualistic activities (social, economic, religious) would, needless to say, provide a further powerful stimulus to an increased symbolic investment in material culture.

Late Mousterian innovations

If we turn now from theoretical speculation to archaeological reality, the central question is how far we can recognize any hard evidence for the kinds of behavioural and cultural adaptations discussed above that could potentially be attributable to the climatic and environmental instability of OIS-3. Here I want to focus initially on the earlier part of OIS-3 between *c*. 60,000 and 40,000 BP - the time-range of the later Middle Palaeolithic or Mousterian of Europe, prior to the critical cultural threshold of *c*. 40,000 BP[1]. As we shall see, the whole issue of the "Upper Palaeolithic revolution" in Europe poses a special set of questions, which will be discussed separately in the following section. The primary focus of what follows will be on the archaeological evidence from southwestern France: partly, no doubt, as a reflection of my own particular research interests, but above all as this is still the area that provides by far the richest, best-documented, best-dated and most fine-grained record of late Neanderthal behavioural patterns anywhere in Europe.

The earlier part of OIS-3 (*c*. 60,000-40,000 BP) coincides broadly with the last major episode of Middle Palaeolithic technology in southwestern France, in the form of the Mousterian of Acheulian Tradition (usually abbreviated to "MTA": see Mellars 1996a for a full review of the relevant dating and technological succession). Climatically, this period spans two major episodes of relatively warm climate (the Glinde and Oerel interstadials) together with a number of shorter oscillations that collectively comprise interstadials 13 to 17 of the Greenland ice-core sequence (fig. 1; Dansgaard *et al*. 1993). The issue at stake is how far we can identify any significant shifts or innovations in the archaeological records of this time range which could be attributed to the kind of climatically driven evolutionary mechanisms discussed in the preceding sections. The answer, I would suggest, is that while we can perhaps detect certain potentially significant innovations in the archaeological records of the MTA, the precise significance of these changes remains difficult to evaluate.

Demography

One of the most striking features of the MTA is the relatively large number of site locations which have now been documented - especially from open-air localities between the major river valleys of the region (Mellars 1996a:245-268, fig. 8.11). These certainly dwarf the numbers of sites which can be confidently attributed to the earlier stages of the Mousterian sequence (Ferrassie, Quina, Denticulate, etc.) and could no doubt be seen as a reflection of some major population expansion during the final stages of the Mousterian succession, perhaps in response to the generally milder and more ecologically-productive conditions of OIS-3 (fig. 2). The problem in this case (as in most site-based estimates of population densities) is to know how far the large total of open-air MTA sites is simply a reflection of either the high visibility of the distinctive bifacial hand-axe forms in surface collections (and no doubt their special attractions to collectors), or simply a much more mobile and dispersed pattern of use of open-air localities during the major warm phases of early OIS-3, compared with the much colder conditions of the preceding OIS 4. Since a high proportion of the recorded MTA sites seem to consist of isolated finds of just one or two bifaces, particular caution is required (Mellars 1996a:262).

Subsistence patterns

The widespread distribution of open-air MTA sites on the plateaux of southwestern France could no doubt be seen (as noted above) as a simple response to milder and more ecologically-productive environmental conditions, with a corresponding broadening of the subsistence base to include a wider range of more temperate species (red deer, horse, bison, aurochs, etc.) as opposed to specialized steppe/tundra species such as reindeer (Mellars 1996a). Potentially more significant is the occurrence in at least some late Mousterian sites of much more highly specialized faunas, focused heavily on the exploitation of large bovids - either *Bison* or *Bos primigenius*. Examples of these highly-specialized bovid faunas have now been documented from apparently late Mousterian contexts in at least two or three open-air or plateau-top locations in southwestern France (most notably Mauran and Le Roc). They may be reflected equally in the old faunal collections from the classic MTA levels in the Le Moustier rock-shelter in the Vézère valley (Mellars 1996a: 48, 231-244; Farizy *et al*. 1994; Jaubert 1999). In Germany and Italy the possibility of more specialized faunal exploitation during the later stages of the Middle Palaeolithic has been raised (Stiner 1994; Gaudzinski 1999; Kuhn & Stiner 2001). In all these cases, of course, one has the perennial problem of assessing how far the documented *quantitative* specialization in the faunal assemblages represents a deliberate element of *selection* on the part of the human groups, and how far it could simply reflect the natural composition of the local faunal communities at the specific times and locations in question (Mellars 1996a:196-201, 2004; Grayson *et al*. 2001). Nevertheless, the possibility remains of some significant shift in faunal exploitation patterns during the later stages of the Middle Palaeolithic, perhaps (though highly speculatively) reflecting more logistical organization of hunting patterns, and conceivably improved forms of hunting technology.

Social organization

In terms of social patterning we can still say very little about potential changes in the later Middle Palaeolithic with the exception perhaps of hints of a shift towards a more intensive pattern of site occupation in some of the cave and rock-shelter sites. The MTA levels at Pech de l’Azé I, for example, seem to be characterized by an unusually high density of archaeological material, associated with a succession of closely-spaced hearths (Bordes 1954-55, 1972). In the similar, later MTA levels at Le Moustier it was commented that some of the levels comprised more artefacts and faunal remains than intervening sediments (Laville *et al*. 1980:177). And the large, complex and heavily-burned hearth recently documented in the MTA levels at Grotte XVI is perhaps one of the most substantial and impressive hearths so far documented in a Middle Palaeolithic context (Rigaud *et al*. 1995). Immediately beyond southwestern France, one might note the pattern of closelyspaced occupation levels and associated hearths in the late Mousterian levels in the Abric Romaní rock shelter in Catalonia (Vaquero 1999). All of these could hint at a potentially increased intensity - and perhaps increased duration - of site-occupation patterns during the later stages of the Middle Palaeolithic. The evidence, however, remains at best tenuous. Whether any of these sites show significantly more intensive patterns of occupation than those reflected in much earlier Mousterian levels, such as the OIS-5 levels at Combe Grenal and elsewhere (Bordes 1972; Turq 1999), remains to be documented. Whether or not the MTA sites could be taken to reflect the formation of residential groups any larger than those of the earlier Mousterian is equally unclear.

Technology

Potentially the most interesting feature of the French MTA lies in one or two novel features in lithic technology. Unlike most of the earlier phases of the French Mousterian, the MTA is characterized by two well characterized and visually distinctive type fossils - bifacial cordiform or triangular hand-axes, and steeply blunted-back knives. The former could certainly be argued to exhibit a clear element of deliberately "imposed form" (though perhaps no more strikingly than in some much earlier Acheulian bifaces) while a small proportion of the backed knives show an invasiveness of blank reduction which at least hints at some attempt at intentional shaping (Mellars 1996a:120-132). Similar visually distinctive "type-fossil" forms are of course equally conspicuous in the later Mousterian leaf-point industries of Central Europe, and perhaps in the idiosyncratic flake cleavers from the later Mousterian levels in northwest Spain and the Pyrenees (Mellars 1996a:130-132).

The point has already been argued by Hopkinson (2004) and others that the appearance of these visually distinctive bifacial forms in the later Mousterian of western and central Europe could well reflect the emergence of a new (or at least increased) element of social or ethnic patterning in the forms of stone tools, possibly as a direct response to the demographic pressures and associated social competition of OIS-3. The point clearly remains hypothetical, but it is at

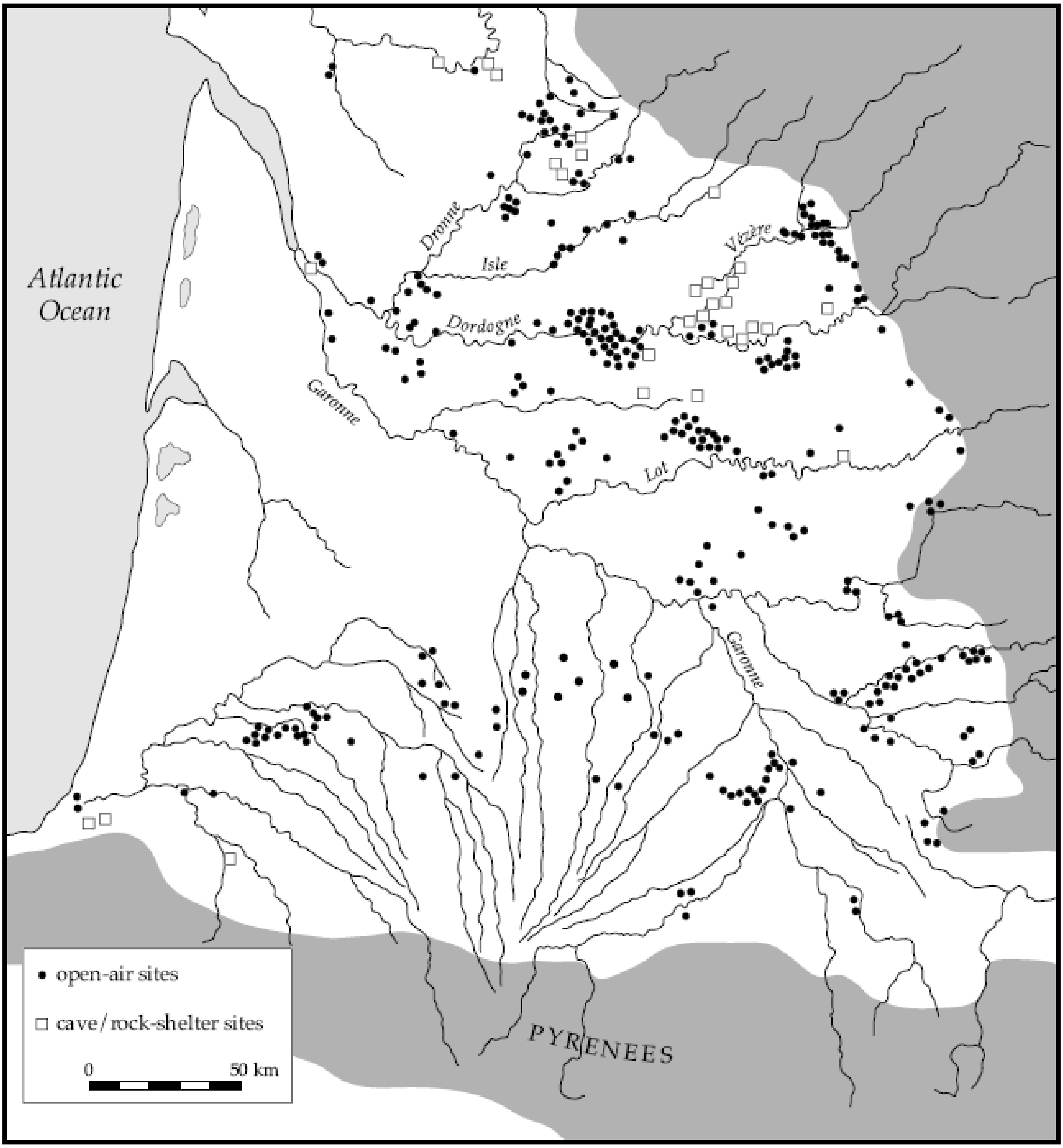

Figure 2. Distribution of Mousterian of Acheulian Tradition (MTA) sites in southwestern France as reflected by finds of cordiform hand-axes (after Mellars 1996a).

least interesting that these new, distinctive type-fossil forms seem to emerge more conspicuously during the later stages of the Middle Palaeolithic than during its earlier stages. Perhaps we do have a significantly new element in material culture patterning here.

How far significant innovations can be recognized in other aspects of technology remains more debatable. MTA industries certainly include some element of deliberate blade technology (Pelegrin 1990) but equally if not more impressive blade techniques have been documented in much earlier Mousterian contexts probably extending back to the time of OIS-7, between *c*. 200,000 and 250,000 BP (Mellars 1996a:77-87; Bar-Yosef & Kuhn 1999). As regards the emergence of distinctively Upper Palaeolithic tool forms, both Rigaud (1993:118) and Anderson-Gerfaud (1990:406) have claimed that both end-scrapers and burins are not only extremely rare in Mousterian contexts in France, but almost invariably "atypical" in form. Most conspicuous of all is the lack of any clear element of systematic bone, antler or ivory technology in the French MTA, or indeed in earlier Mousterian industries, as d'Errico (2003) has recently stressed.

Symbolic expression

How far one can detect evidence for increased "symbolism" in the MTA depends largely on how one interprets the evidence for the two new type-fossil forms discussed above, and the potentially symbolic significance of the use of colouring pigments. Bordes, for example, noted the occurrence of large numbers of fragments of black manganese dioxide in the MTA levels at Pech de l'Azé I, and several fragments of red ochre, some of them with clear evidence for scraping of the surfaces (presumably to produce powder) or deliberate facets or rounding suggesting application to either a hard or soft surface (Bordes 1954-55, 1972). Colouring pigments have also been recorded from several other MTA sites, such as Les Merveilles, Combe-Capelle Haute and Abri Brouillaud.

There are, however, two main problems with the interpretation of this evidence. First, it is an open question how far we can reliably interpret the simple use of colouring pigments as an unequivocally 'symbolic' activity, in the absence of any clear evidence as to exactly how and in what contexts they were employed (Mellars 1996a:369-371; see also Keeley 1980; Knight *et al*. 1995). Secondly it is now clear that the use of these pigments extends well back before the time-range of the MTA industries and OIS-3, as for example in the long succession of earlier Mousterian industries at Combe Grenal (Demars 1992), and apparently in much earlier Acheulian levels at Terra Amata and elsewhere (Barham 2002). Even if we accept some symbolic significance for the use of colouring materials, this can hardly be seen as a specifically late Neanderthal innovation.

Aside from these features, other evidence for unequivocally symbolic artefacts in the MTA is conspicuous mainly by its absence. There are at present no claims for perforated animal teeth, imported marine shells, regular notching or other "notational" marking, or clearly intentional "design" motifs on either bone or stone artefacts. Clear features of this kind (as discussed below) appear only during the Aurignacian and later Châtelperronian episodes in France from (at most) 36,000-38,000 BP onwards, and almost certainly contemporaneously with the presence of anatomically modern populations in adjacent areas of Europe (White 2001; Conard & Bolus 2003). While we could no doubt argue for some potentially 'incipient' patterns of symbolic expression in the later Mousterian of western Europe, the evidence remains at best sparse and distinctly ambiguous in its interpretation. The same, of course, could be said for the emergence of deliberate burial practices (Defleur 1993) which, in the absence of unambiguous grave offerings, remain once again controversial in terms of their symbolic significance.

Discussion

Following the lines of reasoning outlined above one could no doubt formulate an argument that at least some of the cultural and behavioural features which characterize the Middle to Upper Palaeolithic transition in Europe could have originated by a purely internal process of evolutionary change, largely if not directly in response to the climatic oscillations and associated human demographic adjustments of OIS-3. One could go on to argue that an increased tempo of climatic and associated ecological changes during the later stages of OIS-3 - between, say, 45,000 and 25,000 BP (fig. 1) - would have put further selective and adaptive pressures on the local European populations. These could have intensified all of the selective pressures towards more "complex" patterns of subsistence, technology, social organization and associated symbolic expression, and could have led directly, and perhaps inexorably, into a characteristically Upper Palaeolithic pattern of culture. In an earlier paper I have in fact explored a broadly similar scenario, founded essentially on the notion of sharply increasing population densities, and associated demographic and social competition, during the initial stages of the Upper Palaeolithic sequence (Mellars 1996b; see also Gilman 1984, Gibson 1996). This scenario remains an intriguing theoretical perspective which will no doubt continue to attract close scrutiny in future research (e.g. Clark 1997; Zilhão & d'Errico 1999).

Making the most generous possible allowance for these arguments, however, I continue to see a range of major obstacles to viewing this kind of local, indigenous evolution as more than, at best, a very partial and incomplete explanation for the broad sweep of behavioural and cultural innovations which define the Middle-Upper Palaeolithic transition in Europe. The problems as I see them are essentially as follows:

1. First, any attempt to explain the Upper Palaeolithic revolution entirely in terms of local evolutionary processes would effectively ignore the totality of the available biological evidence for a major episode of population dispersal and relacement in Europe, coinciding closely if not precisely with the initial stages of the Upper Palaeolithic (Stringer & McKie 1996; Stringer 2002; Lahr & Foley 1998; Krings *et al*. 2000; Richards & Macaulay 2000; Churchill & Smith 2000; Trinkaus *et al.* 2003). Here we have to account not only for the rapid changes in skeletal morphology (from typically Neanderthal to typically anatomically modern form), but also for the massively accumulating DNA evidence - derived from both mitochondrial and Y-chromosome studies - for the effective elimination of Neanderthal genetic patterns in Europe and their replacement by new, essentially African patterns of DNA (Richards & Macaulay 2000; Krings *et al*. 2000; Underhill *et al.* 2001; Caramelli *et al.* 2003). Unless all of this evidence is wildly misleading, it would seem impossible to deny some major injection of new human populations into Europe at a point coinciding closely with the Middle-Upper Palaeolithic behavioural transition.
2. A closely related problem stems from both the scale and the evident rapidity of the cultural and behavioural changes which characterize the initial stages of the Upper Palaeolithic in the different areas of Europe. This is hardly the place to repeat all the widely-rehearsed arguments for the dramatic character of the Upper Palaeolithic revolution, but it should be recalled that these embrace not only radical changes in stone and (above all) bone, antler and ivory technology, but

also the sudden explosion of explicitly symbolic artefacts in an extraordinary diversity of forms:

- perforated animal teeth and marine shells, together with laboriously manufactured ivory, bone and stone bead forms - now recorded in thousands from early Upper Palaeolithic levels (White 1993, 1997);
- various forms of symbolic "notation" on bone and antler artefacts (Marshack 1991); and
- the sudden appearance of highly varied and complex art forms, ranging from outlines of animals and female "vulvar" symbols through to carved phallic symbols, the extraordinary ivory animal and human statuettes of Central Europe, and (by at least 30,000 BP) remarkably sophisticated cave art (Mellars 1989a, 2001; White 1993, 1997; Bar-Yosef 1998, 2002; Gamble 1999; Clottes 2001; Conard & Bolus 2003).

These forms of expression are not only conspicuously absent from well-documented Middle Palaeolithic contexts in Europe but show a striking correlation with the distribution of various forms of "Aurignacian" technologies across Europe around 43,000-35,000 BP (Mellars 1992, 2001; Gamble 1999; Kozlowski & Otte 2000; Conard & Bolus 2003). One should note a sharp contrast here between the relative suddenness with which these features appear together in the archaeological records of Europe and the much more gradual, mosaic-like fashion with which similar innovations appear in the archaeological records of Africa (McBrearty & Brooks 2000; Deacon & Deacon 1999; Henshilwood *et al*. 2002; Lewis-Williams 2002). Any attempt to explain these patterns in terms of purely indigenous, local evolutionary processes in Europe would need to explain not only the relative scale and rapidity of the cultural changes in question, but also why they occur so much more rapidly and abruptly in Europe than they do in Africa (Mellars 2002).

3. Pursuing further the comparisons between Europe and Africa, there is now unambiguous evidence that many of the conventional behavioural innovations of the European Upper Palaeolithic occur significantly and substantially earlier in several parts of Africa than they do anywhere in Europe. Leaving aside blade technology (which, as noted above, occurs well before the last glaciation in both Europe and Africa) these include:

- relatively abundant and classic forms of endscraper (identical to European forms, and apparently implying new forms of skin-working technology);
- a range of carefully shaped geometric forms - evidently employed as inserts in multi-component armatures, and perhaps implying the appearance of archery;
- extensively shaped bone tools; and
- large quantities of red ochre, including two recently discovered pieces from the Blombos Cave in South Africa showing complex geometrical designs on their surfaces (Singer & Wymer 1982; Knight *et al*. 1995; Henshilwood & Sealey 1997; Deacon & Deacon 1999; McBrearty & Brooks 2000; Henshilwood *et al*. 2002).

All of these features can now be securely documented in the archaeological records of Africa by at least 70-80,000 BP - at least 20-30,000 years before their appearance in Europe. And from the immediately adjacent region of Southwest Asia we now have deliberately perforated marine shells associated with ceremonial burials of anatomically modern humans at the site of Qafzeh in Israel dated to *c*. 90,000 BP, making them by far the earliest personal ornaments so far known (Inizan & Gaillard 1978; Bar-Yosef 2000; Hovers *et al.* 2003). In other words, it is now clear that we have a potential *source* for many of the most distinctive behavioural innovations of the European Upper Palaeolithic much earlier in Africa and the immediately adjacent parts of Southwest Asia than in Europe. How far these innovations dispersed directly with the earliest dispersing populations of anatomically modern humans from Africa (via Asia) to Europe remains to be established (Ambrose 1998; Lahr & Foley 1998; Eswaran 2002). But to ignore this occurrence of distinctively 'modern' behavioural features at a much earlier date in Africa than in Europe would be to adopt a strangely blinkered view of the archaeological evidence as a whole.

4. In this context we should also note what appears to be a more general chronological cline in the pattern of technological innovations across Europe and western Asia (Mellars 1992, 2001). From Southwest Asia there is evidence for a relatively sudden and sharply defined transition from typically Middle to typically Upper Palaeolithic technology (i.e. a proliferation of blades, end scrapers, burins, new "type fossil" forms, together with perforated shell ornaments), clearly dated at the two sites of Boker Tachtit in southern Israel and Ksar Akil in Lebanon to around 45,000-47,000 BP in radiocarbon terms (Bar-Yosef 1998; 2000; Kuhn *et al*. 2001; Mellars & Tixier 1989). Dates for a similar transition in southeastern Europe (as at Bacho Kiro in Bulgaria) seem to centre on *c*. 43,000 BP, while in western Europe there is no evidence for any substantial, analogous shift in technology until *c*. 40,000-38,000 BP (Bar-Yosef 1998; Kozlowski & Otte 2000; Mellars 2000, 2001). If there is indeed a significant chronological cline in the appearance of distinctively Upper Palaeolithic technology from east to west across Europe - and with a much earlier emergence of similar features in Africa - it would accord much better with the hypothesis of a gradual dispersal or diffusion of these technological elements (regardless of whether carried by new populations) than with their totally independent evolution within the individual regions of Europe.

5. Finally, it should be recalled that strong arguments have been advanced from a range of purely archaeological evidence for a major phase of population dispersal across Europe in the earliest stages of the Upper Palaeolithic, in the form of the classic "Aurignacian" technologies (Mellars 1992, 2001; Zilhão & d'Errico 1999; Kozlowski & Otte 2000; Davies 2001; Conard & Bolus 2003). There is hardly space to repeat all the relevant arguments here, but they relate to:

- the remarkable similarities in these Aurignacian technologies extending from sites in northern Israel to the Atlantic coasts of Europe, best reflected perhaps in the distribution of idiosyncratic 'split-base antler point' forms, and contrasting sharply with the diversity of the immediately preceding technologies in the same areas[3];

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[3] Current evidence suggests that there were two main routes of dispersal of anatomically modern populations across Europe - one along the Danube Corridor, marked by the "classic" Aurignacian technologies, and the other along the Mediterranean coast, characterized by a range of small "Dufour"

- the apparently earlier emergence of this technology both in southeastern Europe (as at Bacho Kiro and Temnata in Bulgaria) and in the Levant (as in the long succession at Ksar Akil in the Lebanon) than in western Europe;
- the close association of the Aurignacian with all of the most striking features of early Upper Palaeolithic culture - elaborate bone, antler and ivory technology, long-distance exchange networks, and the proliferation of personal ornamentation and various forms of art; and
- the clear association of at least the middle and later stages of the Aurignacian with skeletal remains of fully anatomically modern form and (according to Churchill & Smith) probably also in the earliest Aurignacian levels at Bacho Kiro (Churchill & Smith 2000; Svoboda *et al.* 2002; Conard & Bolus 2003). In short, the Aurignacian presents most if not all the features one might reasonably expect to find as a plausible archaeological signature for the dispersal of anatomically modern populations across Europe (Zilhão & d'Errico 1999; Davies 2001; Conard & Bolus 2003).

Conclusion

My overall conclusion is that, however much credence we may attach to the potential of OIS-3 climatic oscillations to foster shifts or adaptations in the behavioural patterns of later Neanderthal populations in Europe, this still remains very inadequate to explain the total spectrum of radical cultural innovations which characterizes the classic Middle-Upper Palaeolithic transition. Clearly, we cannot dissociate this transition from the well-documented evidence for the dispersal of anatomically modern populations across Europe somewhere within the time-range *c.* 45,000-35,000 BP, and it is inconceivable that this dispersal would not have brought with it new cultural elements derived ultimately from either African or Asian sources. How far this dispersal also brought with it radically new cognitive elements - including the capacity for fully complex language - remains, of course, one of the central issues in modern human origins research.

But an equally inescapable conclusion is that any process of population dispersal - however we envisage this in precise demographic terms - must necessarily entail some degree of contact and interaction between the dispersing populations and the local, indigenous populations across the whole of the relevant geographical range (Eswaran 2002). Again, there is hardly space here to rehearse all of the recent arguments over patterns of apparent "acculturation" between late Neanderthal and early anatomically modern populations in various parts of Europe (Harrold 1989; Harrold & Otte 2001; d'Errico *et al.* 1998; Zilhão & d'Errico 1999; Mellars 1989a, 1999, 2000, 2003). Ultimately, the fate of these arguments will rest heavily on the precision and reliability of the associated dating evidence. The only point I would insist on here is that for the most fully documented example of these apparent acculturation scenarios, the French Châtelperronian, the totality of the available dating evidence (from radiocarbon, TL and ESR methods) leaves no significant room for doubt that the greater part of this development (including the bone and ivory artefacts and animal tooth pendants in the later Châtelperronian levels at Arcy-sur-Cure in Central France) is contemporaneous with the presence of typically Aurignacian technologies and anatomically modern populations in both the adjacent areas of Central Europe and almost certainly on the Mediterranean coast and in northern Spain (Mellars 1999, 2000; White 2001; Conard & Bolus 2003). Indeed, recent dates from early Aurignacian levels in southwestern France (ranging between 35,000 and 37,000 BP: Mellars 2000; Cole 2001) would reinforce the impression of a close juxtaposition of later Châtelperronian and early Aurignacian populations within France itself.

Any discussion of direct interaction or "acculturation" between Neanderthal and expanding anatomically modern populations must of course take account of the closely related notion of a potential "bow-wave" effect of cultural and technological diffusion spreading some way in advance of the dispersing anatomically modern populations (Mellars 1999; Harrold & Otte 2001). The assumption here, quite simply, is that among the final Neanderthal populations across Europe there must inevitably have been certain forms of interaction or cross-communication between adjacent groups. Whether visualized in terms of mating contacts, raw material exchanges or whatever, this could have provided channels of communication for specific elements of technology or other innovations, potentially extending across large areas, and between groups who were only distantly related in demographic terms. These "chains of connection", as Mulvaney (1976) has described them, may have connected adjacent late Neanderthal groups well ahead of the expansion of anatomically or behaviourally modern populations into the areas in question. One critical factor in the rate of dispersal of technological innovations of this kind would presumably have been the relative adaptive *efficiency* of the innovations in question, in comparison with the preceding Middle Palaeolithic technologies. But it is not difficult to see how certain specific features which had strong adaptive advantages (such as improved methods of skin-working as reflected in the appearance of new end-scraper forms, or new forms of bone or antler technology) could have dispersed in this kind of "bow-wave" pattern of technological diffusion some way in advance of the dispersal of the anatomically modern populations into central and western Europe.

Our final reconstruction of the nature and mechanism of the Middle-Upper Palaeolithic transition in Europe is, therefore, unlikely to be entirely simple and straightforward. Certain of the conventional elements in this transition could conceivably have emerged among the later Neanderthal populations by a process of essentially local, internal adaptation to the climatic and ecological pressures imposed by the rapid climatic changes of OIS-3, and related economic, social and demographic pressures. Other features - particularly the dramatic eruption of art, bonework, personal ornamentation and other forms of symbolic expression - are highly unlikely to be entirely indigenous, independent developments, and seem impossible to dissociate from the expansion of anatomically modern populations across the continent. Whether or not

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and "Font Yves" retouched bladelet forms (Davies 2001; Mellars 2001). These show interesting parallels with the routes of dispersal of the earliest Neolithic communities across Europe.

this involved a radical change in human cognitive capacities remains perhaps the $64,000 question (e.g. Mithen 1996; Klein 2000). If we accept the accumulating evidence that Neanderthal and genetically modern populations pursued effectively separate lines of evolutionary development over a period of at least 300,000-400,000 years (Krings *et al*. 2000; Beerli & Edwards 2002), then the possibility that there were significant divergences in cognitive capacities over this time span can hardly be ruled out. At the same time, it remains extraordinarily difficult to present a totally detached and objective argument for the relative "intelligence" of the two populations on the basis of the archaeological evidence alone. This is certainly part of what Colin Renfrew had in mind when he referred to "the Sapient behaviour paradox" (1996) in studies of modern human origins.

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LEVALLOIS, QUINA AND LAMINAR REDUCTION AT VELDWEZELT-*HEZERWATER*

Patrick M.M.A. BRINGMANS[1], **Pierre M. VERMEERSCH**[1], **Frans GULLENTOPS**[1],
Erik P.M. MEIJS[1], **Albert J. GROENENDIJK**[1], **Jean-Pierre de WARRIMONT**[1] **& Jean-Marie CORDY**[2]
1. Laboratory of Prehistory, *Katholieke Universiteit Leuven, Redingenstraat* 16, B-3000 Leuven. p.bringmans@thermenmuseum.nl
2. Ethologie et Psychologie Animales, Bât. L1 Inst. Physiologie L. Frédéricq, Université de Liège, Place Delcour 17, B-4020 Liège. JM.Cordy@ulg.ac.be

Résumé: le site de plein air à Veldwezelt-*Hezerwater*, Belgique, riche de plusieurs niveaux du Paléolithique moyen, offre la possibilité de procéder à une étude diachronique des diverses occupations. Les traveaux technologiques permettent d'évaluer les caractéristiques techniques des assemblages, où se côtoient (1) une "Production Levallois Spécialisée de Tendance Laminaire" au site ZNB (Fin du Saalien), (2) une "Production Laminaire à partir de nucleus prismatique à débitage semi-tournant" avec des "petits outils" aux sites VLL et VLB (Fin du Saalien - Interstadiaire de Zeifen), (3) une "Production Levallois Récurrente Centripète" avec des outils bifacials au site VBLB (St. Germain II) et (4) une "Production Linéale à éclat Levallois Quadranulaire" et une "Production Levallois Récurrente Bipolaire" avec des outils de type "Quina" aux sites TL (Interstadiaire de Goulotte) et WFL (Interstadiaire de Pile).

Abstract: at the open-air site at Veldwezelt-*Hezerwater*, Belgium, several Middle Palaeolithic horizons have been discovered. This allowed the diachronic analysis of the various occupation levels. The technological analysis of the lithic assemblages showed that (1) "Specialised Levallois Blade Reduction" was employed at the ZNB Site (Late Saalian), (2) "Semi-rotating Prismatic Core Reduction" together with "small tools" were present at the VLL and VLB Sites (Late Saalian - Zeifen Interstadial), (3) "Recurrent Centripetal Levallois Reduction" together with medium-sized bifacial tools were found at the VBLB Site (St Germain II) and (4) "Lineal Levallois Reduction" and "Bipolar Recurrent Levallois Reduction" together with big "Quina" tools were present at the TL Site (Goulotte Interstadial) and at the WFL Site (Pile Interstadial).

Key Words: Veldwezelt-*Hezerwater*, Middle Palaeolithic, Levallois, Quina.

Introduction

The stretch of land on the left bank of the now dry *Hezerwater* valley in the *Vandersanden* brickyard quarry at Veldwezelt-*Hezerwater* (Province of *Limburg*, Belgium) has repeatedly been an advantageous location for human settlement during the late Middle and Late Pleistocene. The industrial exploitation by the *Vandersanden* brickyard, which exploited the loamy fill of the asymmetrical *Hezerwater* valley, started in 1993 and came to an end in 2002. In order to deal with the expected archaeological finds in a structured way, Prof. Dr. Pierre M. Vermeersch stepped in and started the "Veldwezelt-*Hezerwater* Project" in 1995. The six successive summer excavation campaigns at Veldwezelt-*Hezerwater*, which were mainly directed by Patrick M.M.A. Bringmans of the Laboratory of Prehistory (*e.g*., Bringmans 2000, 2001; Bringmans *et al*. 2001, 2003, 2004a, b, c; Bringmans 2006), yielded more than 2,500 flint artefacts, 835 pieces of charcoal and 613 animal bones and teeth. These archaeological remains were excavated at 25 different *loci* [spots where concentrations of artefacts were found]. Only 6 of these *loci*, which yielded the bulk of the lithic artefacts, have been interpreted as *in situ* occupation sites [(1) "ZNB Site" (n=43), (2) "VLL Site" (n=795), (3) "VLB Site" (n=687), (4) "VBLB Site" (n=350), (5) "TL Site" (n=113) & (6) "WFL Site" (n=133)]. Indeed, Middle Palaeolithic humans were present at this spot in the *Hezerwater* valley at different times during the Late Saalian (late MIS 6), the late Last Interglacial *s.l.* (MIS 5a) and the first half of the Middle Weichselian (first half MIS 3).

Climate Change and the Northwest European Loess-soil Sequence

The Middle Weichselian (MIS 3) in Northwest Europe included several interstadials during which temperatures were up to 7°C warmer (*e.g*., Dansgaard *et al*. 1993) than during the intervening cold spells [stadials]. At times, temperatures were only 2°C cooler than the local Holocene average (*e.g*., Dansgaard *et al*. 1993). However, most of the Middle Weichselian warmer oscillations were short lived, of the order of *ca* 1,000-2,000 years. Nevertheless, at four points in the Middle Weichselian sequence, there is evidence for "complex" interstadials of more prolonged warming of *ca* 3,000-5,000 years. However, an oscillating climate was not only characteristic of the Weichselian, but appears to have characterised the Last Interglacial *s.l.* (MIS 5) and the Saalian ice age *s.l.* (MIS 8, 7 & 6) as well. The oscillating climate also left its traces in the European loess-soil sequences, which provide high-resolution terrestrial proxy archives of climate change. The sections show cycles of deposition of loess during cold stadials, alternating with landscape stabilisation and soil formation during warm interglacials and temperate interstadials. Not only the loess-soil sequence at Veldwezelt-*Hezerwater* (*e.g*., Gullentops & Meijs 2002; Meijs 2002), but also the loess-soil sequences in the nearby German Rhine valley (*e.g*., Schirmer 2000, 2002, Schirmer & Kels 2006) show that the Middle and Late Pleistocene climate in Northwest Europe was quite variable. However, pauses in loess accumulation lasted usually long enough for soils to develop. One extreme example of pedogenesis is the so-called "Rocourt Soilcomplex" at Veldwezelt-*Hezerwater*, which is the terrestrial equivalent of the Last Interglacial *s.l*. (MIS 5). As a record of Middle Palaeolithic occupation and climate change throughout the late Middle and Late Pleistocene, the "Veldwezelt-*Hezerwater* loess-soil climate calendar" is of particular interest.

Overview of the Core Reduction Strategies Attested at Veldwezelt-*Hezerwater*

In this paper, we will only briefly discuss the different core reduction strategies attested at the six Veldwezelt-*Hezerwater in situ* occupation sites. More detailed presentations of the Veldwezelt-*Hezerwater* data can be found in: Bringmans 2000, 2001; Bringmans *et al*. 2001, 2003, 2004a, b, c; Bringmans 2006. Core types at Veldwezelt-*Hezerwater* include "Levallois", "prismatic" and "opportunistic" cores, with single, opposed and multiple platforms (fig. 1). The "Levallois" core reduction strategy is typical of the Middle Palaeolithic in general, although of course many variants exist (*e.g*., Crew 1975; Boëda 1986, 1988; Mellars 1996; Brantingham & Kuhn 2001). At Veldwezelt-*Hezerwater*, "Levallois" products are abundantly present at the ZNB Site (late MIS 6), the VBLB Site (MIS 5a), the TL Site (first half MIS 3) and the WFL Site (first half MIS 3). “Levallois” products are completely absent at the VLL Site (MIS 6.01) and virtually absent at the VLB Site (MIS 6.01). An interesting phenomenon at several sites at Veldwezelt-*Hezerwater* is the surprisingly strong component of deliberate and highly specialised blade production: (1) "Levallois" blade core reduction (*sensu* Boëda 1988) was attested at the ZNB Site and at the WFL Site and (2) Non-Levallois prismatic "Upper" Palaeolithic core reduction (*sensu* Révillion & Tuffreau 1994) was present at the VLL Site and at the VLB Site. Especially the VLL and VLB lithic assemblages show an overall high degree of "bladeyness". At the VLL Site, prismatic core reduction strategies led to the total exclusion of "Levallois" core reduction. However, at the VLB Site, "Levallois" core reduction was employed alongside typical prismatic core reduction strategies. Thus, at Veldwezelt-*Hezerwater*, core reduction strategies included: (1) "Specialised Levallois Blade core reduction" at the ZNB Site (late MIS 6), (2) "Semi-rotating Prismatic core reduction" at the VLL Site (MIS 6.01), (3) "Semi-rotating Prismatic core reduction" together with "Recurrent Unipolar Levallois core reduction" at the VLB Site (MIS 6.01), (4) "Recurrent Centripetal Levallois core reduction" at the VBLB Site (MIS 5a), (5) "Lineal Levallois core reduction" and "Bipolar Recurrent Levallois core reduction" at the TL Site (MIS 3) and finally (6) "Lineal Levallois core reduction", "Bipolar Recurrent Levallois core reduction" and "Classical Levallois Blade core reduction" at the WFL Site (MIS 3).

Contextual Factors that Constrained Choice amongst Lithic Reduction Strategies

At Veldwezelt-*Hezerwater*, many different contextual factors seem to have influenced lithic variability. Some contextual factors we may never fully understand, such as the *ad hoc* response to local situations. Nevertheless, some general trends have been observed: (1) high raw material quality seems to have led to more formal core and tool designs, whereas (2) low raw material quality seems to have led to more informal designs. Indeed, it seems that at Veldwezelt-*Hezerwater*, humans varied their reduction strategies according to the initial shape and quality of the flint nodules. There is an apparent link between the exploitation of local low-quality raw materials, opportunistic and prismatic core reduction and the virtual absence of tools. On the other hand there is also a link between the exploitation of imported high-quality raw materials, "Levallois" core reduction and the presence of heavily retouched tools. The so-called "Lower Sites" (VLL Site & VLB Site) at Veldwezelt-*Hezerwater* were located on sources of low-quality flint. At these "Lower Sites", elongated low-quality flint nodules, which were unsuitable for centripetal core reduction, were used for prismatic reduction of small cores. This resulted in the production of small blades (4-5cm). These Late Saalian flint knappers deliberately searched the gravel-bed of the local "side-valley" of the *Hezerwater* brook for elongated flint nodules. On the other hand, at the Middle Weichselian TL and WFL Sites at Veldwezelt-*Hezerwater*, sources of local low-quality flint were also available. However, these local raw material sources were not exploited. Instead, fresh high-quality "*Lanaye* Flint" (source: 5 km) and translucent "*Hesbaye* Flint" (source: 35 km) were imported to the TL and WFL Sites (early MIS 3). The import of high-quality spherical flint nodules and the neglect of the locally available raw materials during the early Middle Weichselian led to "Levallois" core reduction and the production of large tools (up to 10 cm). The fact of the matter is that at Veldwezelt-*Hezerwater*, prismatic cores were always made of local, elongated low-quality flint nodules, whereas "Levallois" cores were made of "exotic" spherical high-quality flint nodules. So, it seems that the original morphology and quality of the flint nodules resulted in specific core and tool reduction sequences. Thus, the selection and (if required) the transport of raw materials with their specific characteristics and not the mere availability of (local) raw materials was of paramount importance.

There also seems to have been a great deal of "equifinality" in the processes by which these people reduced their cores and tools. Indeed, formal convergence in core and tool morphologies covering a broad chronological and geographical span must necessarily have been achieved unintentionally. Indeed, comparable but slightly different sets of contextual factors may unintendedly have led to "identical" core and tool forms. It seems that lithic toolkits may be designed to satisfy a whole range of demands, including technological

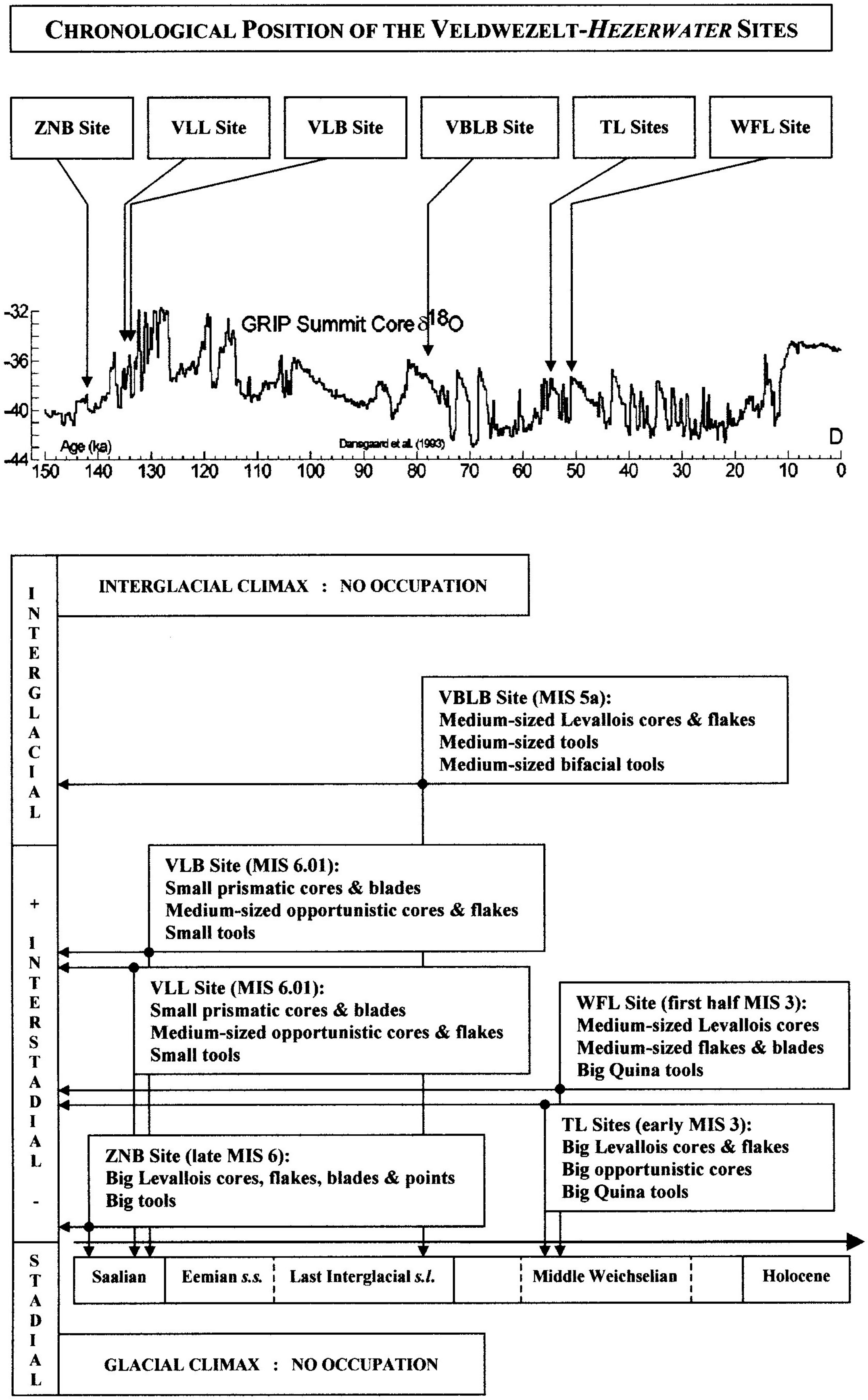


Figure 1. Chronological position and characterisation of the Veldwezelt-*Hezerwater* sites.

reliability, transportability, flexibility, maintainability and versatility (*e.g*., Torrence 1989; Bousman 1993; Richter 1997; Brantingham & Kuhn 2001; Clark 2002a, b). Technological design is therefore seen as an optimisation problem of maximising one or more of these design attributes, while minimising the rate of raw material consumption. These and other design-concerns influenced both primary core reduction strategies and patterns of tool reduction. Indeed, any deviation from, for example, the ideal "prismatic" or "Levallois" core geometry resulted in significant declines in both raw material efficiency and productivity. What we now know as "prismatic" and "Levallois" core reduction just seems to have been the "optimal" solution to some of the potential costs associated with core reduction. This phenomenon resulted in the independent "convergence" on the basic core geometry in diverse contexts. Indeed, at Veldwezelt-*Hezerwater*, formal convergence seems to be conditioned by the size, shape and quality of the raw material nodules. Nevertheless, core and tool reduction is by necessity dynamic and flexible, since it must "manage" an ever-decreasing amount of raw material. So, flint knappers also had to cope with the irreversible consequences of subsequent removals and the often-unpredictable nature of stone fracture. Any mistake in the reduction process had to be paid cash on "delivery". Indeed, the ability to execute formal technological designs was severely limited by the quality of the raw material. As a consequence, toolkits based on high-quality raw materials are easier to design, because fracture is easier to control. While on the other hand, toolkits based on low-quality raw materials are more difficult to design, because stone fracture is more unpredictable and often results in irreparable errors during the reduction process.

We think that the overriding factor constraining choice amongst lithic core and tool reduction strategies is raw material quality. However, raw material quality is not a simple qualitative variable, but rather is composed of several potentially quantifiable properties, including raw material nodule size, shape and mineralogical structure. So, it is likely that these flint knappers had an optimal "plan" or "format" in mind about how to reduce a particular elongated (*e.g*., "prismatic" core reduction) or spherical (*e.g*., "Levallois" core reduction) volume of raw material (formal convergence). However, it is just not possible to predict exactly the nature of stone fracture (formal divergence). So, any deviation from the "planned reduction format" created "variability". In order to restore the "original reduction format", these Middle Palaeolithic flint knappers would have to react and adjust to the new situation. Flint knappers thus had to "calibrate" the core and tool reduction process on several occasions during the reduction sequence. However, the "adjustments", "corrections" and "reparations", which they would have needed in the course of the reduction process, were probably built into the "original reduction format". So, economic considerations (*e.g*., flexibility, versatility, maintainability, portability, reliability, *etc*.) would inevitably push core and tool reduction strategies back towards the "planned reduction format". Independent occurrences of similar lithic core and tool reduction strategies covering a broad chronological and geographical span are thus not surprising. Not the "appearance" or the "reappearance" of certain core reduction strategies and their products, but the "recognition" of their usefulness in new environmental contexts is the "new" phenomenon that occurred.

The Simultaneous Presence of Levallois Core Reduction and Quina Tools

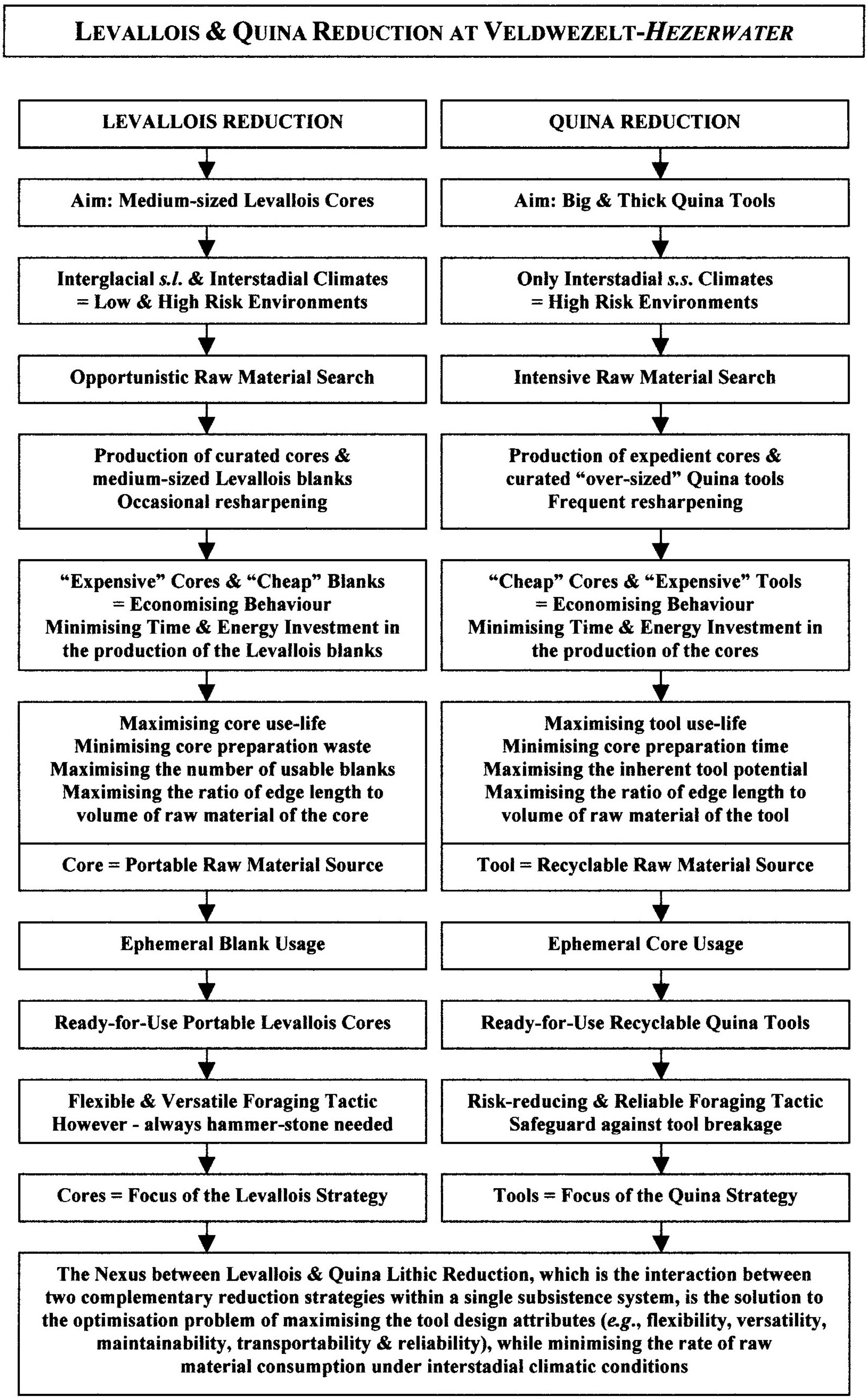
After usable tool blanks had been produced, retouch was usually applied to transform these tool blanks into formal tools. It appears that two major objectives lie behind the application of systematic retouch to the edges of the tool blanks (*e.g*., Mellars 1964, 1996): (1) to secure the maximum possible length of working edge and (2) to impose a regular, smooth form on the working edge. Retouch was thus applied not merely to rejuvenate heavily worn and damaged edges, but as a deliberate policy to maximise the inherent potential of the available blanks for the specific functions envisaged. However, the "Dibble and Rolland Tool Reduction Model" (1992) was probably always working in the "background", but it cannot account for all variation in the tool forms. Retouch thus seems to have been applied essentially to enhance the functional aspects of the tools. It is obvious that, for example, most "transverse side-scrapers" can never have started life as conventional lateral forms. Indeed, the tool edges are frequently oriented at almost 90° to the main flaking axis of the original blank (*e.g*., Turq 1989). Many of these transverse side-scrapers have been worked into so-called "Quina" transverse side-scrapers. Overall, the "Quina" techno-functional system (*e.g*., Lenoir 1973; Turq 1989; Rolland 1996) seems to have emphasised (1) the preference for fine-grained lithic raw materials, (2) optimal tool sizes and (3) intensive tool retouching. However, the recurring need to manufacture thick, large blanks may in some cases have overridden a preference for fine-grained flint. Typical "Quina" transverse side-scrapers have been excavated at Veldwezelt-*Hezerwater*, only at the early Middle Weichselian TL and WFL Sites. The "Quina tools" (length: up to 10 cm), which were excavated at these sites, represented the biggest tools discovered at Veldwezelt-*Hezerwater*. The forms of these early Middle Weichselian "over-sized" and "over-designed" Quina tools, which were made of fresh flint, were probably influenced by the fact that they were used under "high-risk" cool climatic conditions. Indeed, lithic technologies that were employed in high-risk environments can be expected to be "over-designed", because flint knappers usually wanted to maximise core or tool use-life in dangerous circumstances. So, big and thick "over-designed" Quina tools guard against tool breakage. This may be explained as a technological risk-reducing response to relatively cool and "hostile" environments. In more temperate and "friendly" environments, most toolkits are casual and display little effort to extend tool use-life (*e.g*., VBLB Site).

However, "Quina" assemblages were excavated in Late Pleistocene as well as in Middle Pleistocene contexts. Geneste *et al*. (1997) point to several autonomous "Quina" developments in different regions (*e.g*., Les Tares 1, La Micoque 3, High Lodge, *etc*.). New research has claimed that for example the so-called "Charentian" assemblage at High Lodge (UK) is pre-Anglian in date, thus prior to MIS 12 (Rose 1992). These very old "Quina-like" assemblages are separated from Late Pleistocene "Quina" assemblages by time-gaps too substantial to indicate linear continuity. Evidence seems to point to multiple and independent developments by formal convergence. Notwithstanding this, one of the few tool forms of the Late Pleistocene that still seems to carry some sort of "chronological" information is the "Quina" tool. During MIS 4, a gradual shift from "Ferrassie" to "Quina" lithic assemblages is attested in Southwest France (Mellars 1969, 1986, 1996). However, "Ferrassie" and "Quina" assemblages do not seem to represent discrete "facies", but rather two etic "stages" in a continuum of decreasing "Levallois Index" (IL) percentages and increasing "Quina Index" (IQ) percentages. It appears that the Quina tools have replaced the Levallois blanks progressively during the first half of the Weichselian ice age. However, the progressive decrease in the Levallois component clearly cuts across the "Ferrassie-Quina" interface. The climate got colder and colder and the "Quina" tools became more and more important, while the "Levallois" blanks became less and less important. So, "Quina" tools have probably functioned as "*Ersatz*-Levallois-Blanks" under cool and "hostile" climatic conditions.

In the South of France during MIS 4 and in Northwest Europe during MIS 3, there seems to exists a clear nexus between "Levallois" core and "Quina" tool reduction, which actually seem to represent two complementary lithic reduction strategies. The integrated interaction between Levallois core and Quina tool reduction within a single subsistence system was the solution to the optimisation problem of maximising the tool design attributes (*e.g.*, flexibility, versatility, maintainability, portability & reliability), while minimising the rate of raw material consumption under cool climatic conditions (fig. 2). Indeed, in the *Aquitaine* Basin, France (*e.g.*, Mellars 1996; Rolland 1996), "Quina tools" largely correspond with the "stadial" climatic fluctuations correlated with MIS 4, which is characterised by the onset of more severe, continental conditions, the spread of steppe habitats and steppe faunal communities. These conditions created mosaic vegetational landscapes, which had a direct impact on Middle Palaeolithic technology, subsistence, land use and settlement organisation. At the TL and WFL Sites at Veldwezelt-*Hezerwater*, in the *Maas* Basin, the presence of "Quina tools" corresponds with the warmest phases of the interstadial climatic fluctuations during the first half of the Middle Weichselian (first half of MIS 3). It is important to keep in mind that the *Maas* Basin lies at higher latitudes than the *Aquitaine* Basin, which implies that in the *Maas* Basin the climatic conditions have always been cooler than in the *Aquitaine* Basin. In the *Maas* Basin repeated interruptions of Middle Palaeolithic occupation effectively occurred during fully stadial episodes. For instance, during the second half of MIS 4 and during the second half of MIS 3. During the cold interstadial and stadial periods of the Weichselian ice age, the *Maas* Basin was characterised by a cold climate, sparse tundra vegetation and low-density arctic fauna (*e.g.*, Cordy 1988). However, Middle Palaeolithic people were certainly present in Northwest Europe during the milder interstadials during the first half of the Middle Weichselian (first half of MIS 3). Given the latitude differences, there was a predominance of horse over reindeer in the *Maas* Basin. The evidence from Veldwezelt-*Hezerwater* shows that there were at least two major Middle Palaeolithic interstadial occupation episodes during the first half of the Middle Weichselian (first half of MIS 3) with habitat conditions comparable to those of MIS 4 in Southwest France. The bio-climatic transition from intensely cold and dry stadial conditions (MIS 4) towards climatic amelioration (MIS 3) during the so-called "Goulotte" interstadial (Woillard 1975, 1978) is attested at Veldwezelt-*Hezerwater* at the TL Site. The Middle Palaeolithic occupation of the WFL Site under interstadial conditions could probably be correlated with the so-called "Pile" interstadial (Woillard 1975, 1978). The interstadial vegetation at these sites must have been characterised by a steppe environment with mainly pine and birch. At the WFL Site at Veldwezelt-*Hezerwater*, a typical steppe fauna was in place (Bringmans *et al*. 2003). The presence of the badger at the WFL Site during the Pile interstadial indicates that the climate was not cold, but for a short period of time, almost Holocene-like. Middle Palaeolithic humans must gradually have reoccupied Northwest Europe by "natural migration" during the "Goulotte" and "Pile" interstadials. In the *Maas* Basin, camps were mostly installed in caves (*e.g.*, Toussaint *et al*. 2001; Jehs 2004), however ephemeral open-air hunting and butchering stations were also attested (*e.g.*, TL & WFL Sites). Very often, low-quality flint is found in cave sites, whereas high-quality flint is attested in most open-air sites. Middle Palaeolithic humans probably combined semi-sedentary cave occupation during prolonged, cold winters, with warm season semi-nomadic mobility in the Northern *Maas* Basin. There, several game herd species were present together with opportunities for procuring fine-grained high-quality flint from Cretaceous limestone outcrops. Exploitation of imported high-quality flint in the base camps took place during the intensive winter occupation episodes. The repeated cave residence episodes and the frequent resharpening of thick tools resulted in the palimpsest accumulation of "Quina" tool assemblages at the cave sites. "Levallois" cores and "Quina" tools (fig. 2) were functioning alongside each other in the same subsistence system, because they were reliable safeguards against technological failure. "Levallois" cores and "Quina" tools were also exported to the ephemeral open-air hunting and butchering sites (*e.g.*, TL & WFL Sites at Veldwezelt-*Hezerwater*). "Levallois" and "Quina" reduction thus seem to represent two sides of the same coin. Finally, evidence of Middle Palaeolithic occupation in Northwest Europe decreases rapidly after 50.000 years ago. Stadial and even interstadial climatic conditions during the second half of the Middle Weichselian were probably no longer warm enough to allow humans to migrate from the southern *refugia* to the northern fringes of Europe.

Conclusions

At Veldwezelt-*Hezerwater*, the core and tool reduction strategies appear to change each time climatic changes occur. Indeed, at the Late Saalian ZNB Site (late MIS 6), "Specialised Levallois Blade Reduction" was employed. "Climatic-stress" seems to play a key-role at the VLL and VLB Sites (MIS 6.1), with in general the presence of semi-rotating prismatic core reduction and "small tools" (<5cm).



LEVALLOIS & QUINA REDUCTION AT VELDWEZELT-*HEZERWATER*

LEVALLOIS REDUCTION	QUINA REDUCTION
Aim: Medium-sized Levallois Cores	Aim: Big & Thick Quina Tools
Interglacial *s.l.* & Interstadial Climates = Low & High Risk Environments	Only Interstadial *s.s.* Climates = High Risk Environments
Opportunistic Raw Material Search	Intensive Raw Material Search
Production of curated cores & medium-sized Levallois blanks Occasional resharpening	Production of expedient cores & curated "over-sized" Quina tools Frequent resharpening
"Expensive" Cores & "Cheap" Blanks = Economising Behaviour Minimising Time & Energy Investment in the production of the Levallois blanks	"Cheap" Cores & "Expensive" Tools = Economising Behaviour Minimising Time & Energy Investment in the production of the cores
Maximising core use-life Minimising core preparation waste Maximising the number of usable blanks Maximising the ratio of edge length to volume of raw material of the core	Maximising tool use-life Minimising core preparation time Maximising the inherent tool potential Maximising the ratio of edge length to volume of raw material of the tool
Core = Portable Raw Material Source	Tool = Recyclable Raw Material Source
Ephemeral Blank Usage	Ephemeral Core Usage
Ready-for-Use Portable Levallois Cores	Ready-for-Use Recyclable Quina Tools
Flexible & Versatile Foraging Tactic However - always hammer-stone needed	Risk-reducing & Reliable Foraging Tactic Safeguard against tool breakage
Cores = Focus of the Levallois Strategy	Tools = Focus of the Quina Strategy

The Nexus between Levallois & Quina Lithic Reduction, which is the interaction between two complementary reduction strategies within a single subsistence system, is the solution to the optimisation problem of maximising the tool design attributes (*e.g.*, flexibility, versatility, maintainability, transportability & reliability), while minimising the rate of raw material consumption under interstadial climatic conditions

Figure 2. The nexus between "Levallois" and "Quina" reduction at Veldwezelt-*Hezerwater.*

In times of relative stable climatic conditions, for example during the late Last Interglacial *s.l.* (late MIS 5), lithic technology appears to be more "settled". This seems to be the case at the VBLB Site (MIS 5a) where a "typical" Levallois core reduction technology is present, together with larger unifacial and medium-sized bifacial tools. During the first half of the Middle Weichselian (first half of MIS 3), in relatively cool interstadial climatic conditions, we see in the lithic assemblages of the TL and WFL Sites the presence of in general large Levallois cores and flakes in association with very big Quina tools. There is thus a tendency to manufacture bigger risk-reducing tools under cooler and more "hostile" climatic conditions. Indeed, Middle Palaeolithic humans were forced to change their subsistence strategies when "climatic-stress" situations occurred. The only alternative they had, was to move to the South or to the East, leaving our regions deserted. This seems to be the case at Veldwezelt-*Hezerwater* during the warmest (MIS 5e) and coldest (second half of MIS 4 & second half of MIS 3) climatic phases, when no large herds of food animals seemed to be present. Human "evolution" and "culture" probably were relatively unimportant constraint on the character of core and tool reduction, being overridden in most contexts by mechanical constraints and economic, climatic and ecological processes. Lithic technology seems to represent only a limited range of options very broadly distributed in time and space, which were probably held in common by all contemporary humans and invoked differently according to context (Clark 2002a, b). Contextual factors (*e.g.*, availability, size and quality of raw materials, mobility, anticipated tasks, flexibility, versatility, portability, reliability, *etc.*) seem to have constrained choice amongst lithic reduction options. Notwithstanding this, our approach considers Middle Palaeolithic humans as flexible agents, rather than passive recipients of optimised environmental conditions.

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1997-2005 RESEARCH IN THE CAVES OF GOYET (GESVES, PROVINCE OF NAMUR, BELGIUM)
Tongeren Neandertal symposium excursion, 19 September 2004

Michel TOUSSAINT
Direction de l'Archéologie, Ministère de la Région wallonne, rue des Brigades d'Irlande 1, B-5100 Namur. m.toussaint@mrw.wallonie.be

Abstract: Excavated since 1868, generally without any method, the caves of Goyet are comprised of three principal areas of archaeological interest: the terrace and its caves entrances, the Upper Shelter and Trou du Moulin. They yielded rich occupations from the Middle Palaeolithic, Aurignacian, Gravettian and Magdalenian, as well as traces from later periods: Protohistory, Roman and Middle Ages. Bone and teeth remains from the first excavations (1868-70) and recently identified in the collections from the former excavations might be attributed to Neandertal Man.

Introduction

The caves of Goyet are one of the main prehistoric sites of Belgium, as much because of their role in the development of regional prehistoric studies as for the number of Palaeolithic facies represented and the wealth of material recovered. The scientific importance of the caves has been acknowledged since 1868, when E. Dupont, a geologist from Dinant (1841-1911; Twiesselmann 1952), renowned for his excavation campaign successes in the caves of the Lesse valley, initiated the first excavation (Toussaint 2001).

The Goyet cave system is located at Gesves, in the province of Namur (Belgium; fig. 1). It comprises three areas of major prehistoric interest complemented by adjacent areas that all stretch along the right bank of the Samson river, at the confluence of the Strud (Strouvia) stream (fig. 2). The Lambert coordinates of the centre of the main terrace are: x = 195.71 km; y = 126.20 km (I.G.N. map 48/5).

Numerous archaeological, palaeontological and palaeo-anthropological artifacts were found in the different caves of the site but, for the most part, with scant regard for stratigraphy or plan drawing. Like other emblematic karstic caves of the national prehistory (e.g. Engis, Spy and Fonds de Forêt) the caves of Goyet were excavated too early, at a time when researchers were mainly looking for archaeological material, at best within some semblance of a sequence of deposits, but with hardly any interest either in stratigraphic subtleties or sedimentology and palaeoenvironment (Toussaint & Pirson in press).

Dupont himself, although a better stratigrapher than his contemporaries, was more than casual when he described the layers he identified at Goyet, be it in the "Third Cave" or at Trou du Moulin. Since he had previously done some remarkable studies of cave deposits, notably at La Naulette (Hulsonniaux-Houyet), one can assume that he was already more concerned by his new duties as director of the Natural History Museum, in Brussels, than by furthering his cave research. It also seems that at that time, the last period of his fieldwork, technicians did most of the work on his behalf. At the same period, Dupont would nonetheless include the tools from the three upper ossiferous layers he thought he had identified at Goyet in his attempt at classification of Belgian prehistoric industries. The elements of this broad framework, in which precise typology is restricted to the most characteristic tools, are built on the distinction between six successive phases: layers of Hastière, Montaigle and Trou Magrite at the bottom (dating from the "Mammoth Age"), layer of Goyet with intermediate features, layer of Chaleux-Furfooz ("Reindeer Age") and last, polished stone age, found in the sediments from the "present age".

The many later excavations both on the terrace immediately outside the caves and within the different caves, either by individual collectors or large national institutions, were also perfunctory in character; and their context is badly known. No layer-based inventory of the documents collected by the successive diggers is available, and no distribution maps of the finds. The material is scattered in several private collections, museums and institutions - as well as outside Belgium. Laboratory analyses, conducted more than a century after the first excavations, represent the only significant work (essentially M. Ulrix-Closset (1975), M. Otte (1979) and M. Dewez (1987) for the archaeology and M. Germonpré (1996, 1997, 2000, 2001, 2004) for the palaeontology).

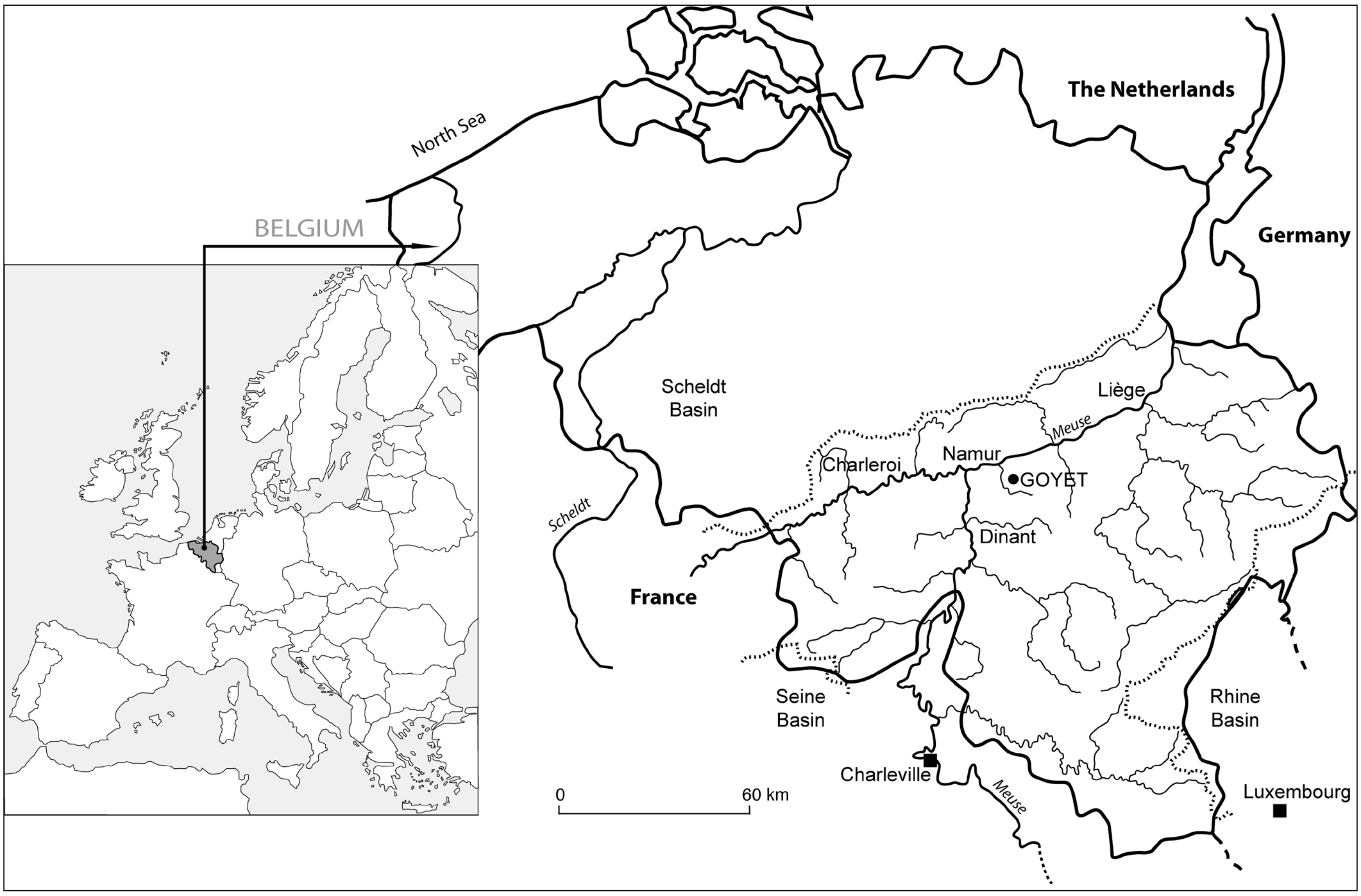

Figure 1. Location of the caves of Goyet in the Belgian Meuse river basin.

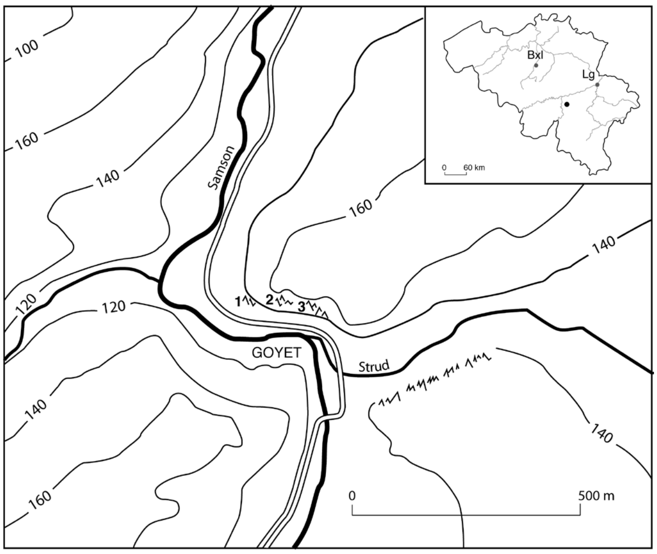

Figure 2. Map of the cliff of Goyet, with location of the main prehistoric sites. 1, Trou du Moulin; 2, Upper Shelter; 3, Main terrace and its cave entrances.

This sorry state of affairs prompted the resumption of field research at the Goyet caves in 1997 by the "Direction de l'Archéologie du Ministère de la Région wallonne", in conjunction with different non-profit organisations, especially "l'Association wallonne d'Anthropologie préhistorique" (Toussaint *et al*. 1998, 1999, 2004). The aim was to assess if some stratigraphic and palaeoenvironmental data was still recoverable from possibly undisturbed sediments on the terrace and in the numerous local caves, and to make new archaeological and palaeoanthropological discoveries at this ill-treated site.

The focus of the last eight years of modern field research was on the following aspects:
- a series of 11 stratigraphic trenches (1997-1998) down to bedrock in the main terrace and in Cave no. 3, where Dupont made most of his discoveries (fig. 3);
- multidisciplinary research (1977-1999) at the Upper Shelter, which, unfortunately, greedy collectors looted almost extensively half a century ago;
- from 1997 onwards, exploration of the newly discovered cave system located between Trou du Moulin and the Upper Shelter, which yielded a Neolithic burial, excavated and studied in situ from 1998 to 2004;
- digging and sieving in the main caves, notably in the "wastebin chamber", mostly from 2003 through 2005;
- in 2004, beginning of stratigraphic trenches in a newly discovered cave under the Upper Shelter, with undisturbed fill;
- study of some yet unpublished material, most notably a protohistoric knife carved in a human radius.

In parallel, colleagues from the Royal Institute of Natural Sciences of Belgium undertook a reassessment of the abundant palaeontological material from Dupont's excavations kept at their institution:

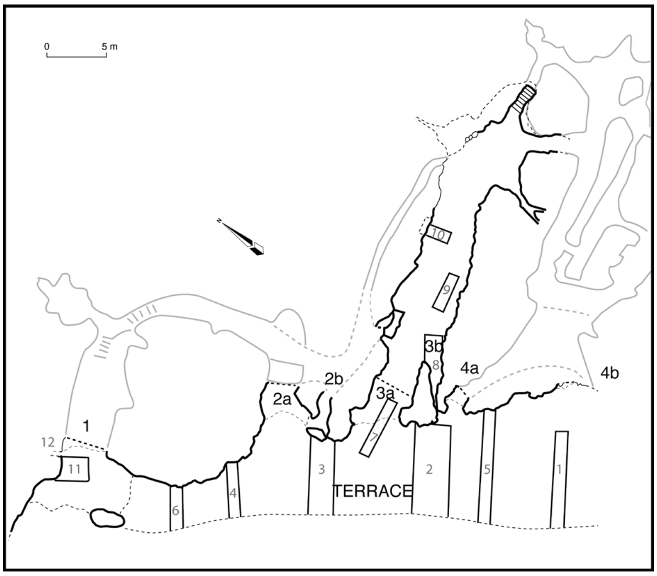

Figure 3. Goyet, the main terrace and cave entrances: numbering of the caves and location of the trenches dug in 1997-1999.

- M. Germonpré for animal palaeontology;
- P. Semal for human palaeontology.

The classic terrace and its cave entrances

History

Dupont was the first to visit the site, mainly the third cave, where he conducted a huge excavation in 1868. In 1891, Doctor F. Tihon dug a series of trenches through the terrace.

From 1907 through 1909, the "Service des Fouilles des Musées royaux du Cinquantenaire" explored the site, particularly the backfill from the previous excavations and portions of undisturbed layers in the second and third caves.

In 1937-38, the Royal Institute of Natural Sciences of Belgium, taking advantage of the construction of tourist facilities, carried out extensive excavations, particularly in the "sheep chamber", located behind the deep chamber called "wastebin" onto which entrances 4a and 4b open, as well as in two corridors connecting to the left wall of Cave no. 1.

Throughout the first half of the 20th century amateur prehistorians followed each other, between and after research of the two large national scientific institutions. They moved backfill from the first digs, and, in places, ruined areas of undisturbed layers without any caution for stratigraphy. Among them: J. Hamal-Nandrin in 1914; J. le Grand-Metz between 1914 and 1920; J. Colette and M. Beaulieu between 1920 and 1935; H. Angelroth between 1920 and 1944; L. Eloy, essentially during the 1940s; D. de Burnonville and M. Drion from 1950 through 1953.

And finally, a programme of modern research conducted jointly by the "Direction de l'Archéologie" and "l'Association wallonne d'Anthropologie préhistorique" has been under way since 1997.

Data from the former excavations

Stratigraphy

During his excavations, E. Dupont (1872: 105-124) identified "five ossiferous layers" alternating with "six alluvial layers" in the fill of the cave he described as "3rd cave of Goyet" (fig. 4). Such an interpretation of the stratigraphy mixes sedimentary data with archaeological and palaeontological data.

The study of the two lower layers, which have a rich fauna, especially in the darker areas of the cave, influenced the digger into thinking that at the corresponding periods, the site was the den of, alternatively, lions and cave bears and sometimes hyenas. The three upper ossiferous layers, essentially present near the entrance, associated numerous knapped flints and bone tools with a varied fauna. They were, partly in error, attributed to the "Mammoth Age". Flints from the third layer, the deepest of the upper layers, were related to those of "Montaigle type", and the flints from the second layer to the Montaigle and "Trou Magrite" type. The objects from the first layer comprise narrow and regular blades, related, though considered better knapped, to those from Chaleux and Furfooz. Clearly, the series of tools related to the three ossiferous layers are far from homogeneous and this testifies to Dupont's poor stratigraphic observations at Goyet.

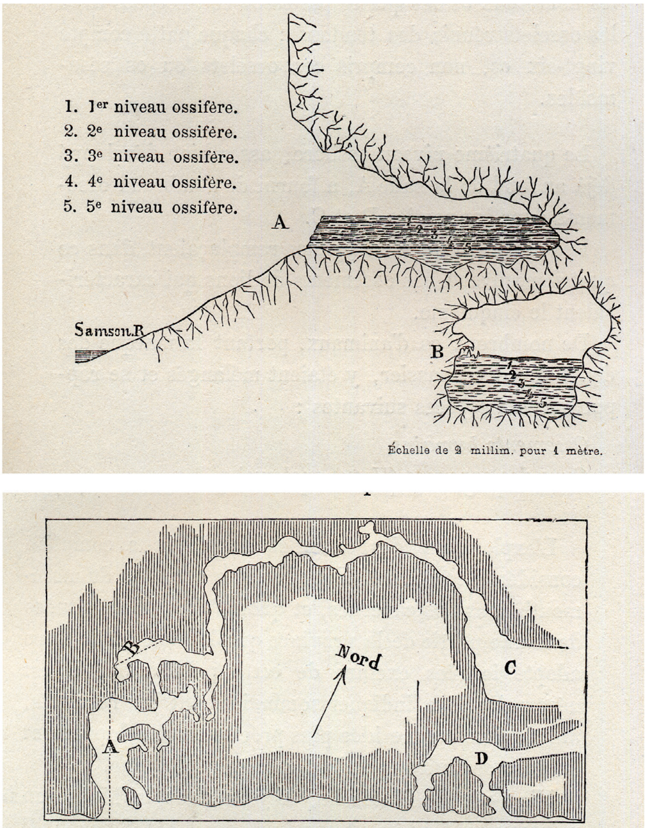

Figure 4. Stratigraphic section of the third cave (after Dupont 1872, fig. 12 et 13; captions: 12, 1st through 5th ossiferous layers, scale is 2 mm for 1 m; 13: scale is 1 mm for 1 m.

Prehistory

Notwithstanding the shortcomings of the first interventions, several prehistorians attempted to describe with some precision the sequence of Palaeolithic occupations of the site, which contains one of the most complete succession of industries of the north-west of Europe (Ulrix-Closset 1975; Otte 1979; Dewez 1987). But these attempts suffered from a number of shortcomings. It is quite probable that the main Palaeolithic periods identified on a strictly typological basis correspond to the artificial grouping of several occupation layers. In this respect, recent excavations in regional caves, notably Walou (Draily 2004), demonstrated the presence of several layers, each containing rare artefacts whose culture could not be identified on a strictly typological basis. Furthermore, numerous documents are difficult to attribute to a particular culture, e. g. several bone points or backed bladelets that may be as much Magdalenian as Perigordian. Finally, the Middle Palaeolithic classifications used, derived from F. Bordes' work in south-west France, are obsolete.

According to Ulrix-Closset (1975), there was some Quina Mousterian material at the bottom of the deposits, characterized by a limited use of Levallois reduction, by a large proportion of sidescrapers and by the presence of special artefacts such as bifacial sidescrapers, limaces, thick convex side-scrapers and thinned back side-scrapers (fig. 5). The different bifaces and leaf points might also have belonged to this industry of Quina type, even though it is not impossible that they belonged to a second Mousterian group. This may then be indicative of a Mousterian of Acheulean tradition or an evolved Mousterian (Ulrix-Closset 1975). The leaf points might also, according to some interpretations (Otte 1984), be related to industries known as "with leaf points" that might characterize the Middle to Upper Palaeolithic transition.

The abundant material typologically Aurignacian from the second and third ossiferous layers identified by Dupont might, according to Otte (1979), be attributed to two industries (fig. 6). Most of the material would in that case be closer to the Aurignacian of Spy cave while a less important group would exhibit features closer to the Trou Magrite Aurignacian.

One (supposedly, but more realistically, several) Gravettian occupation(s) follow(s) the Aurignacian, characterized by the abundance of backed bladelets, notably long points of Gravette type and long bitruncated bladelets, and by the scarcity of Font-Robert points and points with flat retouch (fig. 7).

The last Palaeolithic occupations at Goyet, found in the first ossiferous layer of Dupont, date from the Magdalenian, with possibly several phases represented (fig. 8; Dewez 1987). Two AMS dates were recently obtained from animal bones presenting cut marks that were gathered by Dupont in the first ossiferous layer of the third cave: GrA-3237, 12.770±90 BP; GrA-3238, 12.620±90 BP (Germonpré 1997). They might add new evidence to the theory of the "recolonisation" of the karst valleys of Wallonia by Magdalenian peoples (Charles 1996). The Magdalenian lithic material of Goyet is comprised, among others, of piercers, some of "Chaleux" type, and backed bladelets. Single and double bevelled sagaies, a superb harpoon with double rows of barbs, eyed needles and a beautiful reindeer antler "arrow-shaft straightener" (bâton de commandement) decorated with fishlike motifs, among them a trout (Twiesselmann 1951), constitute the most interesting bone pieces.

Finally, several more recent artefacts, notably Neolithic, Roman or Medieval, testify to the sporadic occupation of the caves of Goyet after the Palaeolithic.

Palaeontology

Fauna from Dupont's excavations come up regularly in palaeontological research. Like the other studies of the material found at Goyet in the 19th century, both in prehistory and human palaeontology, this research is biased by the lack of precision of the stratigraphic context and the confusion between strata from different periods. The most recent work focus mainly on cave bear, studied from the point of view of the timing and length of its dormancy period which, at Goyet as well as in other Belgian caves, was proven to vary according to the changing climatic conditions of the Ice Age (Germonpré 2000, 2004; Germonpré & Sablin 2001). Some cave bear bones bearing cut marks or traces of ochre were also identified; this suggests brief encounters between cave bears and Palaeolithic Man (Germonpré 2000, 2001). Fauna from the Magdalenian layer(s) of the third cave was also re-evaluated from the perspectives of taphonomy and archaeozoology (Germonpré 1996, 1997).

Palaeoanthropology

Most of Dupont's anthropological finds come from the third cave, more precisely from what he called the "second layer". Some of these finds have previously been studied, in particular three fragments of differentmandibles (Hamy 1873), of which one (inventory no. I.R.Sc.N.B 2878-09; fig. 9:1-2) has sometimes been compared to the mandible from La Naulette (Hamy 1873; Walkhoff 1903). All three were also attributed to the Upper Palaeolithic (Twiesselmann 1971). It was recently suggested that another small, left, mandibular fragment found by Dupont (fig. 9:3; inventory no. I.R.Sc. N.B 2878-08), as well as an upper incisor (fig. 9:4), might be Neandertal (Semal *et al.* 2005). The mandibular fragment still has the two premolars and the first molar; the mental foramen is under the anterior portion of the M1.

All these fossils deserve a detailed inventory, modern anthropological studies and radiocarbon dating, in order to separate the Holocene fossils, for the most part Neolithic, from some possibly older fossils.

Radiometric dating

Table 1 lists all the radiometric dates obtained from animal and human bones found at Goyet, with or without relation with prehistoric occupations.

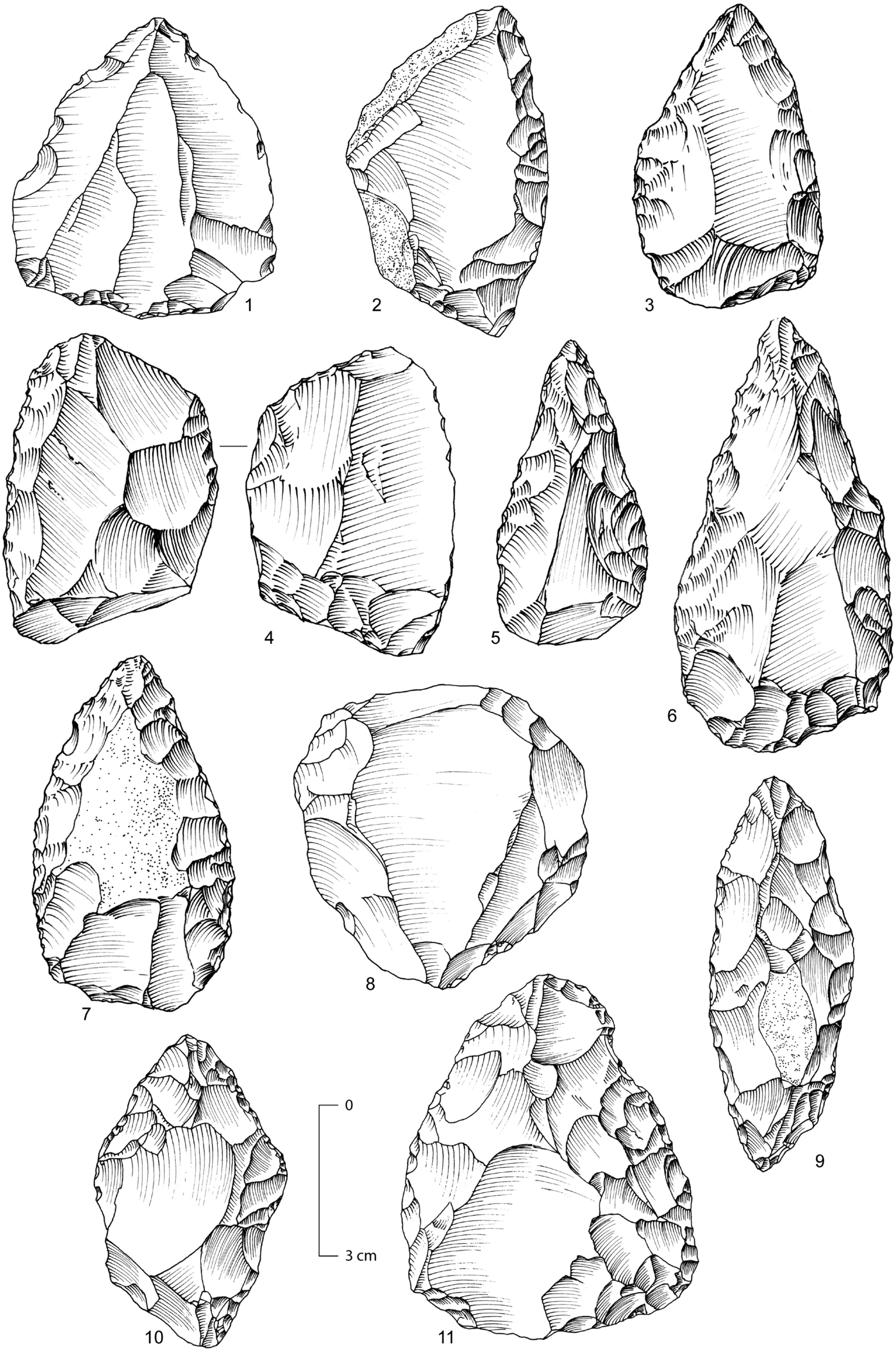

Figure 5. Goyet, the main terrace and its cave entrances, Middle Palaeolithic artefacts, former excavations. 1, Levallois point; 2, convex side-scraper, with atypical back; 3, convergent side-scraper; 4, convex side-scraper, with back thinned by bifacial retouch; 5, elongated Mousterian point; 6, elongated Mousterian point; 7, Mousterian point, on cortical flake; 8, disc on flake; 9, Limace; 10, leaf point; 11, subtriangular biface (after Ulrix-Closset 1975).

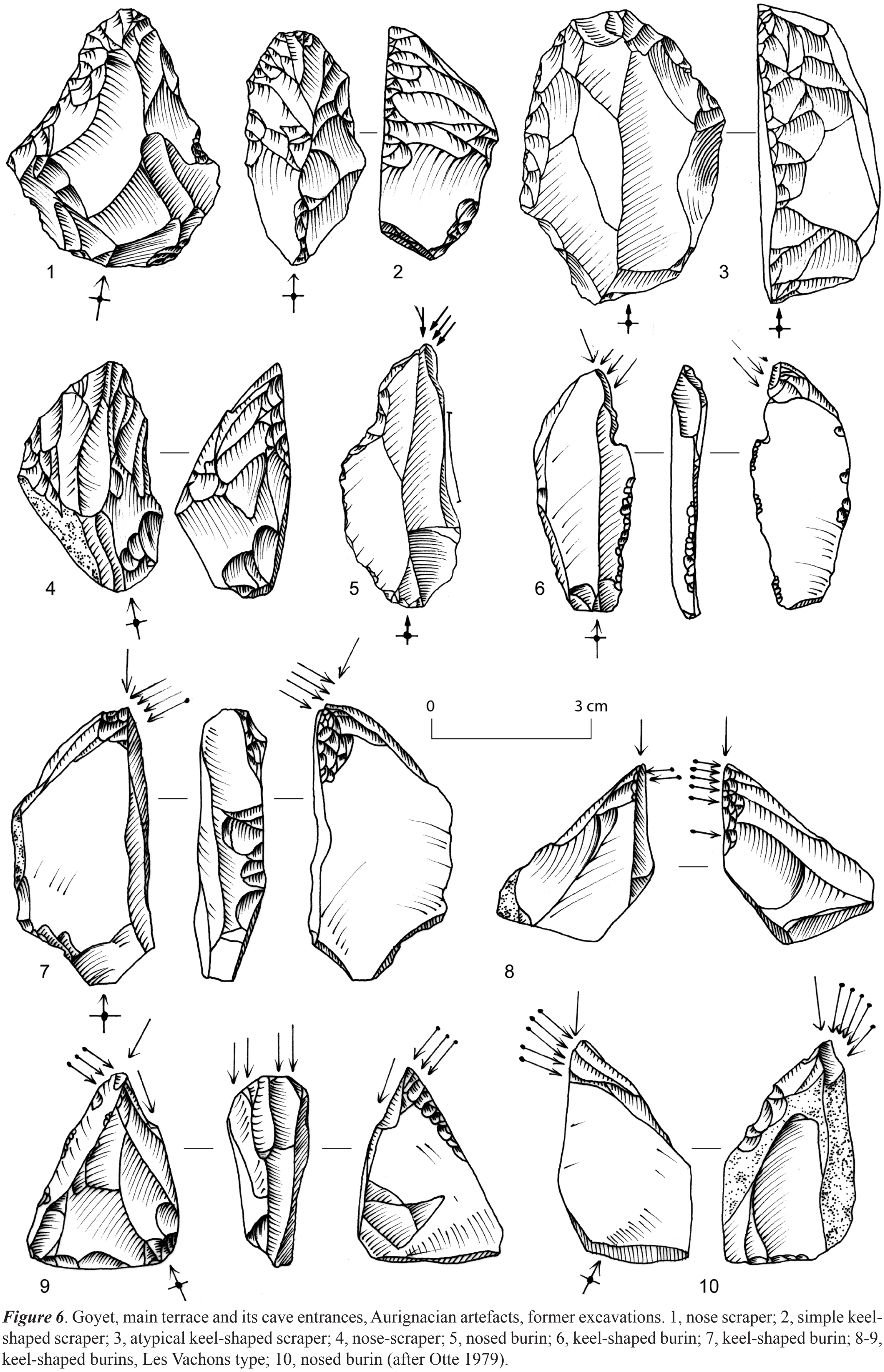

Figure 6. Goyet, main terrace and its cave entrances, Aurignacian artefacts, former excavations. 1, nose scraper; 2, simple keel-shaped scraper; 3, atypical keel-shaped scraper; 4, nose-scraper; 5, nosed burin; 6, keel-shaped burin; 7, keel-shaped burin; 8-9, keel-shaped burins, Les Vachons type; 10, nosed burin (after Otte 1979).

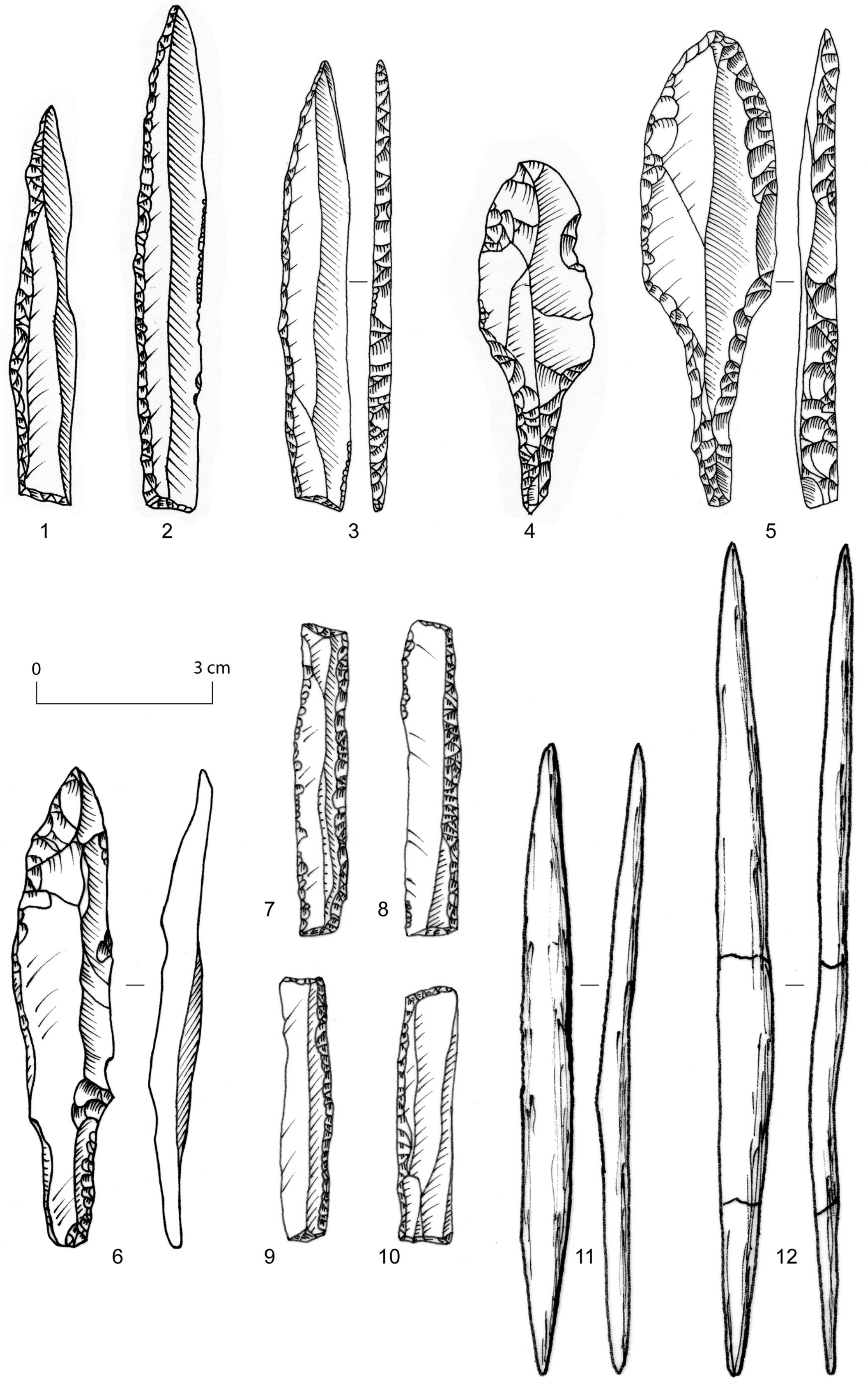

Figure 7. Goyet, main terrace and its cave entrances, Gravettian artefacts, former excavations. 1-3, backed points with troncated base; 4-6, stemmed points, La Font-Robert type; 7-10, bitroncated backed bladelets; 11-12, reinder double bone points (after Otte 1979).

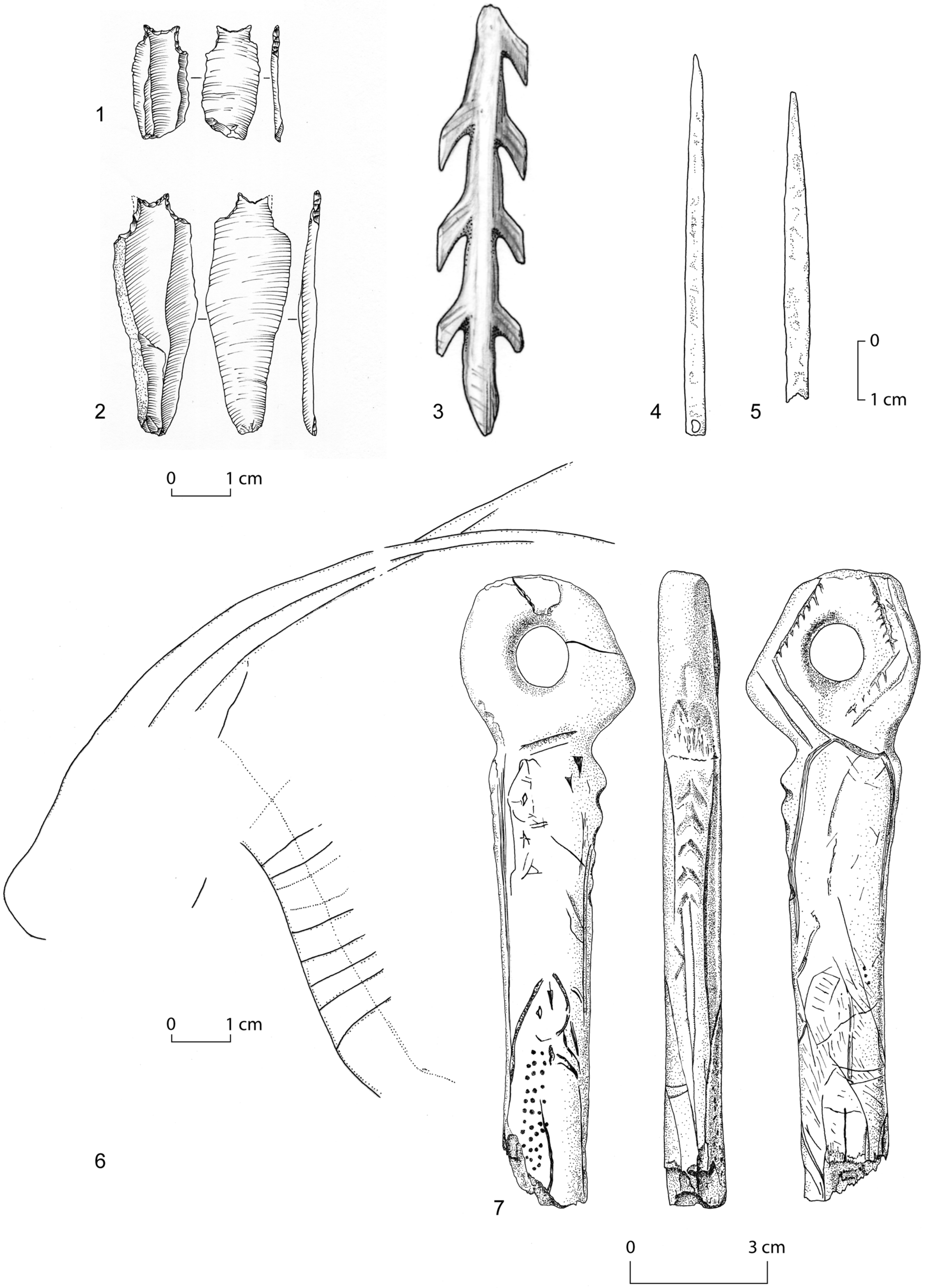

Figure 8. Goyet, the main terrace and its cave entrances, Magdalenian artefacts, former excavations. 1-2, piercers, Chaleux type; 3, harpoon with double rows of barbs; 4-5, eyed needles; 6, mobiliary rock art, ibex head; 7, reindeer antler bâton decorated with fishlike motifs (after Dewez 1987).

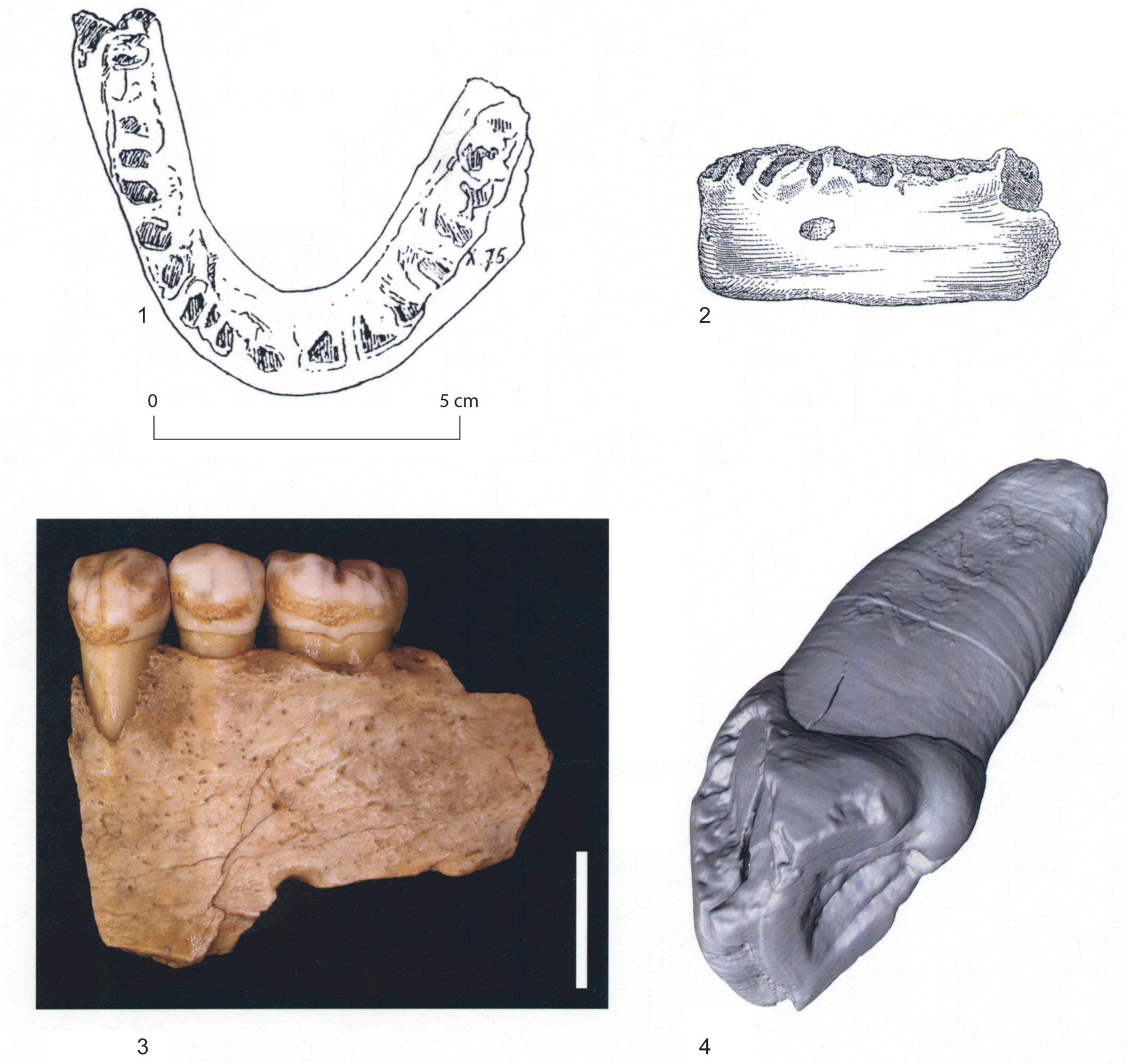

Figure 9. Goyet, third cave, "second layer". 1-2, mandible found by Dupont (inventory no. I.R.Sc.N.B 2878-09); 3, another fragment of mandible also found by Dupont (inventory no. I.R.Sc.N.B 2878-08); 4, left lateral upper incisor (1, after Hué 1937; 2, after Hamy 1873; 3, courtesy of Patrick Semal, I.R.Sc.N.B; 4, after Semal *et al.* 2005).

Modern excavations

Seven trenches were dug on the terrace (fig. 3:1-6, 11). Four others in the third cave; namely, trench 7 at the entrance, trench 8 inside the fissure no. 3b - which is an accessory passage to Cave 3 - and trenches 9 and 10 in the middle of the gallery (fig. 3). These eleven trenches were all dug to bedrock. Finally, trench 12 explored a vertical fissure at the west of the entrance of Cave no. 1.

Trenches 1-6 showed that the terrace in its current layout, flat and 4 to 10 m in breadth, is mostly artificial. It had been essentially modified by backfill moved out of the caves by the former diggers and by the construction of tourism facilities, which was attested by the discovery, between trenches 1 and 2, of the foundations of a 20th century drinking establishment.

In fact, the sections of trenches 2 and 3 reveal that the rock substratum of the "terrace" slopes down steeply. Such a slope is not well adapted to sophisticated prehistoric occupations. Furthermore, *in situ* sediments in contact with the bedrock, under the backfill, in these two trenches as well as in Trench 6 whose rock substratum slopes less, were extremely poor, archaeologically and palaeontologically speaking.

Goyet's so-called "terraces" of the second, third and fourth caves abundantly cited in the archaeological literature are therefore for the most part a mythic construction than a real prehistoric site.

Lab number	Results BP		Interest	Cave	Bone bearing layer of Dupont	Taxon	Cut marks	Industry	References
OxA-4926	24.440	± 280	Prehistory	Upper Shelter		Bovid	no	Gravettian	Eloy & Otte 1995
GrA-3237	12.770	± 90	Prehistory	3	1	*Equus*, vertebra	yes	Magdalenian	Germonpré 1997
GrA-3238	12.620	± 90	Prehistory	3	1	*Ovibos*, phalynx	yes	Magdalenian	Germonpré 1997
UtC 8957	12.560	± 50	Prehistory	3, chamber A	1	*Equus*, MC		Magdalenian	Germonpré 2001
OxA-8875	2420	± 40	Prehistory	classic caves		*Homo s. sapiens*	yes	Protohistory	Toussaint 2005a
Beta-124825	4410	± 50	Palaeoanthropology	Trou du Moulin		*Homo s. sapiens*	no		Toussaint 2005b
OxA-10534	5345	50	Palaeoanthropology	Upper Shelter		*Homo s. sapiens*	no		Toussaint 2002a
OxA-5678	1985	± 50	Palaeoanthropology	3, chamber A	3	*Homo sapiens*			Preud'homme 1995-1996
GrA-9606	35.470	+ 780-710	Palaeontology	3, chamber B	4	*Ursus spelaeus*, metacarpal	no	-	Germonpré & Sablin 2001
GrA-9605	38.770	+1180-1030	Palaeontology	3, chamber A	1	*Ursus spelaeus*, pisiform	no	-	Germonpré & Sablin 2001
KIA-18986	27.440	± 165	Palaeontology	3, chamber A	3	*Ursus spelaeus*	no	-	Germonpré 2002
KIA-16289	34.920	+330-320	Palaeontology	3, chamber A	2	*Ursus spelaeus*	no	-	Germonpré 2002
GrA-2812	27.230	± 260	Palaeontology	3, chamber A	1	*Crocuta crocuta*, calcaneum	no	-	Germonpré 1997
UtC 8958	35.000	± 400	Palaeontology	3, chamber A	1	*Crocuta crocuta*, P4	no	-	Germonpré & Sablin 2001
KIA-13550	10.640	± 50	Palaeontology	3, chamber A	3	*Ursus arctos*, mandible	no	-	Germonpré 2001

Table 1. Radiocarbon dates from the different sites of the Goyet cave system.

These observations suggest that the former excavations conducted on the terrace essentially consisted in reworking the backfill from the inner caves, notably that from the initial excavations of E. Dupont. The fact that the backfill was stratified added to the quantity of material it contained, both archaeological but above all palaeontological, may easily have misled diggers who used to work in small areas, regardless of stratigraphy, only interested as they were in laying their hands on nice objects.

On the other hand, a large fissure located in the floor underneath the arch, just before the entrance no. 1, did not seem particularly engaging at first since the bedrock was visible in places; yet it yielded some promising archaeological data (fig. 3:11).

Trenches 7, 9 and 10 (fig. 3) brought evidence that the third cave had been almost completely emptied to bedrock by Dupont and the numerous diggers who succeeded him, although sediments very low in archaeological content were found in fissure 3b (fig. 3:8).

Trench 12 explored the rift in the west wall of the first cave's entrance area, just outside the iron grid; it was filled essentially by sediments reworked by former explorations. Still, it yielded some flint artefacts and morphologically modern human bones that might come from a disturbed Holocene burial.

The Upper Shelter

History

The shelter is ca. 50 m north-west of the terrace of the 'classic' caves, 12 m above them, 25 m above the alluvial plain (fig. 2:2). This Gravettian site was excavated without any method around 1952, then recently re-excavated with a multidisciplinary perspective by the "Direction de l'Archéologie" (Toussaint *et al*. 1999).

Results from the 1952 excavations

An abundant lithic material has been gathered over the years, as much by L. Keyser, at the time manager of the tourist caves, then by a series of amateur archaeologists to whom Keyser gave permission to loot the site on a regular basis, among them L. Eloy, whose collection is the only one published to date, 4 decades after the fact (Eloy & Otte 1995).

The brief stratigraphy recorded in 1952 comprises only three units: blocks fallen from the cliff, a humic layer and, at the bottom, the archaeological layer "made of a light powdery sediment loessic in aspect", with "fine strata corresponding to past human occupation".

The archaeological material (fig. 10) was gathered without precise measurements or sieving. It includes blades and bitruncated backed bladelets, backed points with truncated bases as well as bi-points which make up most of the arrow points, the latter also comprising some backed bladelets and fragments of Gravette and microgravette points. A stemmed point of Font-Robert type and a fragment of point with flat retouch are also reminiscent of the famous Maisières site industry. Common tools include different burins, composite tools and scrapers of which some, with thick front, are problematic in that they suggest either the persistence of Aurignacian typologies or the presence of an Aurignacian layer underneath the Gravettian.

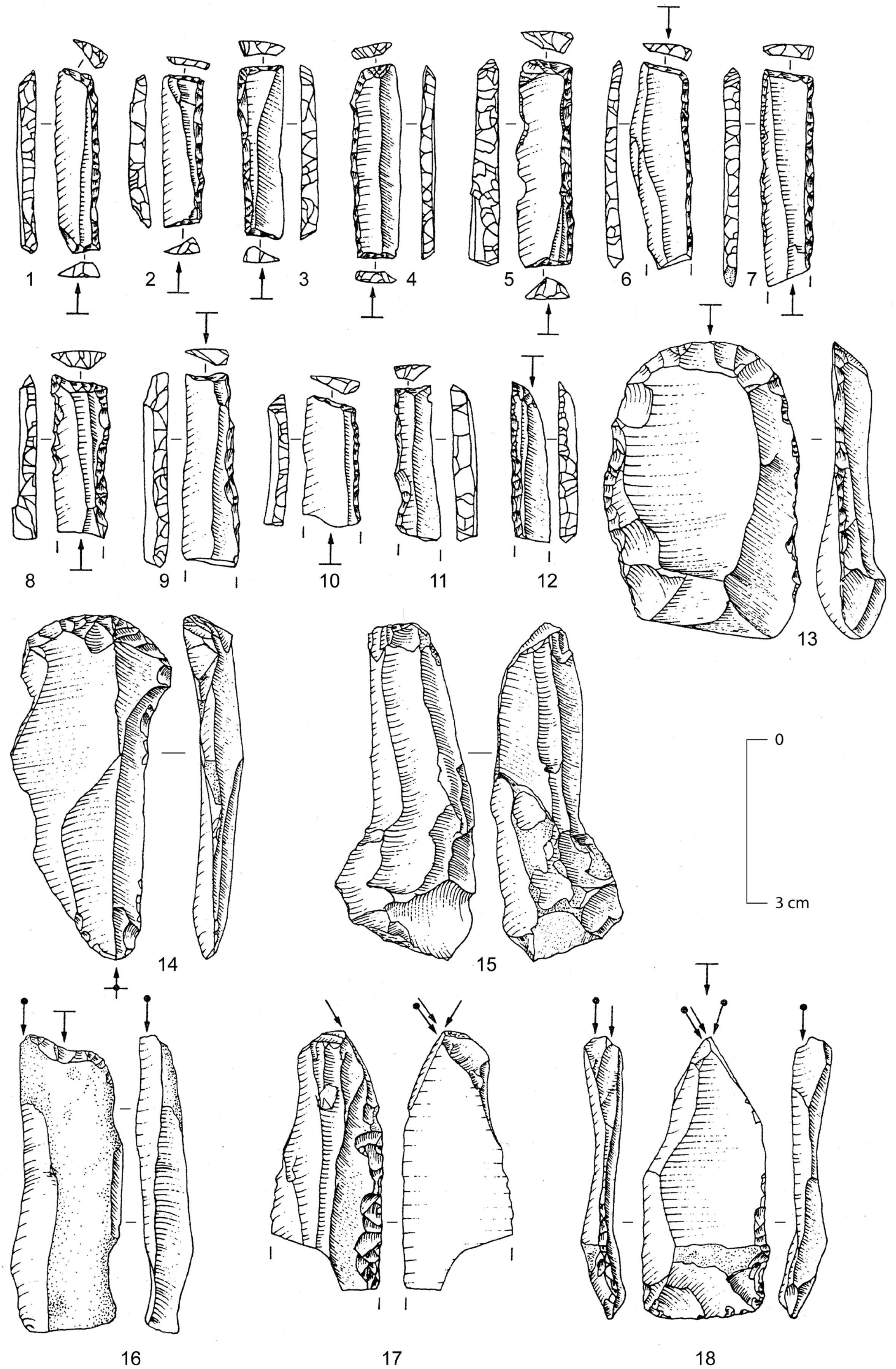

Figure 10. Goyet, Upper shelter, Gravettian artefacts, recent excavation by the “Direction de l’Archéologie” (after Toussaint *et al*. 1999). 1-5, bitroncated backed bladelets; 6-11, troncated backed bladelets, broken; 12, pointed backed bladelet, broken; 13-14, scrapers; 15, core; 16-18, burins.

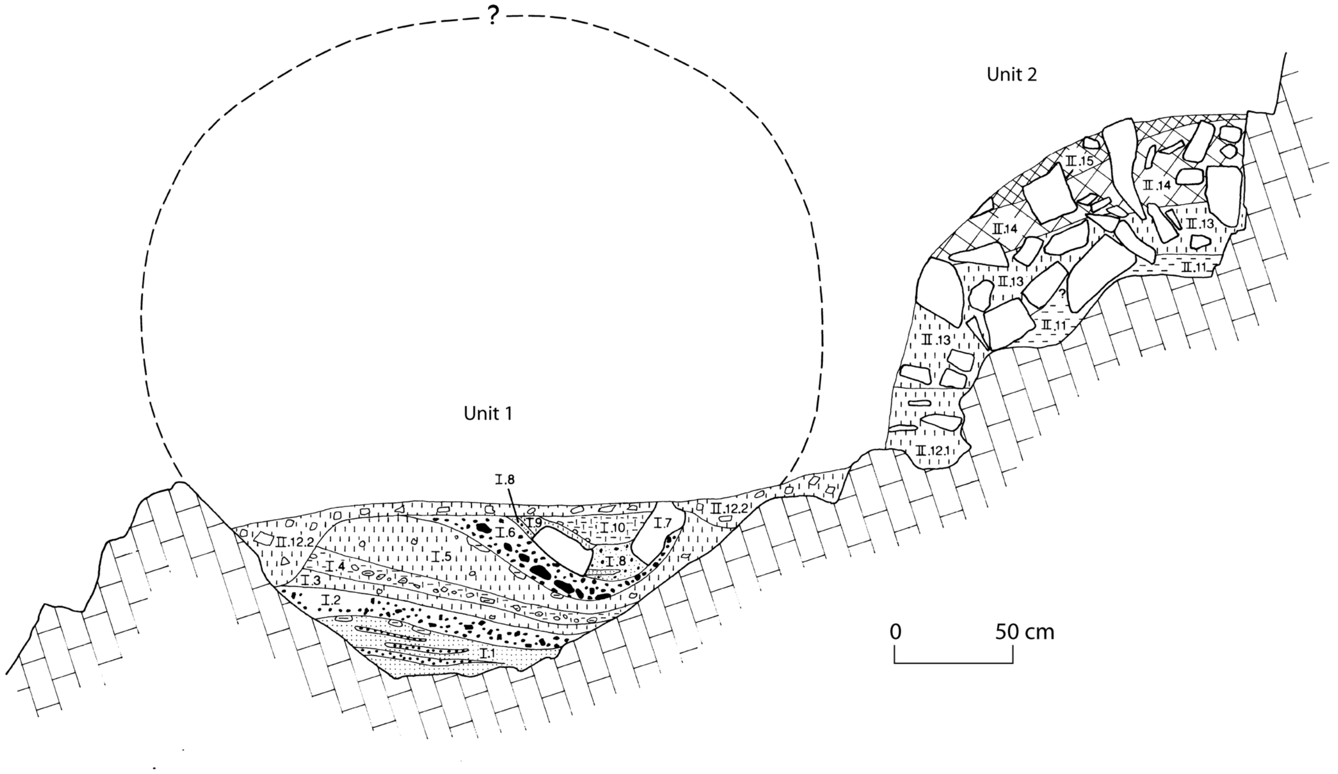

Figure 11. Goyet, Upper Shelter, section drawn by the geologist S. Pirson during the excavation of the "Direction de l'Archéologie" (after Toussaint *et al*. 1999).

Fauna included woolly rhinoceros, cave bear, aurochs, red deer and ibex, but mostly horse and reindeer. AMS dating of a bone fragment from a "large bovine" yielded 24.440±280 BP (OxA-4926).

Modern excavations

The stratigraphic sequence of the Upper Shelter observed after the three years of recent excavations appears more elaborate than that described during the first explorations. These deposits, studied in detail by the geologist S. Pirson (in Toussaint *et al*. 1999) are divided into two units differing by their deposition processes. A series of erosion sequences was also identified.

The first unit (layers I.1 to I.10 and II.12.2; fig. 11) represents deposits filling a decapitated karstic gallery. Layers I.1 to I.8 represent an evolution in karstic context, with high energy fluviatile deposits (layers I.1, I.2 and I.6.1, I.6.2, I.8) interspersed with calmer phases, maybe also of a fluviatile origin (layers I.3 and I.4). Layer I.5 is different in that its input contains deposits probably aeolian in origin, interspersed between two fluviatile phases. Layer I.7 corresponds to blocks collapsed from the roof of the gallery when the streamway was active. Layers I.9 and I.10 have probably been deposited in the karst, before the collapse of the gallery roof; however, no layer can be directly correlated with this collapse, probably because of the perturbations produced by the former amateur excavations and because of strong erosion. A significant hiatus certainly separates this collapse (probably posterior to layer I.10) and the deposit of layer II.12.1. On the other hand, the top layer of the first unit, II.12.2, is clearly related to a rock shelter context, as is the second unit.

The stratigraphy of the second unit (layers II.11 to II.16) - whose stratigraphic links with the first unit were in great part truncated by the 1950's work - starts with a loess-like sediment containing Gravettian archaeological material (layer II.12.1). Layer II.13 represents a phase of strong cryoclasty. Finally, layers II.14 and II.15 are affected by Holocene pedogenesis.

The new research yielded a few bones from large mammals, a marine mollusc shell (*Glycimeris* sp.*)* and abundant samples of microfauna and terrestrial molluscs. The bone remains are deteriorated and very small. They essentially belong to: *Bos primigenius, Equus* sp*., Cervus elaphus, Rangifer tarandus,* woolly rhinoceros and *Vulpes vulpes*. This little series suggests a predatory way of life in the context of a gallery forest and thus, climatic conditions slightly milder than that deduced from the identifications based on photographs of about 20 bones from the 1952 excavations (Eloy & Otte 1995).

Several hundred lithic artefacts including dozens of tools were found in the still undisturbed archaeological layer and in the backfill from the first excavations. The flintwork consists of cores with blades, numerous blades and bladelets as well as flakes of various shapes. The classic tools are represented by scrapers (fig. 10) and burins, essentially on truncations and dihedral There are also backed pieces with two truncations, backed pieces with a truncation at one end and a fracture at the other end, that are probably nothing more than broken bitruncated pieces, as well as bladelets with pointed back that might be fragments from bi-points. Some simple backed bladelets were also found. Typologically speaking, this material belongs to the Gravettian, like the one from the previous excavations to which it is closely related.

A small set of teeth and human bones was found during the latest excavations, notably in a horizontal fissure in the back wall of the Upper Shelter, more or less at the level of the superficial deposits that must have filled the site before its exploitation. These remains belong to at least one morphologically modern child and one adult. This places them within the Middle Neolithic: 5345±50 (OxA-10534), 4250-4040 BC after calibration at 1σ.

Trou du Moulin and its new cave systems

History

Trou du Moulin (Mill Cave), sometimes referred to as "Cave no. 1" or "Mathot Cave", is located downstream of the Upper Shelter. E. Dupont was the first to explore the site, apparently after his important excavations at the "classic" caves of Goyet but before 1872, when the site is mentioned in his main book (Dupont 1872). The site was later transformed by the construction of a shelter during the First World War. In 1948, H. Danthine (1952) had large trenches dug through the terrace and in the cave itself.

Since 1998, our research team has found several new galleries and chambers by exploring a small cleft in the right wall of the main cave (Toussaint *et al*. 1998).

Data from the former excavations

From the limited information available in E. Dupont's book (1872, synoptic table) and the accompanying labels of the material he found (Danthine 1952) that is conserved at the Royal Institute of Natural Sciences of Belgium, there were three ossiferous layers at Trou du Moulin, all belonging to the "Mammoth age". The first two layers yielded some archaeological material, among them a small series of flint artefacts. The purported homogeneity of the groups defined by Dupont must, however, be treated with some caution, as the presence of pottery shards and some human bones found in the second ossiferous layer suggests. While excavating Trou du Moulin, H. Danthine found only disturbed sediments containing various faunal remains belonging to the same species as those found by the first digger, as well as a fragment of a retouched flint and a chert point. This poor lithic material might indicate a short occupation by a "Levallois-Mousterian" Middle Palaeolithic group (Danthine 1952).

Cave bears, hyenas and some rhinoceros were the most represented species in these three layers. The so-called "evidence of human occupation" as identified by Dupont in his "first ossiferous layer" is limited (Danthine 1952) to ten flint artefacts including 3 retouched blades and one core, a chert blade and two rolled cobbles of which one would have served as a hammerstone. The "second ossiferous layer" yielded for its part two rolled cobbles and 13 flint artefacts including 3 scrapers and a long point. Some human bones were also found in the second of these ossiferous layers. Pottery shards coming from the two layers make the homogeneity of the groups as advanced by Dupont disputable.

The child from the new cave systems

The newly discovered (1998) cave systems of Trou du Moulin extend to the Upper Shelter. A series of chambers and connecting corridors, forming an approximate square, constitute the "Central System" (fig. 12). Three long sub-systems with magnificent concretions start from three of the four corners of the Central System: "Régal des Fées", "Atlantide" and "Salle de Cristal".

Bones from a child about 12 years old, probably a boy, were found in two areas of one of the "Central System" chambers (Toussaint *et al.* 2004; Toussaint 2005b). Most of the bones came from a vertical fissure ca. 2 m high and 30-40 cm wide near the roof of "Salle de l'Enfant" (fig. 12). Others were found 4 m below, in the chamber proper, either on fragments of stalactite curtains and stalagmites covering the floor or underneath these fragments. No archaeological material was associated with it. AMS dating of a foot bone yielded a date of 4410±50 BP (Beta-124825), i. e. 3100-2920 BC after calibration at 1σ. This fits well in the rich corpus of dated human bones from the Belgian Meuse basin (Toussaint 2002a). It corresponds to the beginning of the Late Neolithic.

Since the fissure was too tight to allow access to the skeleton, an *ad hoc* methodology had to be developed, comprising precise measurements with laser surveying equipment of small plastic landmarks scattered amid the bones, photographs taken with a digital camera fitted to a pole, software correction of the photographs to recreate a faithful map of the bone distribution based on the surveyed landmarks, and finally dismantling of the burial with a 70 cm long articulated pair of pliers.

Initially, the scattered bones seemed in utter disorder. But after having divided the fissure in sections numbered 1 to 6 (7 being the chamber immediately below the fissure), from back to front, and having studied the distribution of the different types of bones according to this plan, some minimal order became apparent. As shown on figures 13 and 14, most of the cranial fragments were at the back, in section 1. The maxillae and the mandible were closer to the front, respectively in sections 3 and 4. Isolated teeth were in the bottom half of the fissure. Most of the pectoral girdle bones were in section 3, the rest in sections 2 and 4. Vertebrae were found everywhere, a few cervical vertebrae at the back, in section 1, and a concentration in section 3. The ribs were mostly concentrated in sections 3 and 4. The upper long limb bones were somewhat grouped in section 3 and in the back of 4 (fig. 14). Most of the hand bones were in 3. The pelvis parts were in majority in 5 and the front of 4. The femora, broken, were in section 5. The left tibia was in section 4 and the right much further back, trapped by stalagmite B, in section 3. The right fibula was also in section 3. Several bone fragments had fallen in the chamber down below, section 7.

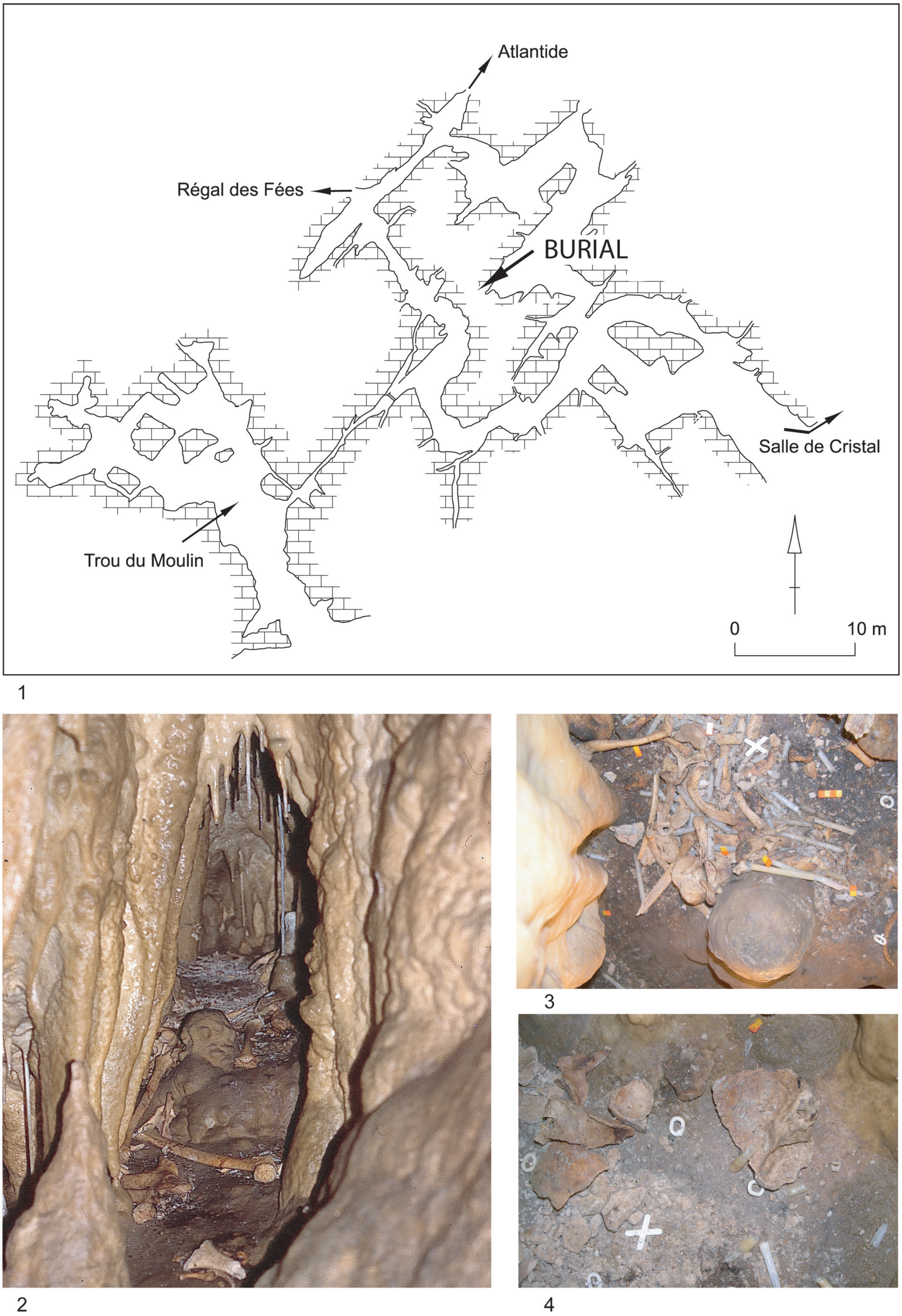

Figure 12. Goyet, Trou du Moulin, Neolithic grave of the new cave systems. 1, map of the "Central System", a series of chambers and connecting corridors forming an approximate square, with location of the Neolithic child burial; 2, general view of the grave; 3-4, detail views of the grave.

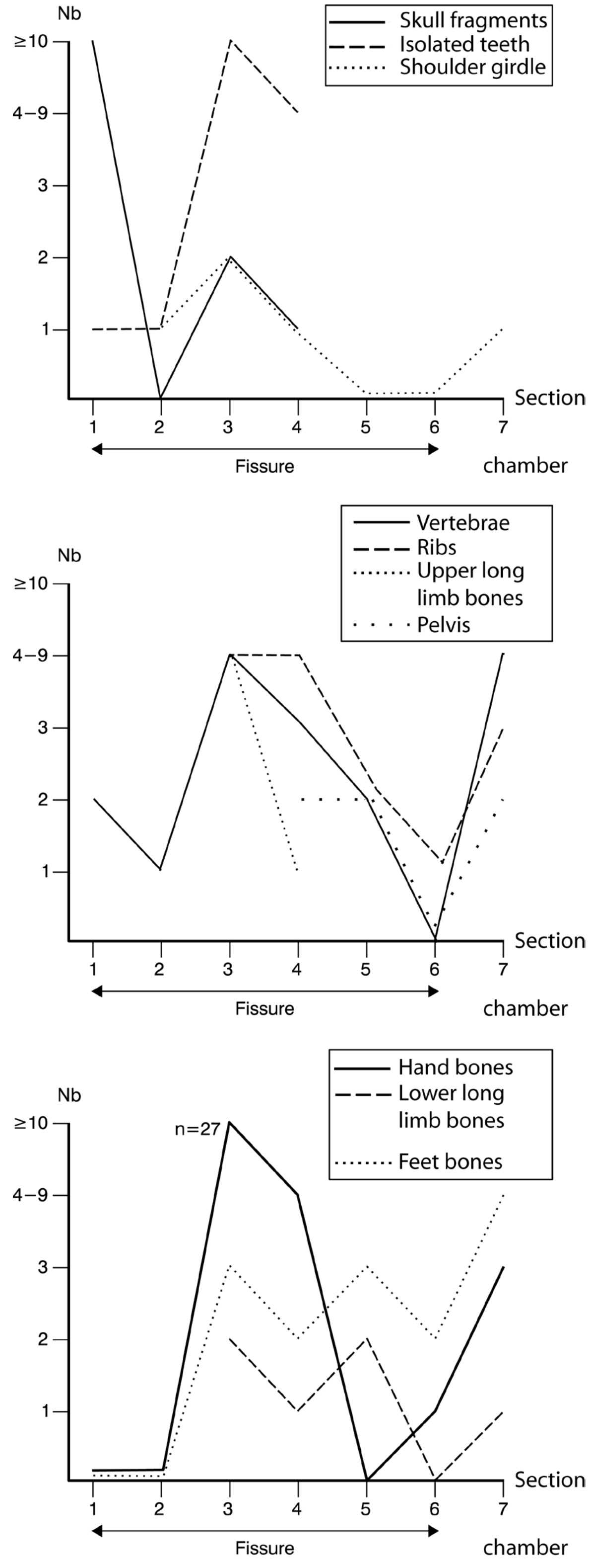

Figure 13. Goyet, Trou du Moulin, Neolithic grave of the new cave systems: distribution of the different types of bones in six sections defined along the longitudinal axis of the grave, from back to front, section 7 being the chamber immediately below the fissure.

This distribution pattern suggest the body had been lain with its head at the back of the fissure and its feet near the entrance, which is supported by the fact that most of the skeletal remains had their proximal epiphysis towards the back of the fissure, where the skull was located.

However, two interesting irregularities appeared during our analysis. First, the femora were turned over, their head towards the entrance, while the orientation of the tibiae was more in accordance with what was expected from a body with its head at the back. Second, the ulnae and radii were further back in the fissure than the left humerus, like the majority of the small hand bones; furthermore, the proximal end of the right ulna was oriented towards the entrance. The comparison between these two sets of observations provides solid evidence in favour of a folded position of the body, of foetal type.

The combination of three intriguing characteristics of the burial, namely: the body was alone, completely sheltered from daylight and in an all but unreachable fissure, confers on this burial a quite specific quality in comparison with the other burial sites from the Late Neolithic Meuse basin.

It seems also that the body of the child decomposed in the open air, as evidenced by the lack of sediments over the bones as well as the numerous bones displaced out of the initial area of the burial, the displacement further back of the skull parts, the displacement of the mandible, the flattening of the pelvic area, fragments from the same bone found separated by a certain distance, etc. Decomposition occurred in a primary burial, which is confirmed by the persistence of "unstable connections" and a certain level of spatial organisation in the distribution of the bones.

As a conclusion, the following sequence of events can be proposed. Neolithics decided, after the death of a child about 12 years old, to bury him in a fissure situated 4 m above the floor, inside the Goyet karstic system. To achieve this, they had to hold and sometimes drag the corpse through tight corridors, in order to access the chamber where they hauled the body in the fissure and laid it to rest with its head at the back. It seems that the legs and forearms were folded. No sediment was deposited on the corpse and no natural sedimentation covered it later. Two stalagmites, formed by water dripping from the roof of the fissure, froze two small sections of the burial. Later, small animals disturbed the distribution of the bones, eroded the ends of some of them and pushed some bones into the chamber below the fissure. Seismic tremors later shattered stalactite curtains adorning the walls of the "Salle de l'Enfant" as well as stalagmites and stalactites and toppled them on the floor, covering in the process the first bone fragments fallen from the burial fissure. Finally, burrowing animals again pushed some bones out of the fissure, the resulting fragments then falling over the pieces of stalactite curtains and other concretions covering the floor of the chamber.

Post-Palaeolithic archaeological evidence

Apart from several series of teeth and human skeletal remains reminiscent of Neolithic Meuse basin collective burials, some post-Palaeolithic prehistoric material found at Goyet was recently studied. The caves have also yielded traces from later periods: Protohistory, Roman and Middle Ages, whose study falls outside the scope of this paper.

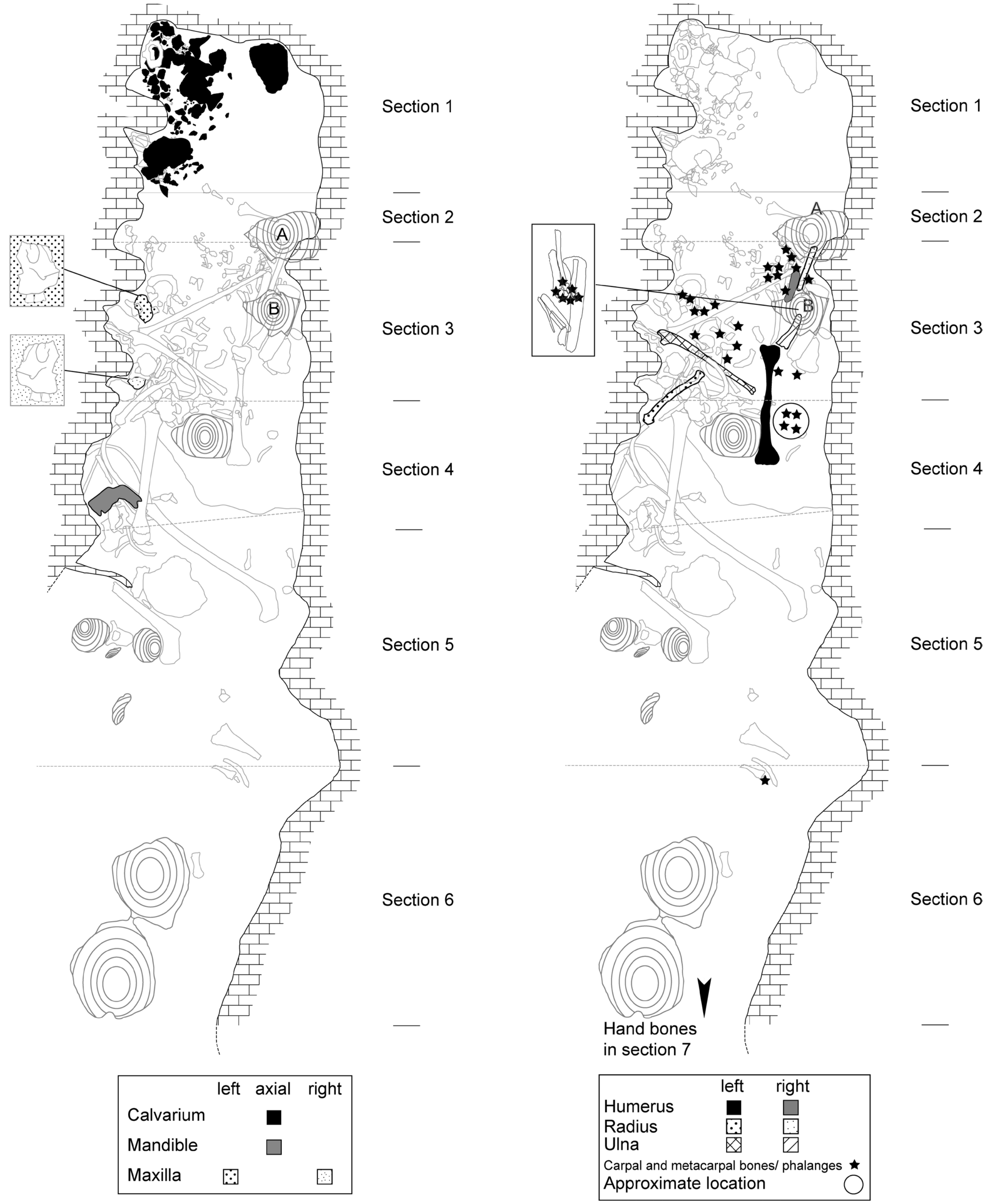

Figure 14. Goyet, Trou du Moulin, Neolithic grave of the new cave systems. 1, distribution of the skull fragments; 2, distribution of the upper limb bones.

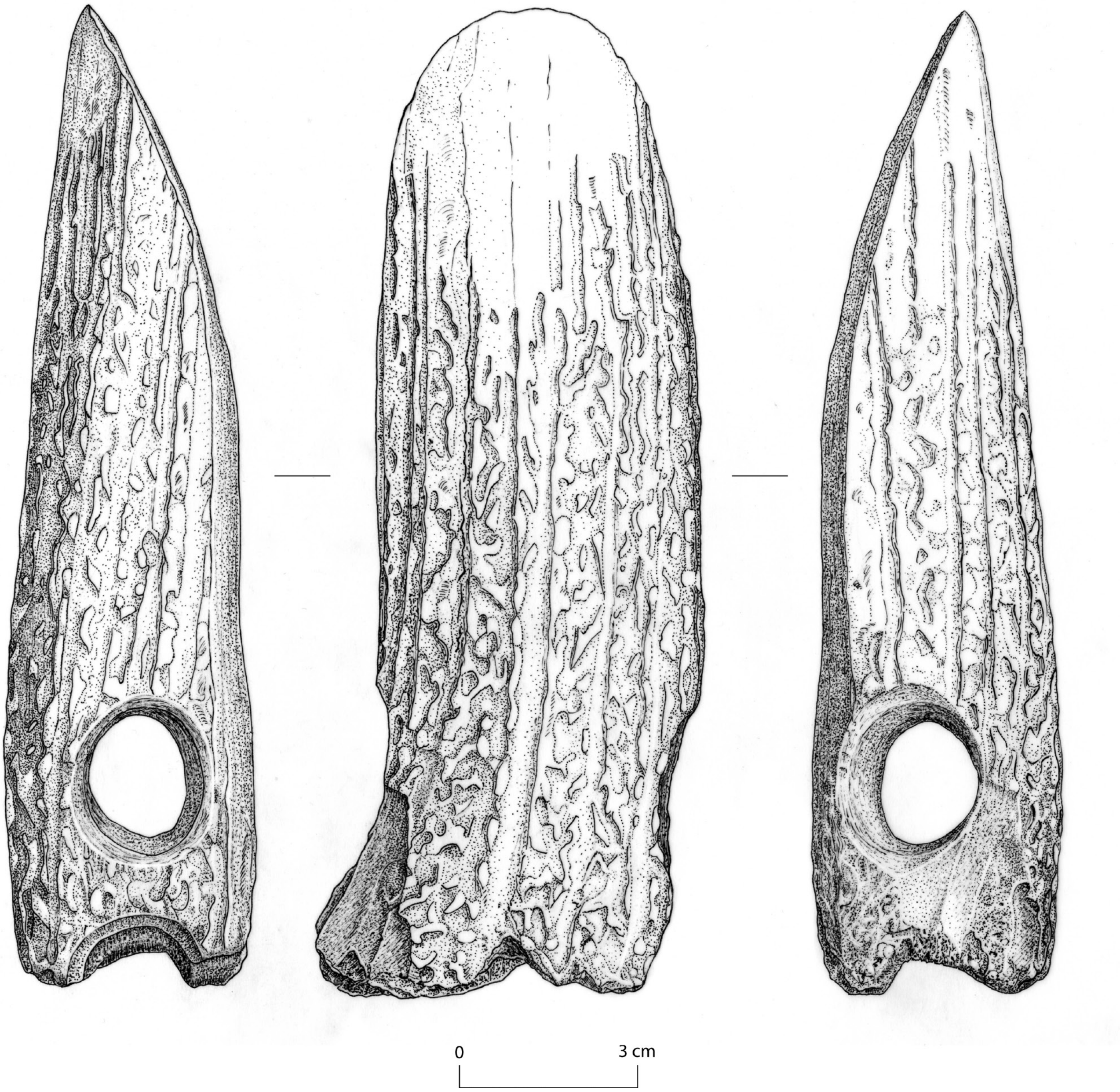

Figure 15. Bevelled antler tool.

The bevelled stag antler mattock

A bevelled and double-perforated stag antler mattock was found at an unknown date (fig. 15). The two perforations are parallel; the first, incomplete, in the axis of the central antler, and the second, complete, about 1 cm from the first one, towards the bevel. The bevel was obtained by obliquely sectioning the beam; it exhibits several microtraces. It matches type ba3 in Hurt's classification (1982). Chronologically, bevelled tools of type Ba seem to make their appearance around 6500-6400 BP (Smith 1989) or 6100 BP (Crombé *et al.* 1999) until, depending on the regions, 5400-5300 BP (Smith 1989) or even 4700 BP (Crombé *et al.* 1999). They date from the end of the Mesolithic or the Early and Middle Neolithic. Without radiocarbon dating, the age of this tool remains undetermined.

The Protohistoric knife (fig. 16)

A tool manufactured on a human radius was discovered between 1935 and 1945 in the classic cave system (Toussaint 2002b, 2005a). A splinter from the artefact yielded an AMS date of 2420±40 BP (OxA-8875), i.e. between 760 and 400 BC after calibration at 1σ and between 770 and 390 BC at 2σ. Such a result dates the object to the Iron Age, although the size of the standard deviation due to large plateaux on the calibration curve prevents greater precision.

The tool was shaped on an adult left radius, perhaps from a male. The distal end of the bone was removed during tool preparation. On the distal part, there is a partial longitudinal edge, prepared by scraping of the palmar and dorsal surfaces and practically aligned with the prolongation of the interosseous crest, from which, however, it is easily distinguished. The lateral face of

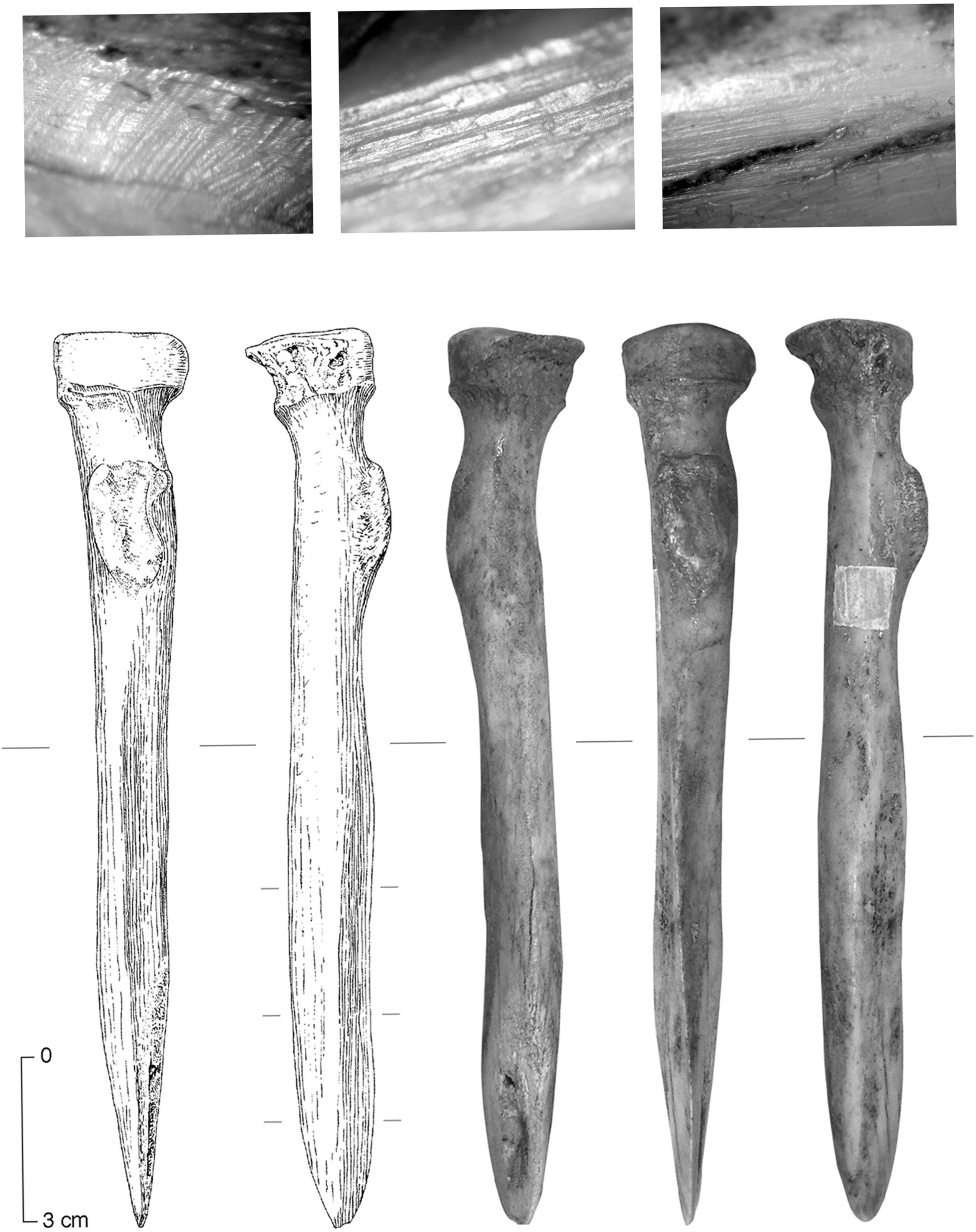

Figure 16. Protohistoric knife from the “classic” caves.

the bone is a longitudinal back opposite the prepared edge. Unworked on all of the central part of the object, this back was, however, worked on the most distal part to contribute to the formation of the point.

Strictly speaking, the object cannot then be considered a dagger. In spite of the relative shortness of the worked edge, it corresponds rather to the definition of a knife. Typologically, the tool is exceptional. On the basis of archaeological literature, it is the only sharp-pointed tool created on a radius known both for the prehistoric and protohistoric periods in Europe and North Africa; the few other tools made from human long bones are typically on fibulae and, more rarely, on ulnae and humeri. In addition, these comparable tools are characterized primarily by their point, which often qualified them as daggers, while the specificity of the Goyet knife is the association of the point with a worked edge opposed to a natural back.

Conclusion

The archaeological richness of Goyet caves was already known back in 1870. The intensity of the careless explorations this site has undergone has profoundly altered the sedimentary deposits and the rich prehistoric material it contains. Data essential to the accurate understanding of the stratigraphy and palaeoenvironment have been lost forever. Both palaeoenvironmental and archaeological studies are consequently seriously penalized, inasmuch as they have to compile documents most probably originating from different strata. Barring the discovery of an undisturbed sedimentary fill, we will never know in detail the different Middle Palaeolithic, Aurignacian, Gravettian and Magdalenian industries present at Goyet.

However, during the research undertaken since 1997, partial layers have been found *in situ*, for example at the Upper Shelter, and the virgin area, in the new systems of Trou du Moulin, where a Neolithic child burial, has been excavated. Much more, though, must still be done if we are to better understand the prehistory of the caves of Goyet.

In the field, several untouched areas should be excavated. Among them, a fissure in the floor of entrance no. 1 of the "classic" terrace stills contains undisturbed deposits. By far the most promising perspectives, however, lie in the pristine gallery directly under the Upper Shelter; filled with sediments to the last 60 cm under the roof, its entrance yielded, as much on the surface as in stratigraphy, lithic material from the Early Upper Palaeolithic and bones from large Quaternary mammals. Finally, diverse small caves spread out along the cliffs of Goyet still contain multiple unexplored burials.

As for laboratory work, analyses of the deposits from the Upper Shelter must be finalized, particularly the sedimentology and palynology, and a monograph has yet to be written. The study of both the collections kept in museums and the private collections might also bring some surprises, as proven by the recent re-discoveries of a knife on human bone unearthed half a century ago as well as a fragment of a mandible found by E. Dupont around 1870.

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CONCLUSION

Marcel OTTE
Service de Préhistoire, Université de Liège. Marcel.Otte@ulg.ac.be

La découverte en Flandre de sites du Paléolithique moyen, liée à l'exposition tenue à Tongres sur le monde des Néandertaliens, fut l'occasion de rassembler les meilleurs esprits travaillant la question et d'établir un bilan sur ce phénomène typiquement européen.

Une lente évolution anatomique régionale a en effet unifié les diverses populations hétérogènes, issues des grands continents asiatique ou africain. La diversité s'estompe vers 500.000 ans pour constituer une véritable "race fossile" qui a tant marqué les esprits au XIX^{e} siècle qu'on la considéra parfois comme une espèce distincte.

L'élasticité de la morphologie a montré qu'il n'existe pas de strict rapport entre la mécanique osseuse et les aptitudes culturelles ou génétiques. Cependant, une tendance évolutive affecte toute humanité, créant des isolats et des effets de stade dès que l'on quitte les aires nucléaires. Ce fut le cas de la "péninsule européenne" au cours du Pléistocène récent (Wolpoff, Tattersall, Hublin, Stringer).

L'immense durée prise par cette gestation et l'extrême variabilité des environnements successivement traversés démontrent à l'évidence la grande souplesse comportementale dont jouissaient les Néandertaliens. Des centaines de millénaires furent traversés sans que de sérieux bouleversements ne viennent affecter ni leur anatomie ni leur souplesse adaptative apparemment totale (Gullentops, Debenham, Van Kolfschoten, Richter, Parfitt).

De plus, les Néandertaliens ont manifesté un extrême développement spirituel, par exemple dans l'élaboration prévisionnelle de leurs outils ou de leurs modes alimentaires, dans l'importance accordée aux matières végétales et, surtout dans leurs sépultures et les gestes ritualisés qui y furent fossilisés. Nous y voyons même, comme aux portes de l'histoire, des variations régionales, telles des réponses à des modes de transmission orale, spécifiques à certaines populations (Van Peer, Patou, Orschiedt, Kozlowski).

La période se termine enfin, un peu comme une migration de peuples aux temps historiques, à la fois par l'apport de flux

The discovery of Middle Paleolithic sites in Flanders, linked with the exhibition held at Tongeren on the world of Neandertals, was the occasion to assemble the best minds working on this topic and to present a summary of this typically European phenomenon.

Slow anatomic evolution on a regional scale in effect unified diverse and heterogeneous populations coming from Asia and Africa. Such diversity subsided around 500,000 BP to form a veritable "fossil race" that so struck the minds of the 19th century that it was sometimes considered to be a distinct species.

Morphological resiliency has demonstrated that there is not a strict relationship between osteological mechanics and cultural or genetic capacities. However, an evolutionary trend affects all of humanity, creating isolates and phase effects once groups left nuclear zones. This was the case for the "European peninsula" during the Late Pleistocene (Wolpoff, Tattersall, Hublin, Stringer).

The long duration taken for this gestation and the extreme environmental variability of successively crossed landscapes attests to the great behavioral flexibility of the Neandertals. Hundreds of millennia passed without serious disruptions affecting either their anatomy or their apparently complete adaptive flexibility (Gullentops, Debenham, Van Kolfschoten, Richter, Parfitt).

Moreover, Neandertals have shown an extreme spiritual development, for example in the anticipatory preparation of their tools and their subsistence practices, in the importance accorded to plant materials and particularly in their burials and the ritualized behavior encoded in them. We even see, as at the gates of history, regional variations, such as responses to modes of oral transmission, specific to certain populations (Van Peer, Patou, Orschiedt, Kozlowski).

The period finally ended, a little like the migration of populations in historic periods, by both the introduction of new gene flow ("anatomically modern humans") and entirely géniques nouveaux (les "hommes modernes"), et par de tout autres traditions culturelles et techniques, telles les pratiques artistiques (Mellars, d'Errico).

Les débats eux-mêmes furent agrémentés de visites aux sites en cours de recherches actuellement: Sclayn, Veldwezelt et Goyet (Bonjean, Bringmans, Toussaint). Ces quelques jours ont conforté la conviction d'être déjà en présence de phénomènes historiques, et non seulement biologiques. Apparemment, les mêmes disponibilités furent atteintes par les Néandertaliens, mais ceux-ci y posèrent des choix culturels distincts et appropriés, tout comme chaque population procède encore actuellement, sous le poids de leurs traditions propres. Pas plus que l'histoire la plus courte, les modifications anatomiques ne furent statiques; elles se poursuivent encore aujourd'hui. Comme l'histoire elle-même, l'évolution doit être vue tel un processus et non un accomplissement. Devant de telles évidences, et grâce à notre lucidité renouvelée, il nous revient donc d'assumer notre double nature, biologique et culturelle, et de fonder des choix. Avec cette liberté, l'humanité reçoit la responsabilité de son destin: la préhistoire ancienne nous apporte ainsi une contribution à la morale, autant qu'à la connaissance.

S'il ne devait exister qu'une seule anthropologie (biologique et culturelle), elle devrait illustrer le passage progressif d'un état naturel où l'environnement "sélectionne" la biologie, à celui où précisément le développement de la conscience tend à libérer l'humanité de ses propres contraintes biologiques. Cette déchirure restera toujours active, quelles que puissent être nos illusions, mais le mode de rapports établis lors du colloque de Tongres est de nature à légitimer l'espoir d'une telle conciliation.

different cultural and technological traditions, including artistic practices (Mellars, d'Errico).

The debates that took place were embellished by visits to archaeological sites currently being excavated: Scladina, Veldwezelt-Hezerwater and Goyet (Bonjean, Bringmans, Toussaint). These few days of encounter have strengthened the conviction of already being in the presence of historical phenomena, and not only biological. These same freedoms were apparently attained by the Neandertals, but they made distinct and appropriate cultural choices, as each population does today, under the weight of their own traditions. Not more than the shortest history, anatomical changes were not static; and continue today. Like history itself, evolution must be seen as a process and not an accomplishment. Confronted with such evidence, and due to our renewed clarity, we must thus assume our double nature, biological and cultural, and to base our choices on it. With such liberty, humanity takes on the responsibility for its destiny: early prehistory contributes to ethics as much as to knowledge.

While a single anthropology (biological and cultural) should exist, it should illustrate the progressive passage from a natural state in which environment "selects" on biology to one in which the development of consciousness tends to liberate humanity from its own biological constraints. This separation remains active, regardless of our illusions, but the mode of relationships established during the Tongres meeting is of a nature to legitimize the mind to such a reconciliation.